Using Microworlds To Study Intuitive Battle Dynamics: A Concept For The Future

Henrik Friman and Berndt Brehmer[1]
Department of Operational Studies /The Swedish National Defence College
PO Box 27805, S-115 93 Stockholm, SWEDEN
henrik.friman@fhs.mil.se, berndt.brehmer.@fhs.mil.se

Abstract

Intuitive Battle Dynamics concerns the understanding of time. The rapid changes in today's society give us less time for reflection and thinking. A commander needs to develop sensitivity to the changes in the battlefield to be able to control the situation. To find out what sensitivity is needed and in a further perspective to be able to train command and control in dynamic processes we have used microworlds, i.e., computer simulations of dynamic tasks. The aim is to explore and develop the Commander's need for intuitive battle dynamics, which we believe, is essential for command and control in the future. This paper is about a concept of using microworlds to study intuitive battle dynamics.

1. Introduction

A military commander must be able to function in environments characterised by high uncertainty and time pressure. The concept of intuitive battle dynamics is a development of strategic thinking for dynamic situations based on non-linear knowledge. The aim is to prepare executives by improve their decision capacity in unknown situations, like chaos, crisis, and wars. A better insight and understanding for the dynamics of the battle field will probably lead to less uncertainty and better ability to exercise command and control. The central and critical dimension in a dynamic process is time. If we can create a better understanding of, and feeling for, time we can probably create a competitive advantage.

Most organisations work with a number of different time scales. At different organisational levels the executive works in different time frames. There the duration gets longer between action and detection of effects the higher up in the organisation. Executives at different organisational levels have different spatial scales to consider, different levels of control are needed to monitor these scales, which creates control problem of sheer magnitude. Concepts of the different levels of warfare have changed over the years in response to advances in technology, which today permit direct near real-time control over events. This has led to a form of war in the twentieth century that is inordinately complex and depends on the extensiveness of real-time command and control, which we had seen practised recently in the Bosnia conflict.

We argue that part of the problems when handling strategic time depends on the lack of adequate methods. By quasi-experimental environments and the creation of microworlds, we found a

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technique that could solve important parts of the problem of the mystery of strategic decisions. The task to create microworlds for strategic decisions is a cognitive engineering task. We are designing methods to support better cognitive functions, which requires supports both for the cognitive process and the social process in the staff. This development of specifications must be based on military analysis (e.g. Brehmer, 1998).

2. **Time as an essential asset that we have problem to manage**

Time has been shown to be an essential asset in management. We could in fact find that the main interest of executives concerning time is being on time and speed. "We have the information in the company, but we don't seem to get it to right place in time" or "We get information to the right place, but we could not choose fast enough"[2] and "We are okay at choosing what to do, but we are too damned slow. By the time we pull the trigger, the targets moved" (Fuller, 1993). These statements indicate the problem we face in management in the perspective of time.

Our studies have shown that executives normally talk about linear time measured by watches, but if time is so simple, why do we have problems controlling it? Time is one of the most complex dimensions in decision making and has be described as a source of fundamental surprise (e.g. Lanir, 1991). Discussions of time are abstract, and we often relate the time to specific events for making it more concrete. Studies have shown that it is differences between the objective time of what we all agree on and the subjective time of what we believe. In the processes of estimating events in the future we rely on our subjective time perspective (see prospect theory of Kahneman and Tversky, 1979). The differences between subjective and objective time can explain some part of the problem with managing time. By synchronising them we could become more effective.

Subjective time preferences are normally tacit and we need to make them explicit in order to be able to manage time and communicate time perspectives with others. To be able to manage time we need to be aware of the different time scales in the decision loop, such as the time between decision and action, between action and result, result and a new picture of the situation, and the time to make the decision. We have found in discussions with generals and executives in business that it is problematic to concretely discuss those different time scales and that the knowledge of the executives' subjective time preferences is still tacit, which makes it problematic to manage time in reality. We believe that part of the solution in managing dynamic processes is to make the subjective time scales more obvious and by creating a better time estimation of events in the future.

3. **To handle time in a military operation**

In history we found a great number of examples of the importance of an adequate understanding of time for the success of a military operation. We will here review some of the main concepts of how time has been used in the discussion of joint military operations

1.. Searching for speed – In the perspective of efficiency we often discovered attempts to make things faster than the competitors, sometimes to unreasonable costs. There is an assumption of optimisation and that it is a competitive advantage to act first. This assumption sometimes meets criticism with arguments about harmony. Statements like Sun Tzu's that the greatest

[2] In discussion at the 1999 Strategic Management Conference in Europe.

winner is he who wins without getting into battles suggests that Generals should searches for alternatives in harmony before running into battles.

2.. Time rulers of war – A common activity in staff procedures is to order activities along time rulers in certain orders to achieve the goal of the fight. This is a creation of a map with resources, geography and time. The starting points and deadlines normally give the framework for the planning procedures. Recently we have followed the discussion of command and control warfare that argued for breaking the enemy's decision loop, with the purpose to delay or paralyse his command and control system. We could here argue that this concept is an attack on time rulers by creating uncertainty that delays decisions. Time rulers are a key element for the Commanders to communicate their will on the battlefield.

3.. Timing – An example of timing is to gain time, which is to create situations that suit the Commander. The Commander tries to win time by delaying the development of events. This is a result of not being able to store time like other resources and that we need to control the processes to create time for other activities. Local superiority by power projection in time is another concept of timing, where a combination of forces is allocated to certain terrain in a certain time frame (Clausewitz, 1991). Timing is also essential in concepts like asymmetric warfare (see the concept of coping with the bounds Czerminski, 1998), manoeuvre warfare (Lind, 1985), and surprise.

All examples point to the need for command and control in the relevant time scales in military operations, and there are many different time scales on the battlefield. The time scales result from the time constants for the activities on the battlefield, and they cause friction. We can see friction as caused by delays of activities and feedback. We cannot assume that Commanders could become aware of all important time scales on the battlefield, but if he could improve the estimation of actual time constants by better an intuitive battle dynamics he would probably gain a comparative advantage.

4. **How can we understand time?**

In the attempt to understand time, there are basically two ways: case studies and experiments. The traditional way has been case studies, but a nation like Sweden has no own modern experiences in joint military. Military joint operations have proved to be a complex issue and it is not obvious that international experiences can be transformed to Swedish circumstances. We need to find other ways by using experiments to collect data. Earlier work has shown that simulation is an important tool in the analysis and modelling of complex work domains in combination with actual field studies. There is reciprocal and continuous relationship between field studies by means of simulations (Brehmer, Leplat and Rasmussen, 1991).

We have also found that few international case studies focused their attention on the problems of time. Most reports discuss the time perspective in terms of friction of the battlefield where delays are seen the result of dysfunctional systems. By transforming the insights from case studies into dynamic models, we are forced to make the time scale explicit. We, therefore, believe that it is necessary to use experiments with models in order to create a better understanding of time. The model will not necessarily give us the right time scales, but it helps us to think in time scales and consequences of its existence. The models will represent how we see different time scales and the relation between different scales.

5. **In strategic war-games time is not the focus**

In military issues there is a long tradition of using war-games to create decision support or to train officers. In these games the three geographical dimensions have been of central interest and time is taken for granted. The games can be run as open, i.e., all participants knows everything, or as closed games where you only know your own view. The games can be event-driven, or clock-driven.. The event-driven games are built on causality and activity, and results follow a rulebook. In clock-driven games there is a time ruler with all activities in order to be executed at the specific time and they are not dependent on the opposite forces activities.

In strategic games there is the problem of playing in real-time, because of the long time duration of the activities. To solve that problem, a *game time* is created. Normally the game is run in sequences in which events are played in environments where time stands still. After necessary decisions are made, the game jumps to the next time frame of interest. This assumes that there is no time pressure in strategic issues and that we have the time we need to make decisions and that there is no new essential information addition when we are making that decision. Both assumptions are highly unbelievable and risk giving a distorted view of reality.

In war-games the time scale is essential, but still very little emphasis is put on time management in strategic games. If we want to create an intuition of battle dynamic, more emphasis is needed to describe the time scales in the game. We believe that what we can learn is the relative time between two activities and thereby create strategic time awareness. Better awareness of time scales could give Commanders a better control of the dynamic processes.

6. **To create Intuitive Battle Dynamics**

There is no agreement yet about what the definition for intuitive battle dynamics should be. There is more of a hypothesis regarding what the characteristics could be like. We see intuitive battle dynamics as the tacit knowledge that helps the commander to handle dynamics in battle. It is a Commander's ability to see the dynamics of a situation and get the opportunity to predict the course of events.

We learn from Molke (in Simpkin, 1985) that there are two different forms of decisions; one before contact with the enemy and one after contact. We can describe these two forms in terms of planning before and accomplishment in contact. Before contact with the enemy we live in a dream where we believe that we can control the enemy by the plan, a process that in many ways can be seen as static. When we enter into combat we turn into a feedback relation where the plan in some aspect will be abandoned. This does not mean that plans are useless in combat, but we need a measure of openness to work outside the plan. "An officer's principal weapon is his mind" (US Marine Corps) and we need to act with emotion and intuition. This conclusion leads us to believe that there are two different contextual time perspectives in battles that Commanders need to be able to handle.

Enrico Quarantelli (in Lagadec, 1993) explained, with a military battle experiences metaphor, that an actor generally only has a limited amount of experience from which he or she will try to make generalisations. He said that military strategy is based not on war memories but on systematic analysis of the situation We can all think of interesting anecdotes, but that is not the

way you learn how to win wars. Subjective experiences from one point of view only are not necessarily representative of the organisation as a whole.

To succeed in a combat environment Commanders need to have situation awareness. This picture has four main dimensions, where three are descriptions of space and one describes temporal relations. To create the executive picture of the situation we then plot all information in those dimensions to create a map. Fuller (1993) points out that it is essential that all information be plotted in the same map to create holistic over views. This map is normally a static representation of the actual situation, delayed by friction in the system. It is already a historical picture, since *"The best way to predict the future is to invent it"* or as William Gibbson stated "*The future is already here but you are not able to see it yet*" (Hammill, 1999)

To enter into a pro-active situation we need to create pictures of the future. Researchers today have shown that there are signs of changes that could signal what will happen (Bond, 1997). The problem we face here is to see these signs and react. Many times there are at first no visible logical reasons so the judgement has to be made on other bases than rationality.

An important part of intuitive battle dynamics is to create conceptual pictures of the future based on the signs in actual situations and to formulate problems for the future. The conceptual pictures make it possible to visualise complex problems that support the understanding for the situation. Depending on the Commander's problem solving approach, he will act differently to solve this problem.

Microworlds

Microworlds are computer simulations designed for experimental purposes (see Brehmer & Dörner, 1993, for a full discussion of microworlds and their use). In experiments with such simulations, the subject is asked to interact with some system and to control its state for some period of time. The system may require the subject to extinguish forest fires, govern a developing country or a small town, or manage a factory (see Frensch & Funke, 1995, for examples of microworlds). The microworlds are not full fidelity simulations. In designing such simulations, it is important to avoid the "cat problem", i.e., the problem that the best simulation of a cat is another cat. However, the second cat will, of course, be as non-transparent and complex as the first cat, and we would learn no more when using the second cat than the first. Hence, microworlds must be simplified, and they are designed to relate to the systems that they simulate in the same way as wood cuts relate to what they represent. That is, we can see what they represent, and the essential relations and characteristics remain. Specifically, microworlds are designed so that they have three important characteristics of real world decision tasks:

- complexity
- dynamics
- and in-transparency

In the present context, dynamics is the most important characteristic. It means exactly what it means in physics, i.e., that we are simulating systems that have a memory and remember what we have done to them. There is a subsequent response and therefore changes, This is a function, both of the state of the microworld (as modified by earlier actions) and the current action.

Additionally, time is important. This means, first that the decision maker has limited influence over when he or she has to make decisions; they must be made when the state of the system requires decisions, rather than when the decision maker feels good and is ready to make the decisions. Second, considering time means that we have to realise that not only the system that we set out to control, but also the means that we use for control, must be seen as processes. In short, the essence of dynamic decision making can be seen as a question of finding a way to use one process to control another process. This brings the various delays: dead time, time constants and information delays to the fore, and the decision maker must be able to master the system with its delays (Brehmer, 1995). Finally, taking time into consideration means that it is necessary to consider all the relevant time scales in the task . In microworlds designed to help us study commanders' understanding of time, all these three aspects of dynamics must be included.

OpWar the first model

We had to create a mental acceptance for modelling and simulation, and develop a commitment to developing models in the education program. In the autumn of 1998 we created a meta-model named OpWar, operational war. This was the first model in what will subsequently become a series of models. OpWar is a conceptual model that describes war on an abstract level and has served as a demonstration and frame model in the education program at the National Defence College. The aim was to show an example of what could be done in microworlds and to get military officers attention paid to working with models in tools such as PowerSim® and STELLA®.

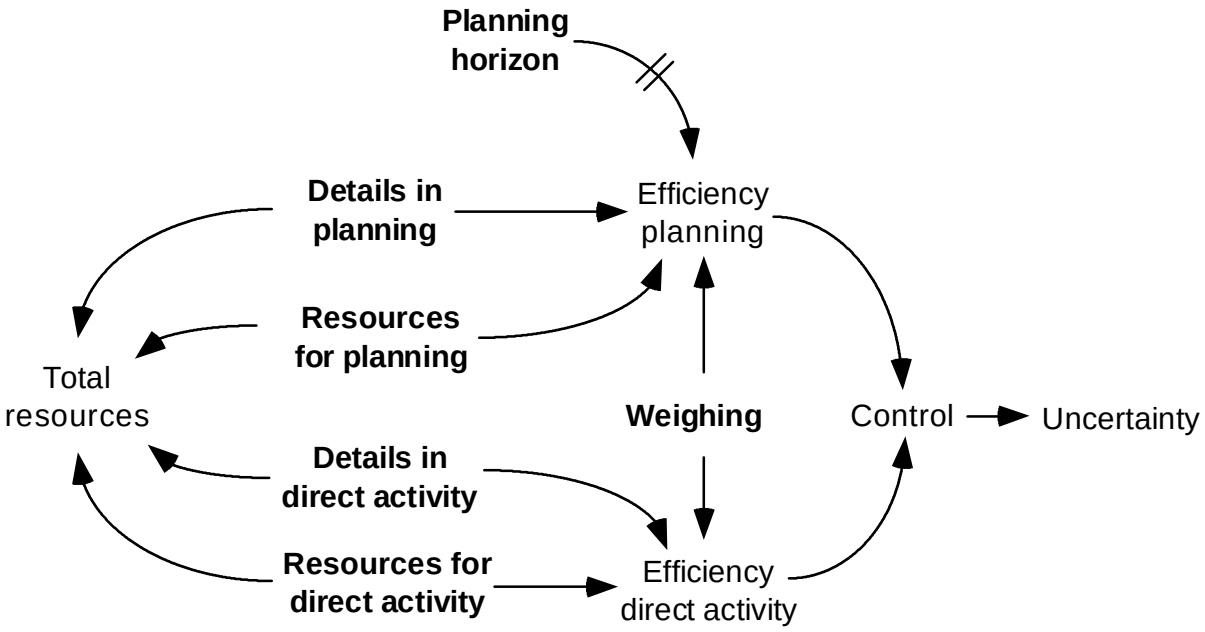

Figure - Causal loop of OpWar

Studies with the simulation should be seen as quasi-experiments in that we face a lack of control of the individuals. What actually happens in the model and the interaction between the persons and the model is logged, but how individuals reason and think is often hard to understand. In this study we focus on what the strategist has on his mind in different time perspectives and his time

awareness. We do this by studying how he uses planning horizons and sees delays in his activities. We are interested in his capability to have control in both retrospective and prospective time frames. The bold components in the model above are the six variables that the participants could affect in the simulation.

The subject can control the events by evaluating the six parameters of interest. Between each time step in the simulation the participants could change the parameters. As support there are two graphs; the total resources left, and the degree of control.

The microworld concept demands that we find the inner logic of the process. This logic is created by dynamic models describing the key elements, their relations, and power. This model gives the opportunity to study the rational part of processes. To study the irrational or non-rational part we need to observe what goes on in the context of the model, for example between participants in a group. Earlier studies have mainly focused on the result of the interaction with the model, but to be able to study intuition, we need to obtain data pertaining to the non-rational processes. Here, it is important to note that the interaction between participants and the microworld involves much more than simply what gets executed in the computer model. Much of the experience from running the model actually took place in the context of the model, and it is hard to observe and interpret in many cases. All thoughts about power projections, staying power etc take place in the mind of participants and it is necessary to make this explicit. As a first step we used questionnaires to measure the attitudes to time and interviews to interpret the results.

The prime results from running the model showed that we could not find any relations between executive experience and time perceptions or capacity to handle time in the model. Still there are indications that participants learn to handle the model, but it has not been shown that these experiences help the executives in their daily life. We believe that by focusing on the problems of time we create a consciousness for its existence and problems that participants later can transform into their own reality.

The students reacted and responded to the model saying, “the model did not describe the reality in practical terms“. Their task in class was now to create a sub-model to OpWar that better suited their view of reality. The only directive they got was that there had to be a connection between OpWar and their model, and that we were open to make changes in OpWar to support this connection. Their work gave us representations of their actual knowledge of the operational system. The models they create force them to show that they understand the circular causality of the function they model. The work with OpWar is an ongoing project that helps us to continue developing the knowledge of joint operational functions and issues.

Exercises to improve time perspectives could feed the development of microworlds at the same time as we educate. When staff members are able to exchange and share the different types of knowledge, a complementary and synergistic learning process occurs (e.g. Bennett III, 1998, experiences of top-management team). Similar conclusions were found at the international peace exercises at the National Defence College. Exercises were built on the basis of information from experts from many different organisations who came and shared their knowledge. These exercises have very little technical support today, and could probably be improved with the help

of supporting systems, for example to be a source of creating a knowledge database which can be used for research and education. We assume that the experiences from the microworlds studies can be useful for the development of the College educational programs.

7. **Next step in the project?**

We have in this study found that time is essential in the intuitive battle dynamics and that Commanders put most effort in building situation awareness on historical data rather than in creating forecasts. In the future we need to pay more attention to a structured way in futurology that could create executive pictures of the situation that includes dynamics for future trends. Focus has been on the design issue and further work has to be done on data collection and analysis. We believe that we have found a suitable design technique for this task that has at least five strong reasons to why we will continue using microworlds for studying the attitudes and behaviour of Commanders.

a.. The creation of microworlds gives *concrete pictures and representation* of the field of knowledge, which could have value in simulation with participants that, have documented experiences.
b.. A system that continues creates a *growing knowledge bank.*
c.. Microworlds give opportunity to *low cost flexible systems.* We could easily try new angles with greater investments.
d.. Models and parts of models could be transformed into decision support systems that give *dual use* to the organisation.
e.. Microworlds give the opportunity to run tests internationally to find differences in concepts.

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