# ADVANTAGES OF BATTLEFIELD SIMULATION SYSTEMS IN MODERN COMBAT TRAINING

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## ABSTRACT

*In the face of global cuts in defense budgets, simulation based training has been recognized as a solution that retains competency while reducing training costs. New tasks for armed forces, new scenarios, multinational structures, and restrictions in both financial and personnel resources including those resulting from environmental considerations require new concepts and solutions in the areas of military training, exercises and planning. The resulting loss of the 'reality' in conventional live exercises due to restrictions in the availability of supporting military personnel and other limitations caused by reductions in training grounds must be compensated for as much as possible through synthetic environment and modern simulation technology. Therefore, computer-based simulations, as training tools for effective planning, have become increasingly important.*
*Modern simulation systems should not have only one application, but should be used for both training and education and planning and analysis. This is important in relation to cost effectiveness and common databases for such areas as mapping, terrain, vehicle characteristics and tactics. Interoperability and reuse of battlefield simulations require the development of simulation systems which take into consideration the HLA (High Level Architecture).*
*This paper will present some experiences that Slovenian Armed Forces have recognized at the field of battlefield simulations and introduction of HLA concepts in the training of commanders and commander candidates, staff exercises and planning.*

## AUTHORS BIOGRAPHY

Tomaz SAVSEK was born in Novo mesto, Slovenia, on the May 11th, 1964. He received a BS in 1989, an MS in 1992 and a PhD in 1998 in the electrical science from the Faculty of Electrical and Computer Engineering, University of Ljubljana. He completed Officer Candidate School in 1997. He was a Research Engineer at the Faculty of Electrical and Computer Engineering from 1989 to 1992, during which time he conducted research on computer vision, pattern recognition and picture processing. Since 1992 he has been the Assistant Director for Education Resources-Information Technology at the Ministry of Defense. He heads a project for the development and construction of a combat simulation system for the Slovenian Armed Forces. His main research interests are System theory and Fuzzy set theory and their applications to battlefield models and decision support systems.

Marjan VEZJAK was born in Maribor, Slovenia, on the September 2nd, 1950. He received a BS degree in 1976, an MS degree in 1985 and a PhD degree in 1990 in the electrical science from the Faculty of Electrical and Computer Engineering, University of Ljubljana. He is a Professor and Research Assistant at the Faculty of Electrical Engineering, University of Ljubljana. His main research interests are System theory, Signal Processing, Ecological Modeling & Simulation and Sustainable Development.

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## 1 INTRODUCTION

Years ago, some experts from HQ Military Schools had the opportunity to participate as observers in a conventional live staff exercise. Beside other, we had the task of investigating ways of including current computer and simulation technology in the support of staff exercise preparation and command. I had to study how to adapt staff exercises and command and control procedures to a computer environment. During the exercise all was going smoothly until I became aware of a couple of details - the commander had, at a time previously agreed upon, ordered a helicopter squadron to engage in reconnaissance over a defined area around 100 km from the base. Half an hour later, the base reported that the order had been carried out and the helicopters had returned. I thought to myself, "They did that really quickly." An hour later, the commander ordered a tank unit to move from one location to another location approximately 50 km away. Fifteen minutes later a report was received that the tanks were in their new position. At the time I thought, "This is impossible. No tank in reality can move that quickly, let alone an entire tank formation."

This and similar situations, such as a certain unit is carrying out two tasks at the same time or fighting for several days with no casualties, led us to think about how current computer and simulation systems can support staff education and training processes. The decision was made to take some decisive steps in that direction regardless.

While this decision was being made, HQ Military Schools was in the process of establishing the Command and Staff School. One of the important justifications behind our decision was to give our officers, who would be going through specific forms of staff training, the opportunity to train and practice the staff procedures in effect in Western countries through current simulations.

## 2 PROJECT SSB

In 1994, therefore, we threw ourselves into the development of the "Simulation System of Battlefield - SSB" project, which had the following basic objectives:

- to investigate the place of military simulations in the world
- to develop new methods and models which can be used in battlefield simulations
- to establish contact with institutions involved in the development of battlefield simulations.

Our visits to several internationally known exhibitions and conferences (such as ITEC and IITSEC) which are, among other things, related to the area of battlefield simulations provided us with a variety of useful information about models (such as ABS2000, GESI, HORUS, ITT, JANUS and KIBOWI) which are already in use in some armed forces. Some of these models are commercially available, some are available through certain Alliance links (such as NATO, PfP) and some were developed primarily for use by a particular armed force.

Working with experts from the Faculty of Electrical Engineering, University of Ljubljana, we also developed several new methods which could be used in battlefield simulation models. Using Lanchester equations, we developed incursive control methods of battlefield modeling and compared them with classic control methods (Savsek, 1994, 1995b). We became deeply involved in the study of fuzzy sets and ways in which they can be used in battlefield simulations and for decision-making support. We also developed a fuzzy support system for battlefield decision-making processes (Savsek, 1995a, 1996a,b). In addition, we were able to make contact at that time with several institutions involved in the development and use of battlefield models. Through the PfP program, we were able to develop excellent relationships with the German Federal Army, especially their Center for Operations Research in Ottobrunn. They gave us the opportunity to

use HORUS, one of the many models which are used at this Center, in the implementation of staff exercises at the Command and Staff School.

## 3 CAXes IN SLOVENIA

In 1996 we carried out the first Computer Assisted Exercise (CAX) in Slovenia using the HORUS battlefield model. We were assisted to a great extent in the preparation and implementation of this exercise by German Federal Army officers, particularly in the methodological approach towards operator training and the preparation of operations plans which correspond to NATO standards. We had technical assistance from experts from IABG, the developers of the HORUS model. Our experts prepared all of the other equipment required such as Unix workstations, LANs and communications systems. Experts in geographical information systems, military operations, tactics and weaponry prepared all of the other data, including terrain, weapons, attrition, formations and battle plans, needed to carry out the exercise. All of the exercise preparation took three months. The methods of communication available through Internet were also used so that physical distance was no barrier to the successful implementation of tasks. Figure 1 depicts a schematic presentation of computer and communication technology that was used at the CAX in Ljubljana in 1996.

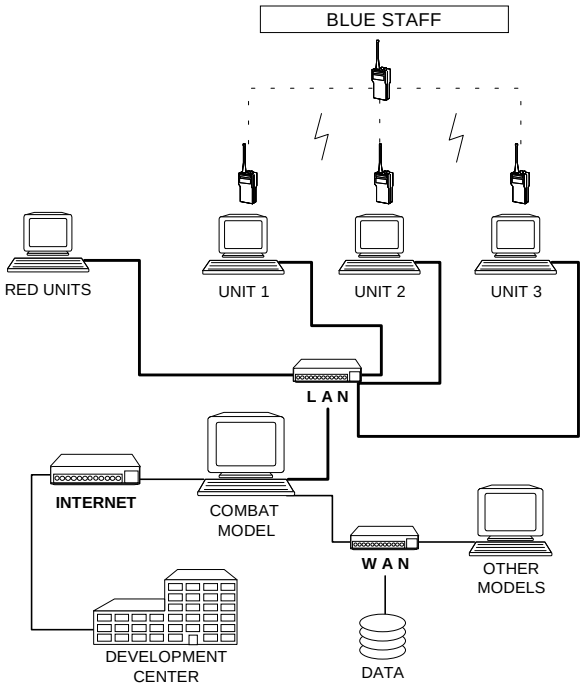


Figure 1. Schematic presentation of CAX

In 1997 and 1998 we continued our cooperation with these institutions. We prepared more joint computer supported exercises. All of these exercises were important in that we took a step forward each time we did them. Each exercise was more complex than the last in that data was defined more precisely, and we became more independent technically, organizationally and methodologically. As a result, in 1999 we were able to carry out our first exercise in which all of the elements, from planning to data preparation to implementation, were done autonomously. One very important characteristic of the HORUS system is that we are able to generate all necessary data by ourselves. Data concerning a 100 km x 100 km field can be processed through a standardized ArcInfo database in 6 hours by a program that has been developed by our experts: this significantly reduces the time and expense involved in the preparation of a staff exercise.

## 4 HORUS

HORUS is a simulation model which represents the combined arms combat of the army. It essentially portrays command levels up to brigade/division level. The simulated elements are: armored units, infantry, artillery, army aviation, engineers, air defense, command and control, communication, logistics, and air attack sorties. HORUS was originally developed as an analysis tool. In this use, it allows to evaluate the impact of changes in terrain, force structure, equipment and operation plan to the outcome of combat in short time. By adding a multi user interface, HORUS was made also to support brigade/division frame exercises - CAX (Knoll, 1999).

HORUS is used for analysis within OR studies and as a tool for (mainly) brigade-level exercises. A further application in the area of mission preparation and support is possible.

### a). HORUS for Analysis

HORUS is used in OR studies to investigate effectiveness, combat power, sustainability and command and control procedures of army units. The combat results yield, whether and how well the units can accomplish their missions depending on the equipment of friendly and enemy forces, the force structure of friendly and enemy forces, and the environmental conditions (terrain, infrastructure, etc.). Each alternative (e.g. different equipment) is then evaluated and put in a ranking order to be presented to the tasking organization (e.g. MOD). Usually there are

several replications of the same case to eliminate the stochastic effects and to receive statistically stable mean values.

**b). HORUS as a CAX-Tool**

HORUS is used in computer aided exercises in the phases preparation, execution, and evaluation. In the preparation phase the initial situation is defined and simulated to verify that the defined forces in the respective terrain can accomplish the requested goals of the exercise.

A multi user version of HORUS was developed which connects the simulation model with several GUI (graphical user interface) stations. At the beginning of the exercise the simulation transmits to each GUI station the initial situation and then every change of the ongoing situation. These information are filtered due to the needs of the GUI station and presented on the screen. Every response cell (RC) does its input of orders for their units to the GUI station. This input then is sent to the server and evaluated in the simulation. The RCs are usually connected to their superior unit via radio or military phones to report to them and to receive new orders or tasks. HORUS is usually set to real time mode during the execution phase. This means that one second of real-time is one second of simulation time. In the evaluation phase the postprocessors are used as they are for the analysis application. Especially one can use the so called HORUS-MOVIE. This is a program which reads the event file of the exercise and displays the course of action on the screen. This ensures the possibility of a fast replay of the whole exercise or of parts of it.

**c). HORUS for Mission Support**

Basically HORUS is able to support units during their "real" missions. The commanders could check alternative operation plans to find the best solution. The command agents of HORUS could support the planning to yield e.g. the best route of approach or the most effective positions.

## 5 ADVANTAGES OF CAX

In 1998 the SSB project was completed. Several conclusions have been reached as a result of this project. Our relatively small initial investment had led to our familiarization with the technology and methodology involved in the implementation of a computer supported exercise. Our own exercise confirmed the following advantages of CAX:

- significantly greater battlefield situation realism (fidelity), which takes into account time, space, military equipment and friendly and enemy force strength factors,
- greater enthusiasm for staff work among participants
- because individual qualities are taken into account, stimulation of both leadership elements and group work
- participants are able to take on responsibility for decisions and experience satisfaction for their own success
- training for both commanders and deputy commanders can be provided at the same time because each work with operator assistance at individual work stations.

The advantages of computer assisted exercises are also the following:

- less cost; fewer people are needed to implement the exercise, less time is required to prepare the exercise and it is unnecessary to use all of the equipment
- less damage to the environment; no contamination, pollution or erosion of earth, air or water
- training is moved from the field to the classrooms; Slovenia has very few training areas available for the implementation of larger exercises, which makes classroom-based training essential.

Of course, computer assisted exercises cannot replace staff exercises entirely. Certain exercise segments will always need to be carried out in the field. However, an exercise as a whole can be carried out through simulation, and certain segments which were unclear or could not be carried out effectively can be implemented in the field. This is especially true of infantry exercises, which are very difficult to simulate on computers.

With this in mind, we are currently planning to link military simulation systems with field exercises. Slovenia has developed the LATRASYS (LAser TRAing SYStem), which makes infantry battlefield simulation possible through the use of laser transmitters and receivers. Linking these two systems together would make it possible to carry out staff training on a battlefield simulation system and unit training in the field at the same time. The simulation system would operate on principles and standards similar to that of HLA.

## 6 ADVANTAGES OF CAX OVER CLX

During battlefield simulations the following factors should be considered: the human factor, terrain,

equipment and time. In computer supported exercises, the human factor is still the main factor of the combat operation. Man cannot be replaced with a machine or a simulator. The only purpose of the battlefield simulation is to set combat within a virtual battlefield which simulates the real battlefield situation as much as possible. Simulation of the battlefield and the equipment used within a simulation timeframe forms an environment which gives the commander the feeling of reality, satisfaction and responsibility in decision-making.

The outcome of the battle in a real battlefield situation is strongly influenced by battlefield factors, which have to be taken into account; i.e. included into the simulation during the training or conduct of exercises. The level of reality of an exercise increases when all these factors are included. Let us have a look at the role individual factors play in a conventional; i.e. computer supported staff exercise:

- *Human* factor plays a crucial role underin any situation. Command posts monitor the course of action in the battlefield and, in accordance with orders and their own perception make decisions which reflect on the situation in the battlefield and the position of the subordinate units.
- *Terrain.* In conventional live exercises (CLX) the terrain is represented by conventional military maps, whereas in computer supported exercises it is represented by a digital terrain model. This includes relief, visibility, mobility, vegetation; i.e. all of the terrain related elements. The more detailed the model, the greater similarity the simulated battlefield bears to the real terrain.
- *Equipment* is a factor that is practically ignored in a conventional exercise. Simulation and the usage of the equipment in a computer supported exercise depends on the model used by a simulation system. More detailed parameters affecting the equipment operational capabilities (range, mobility, type of ammunition, probability of hits and destruction and sheltering) increase the effect of reality in the battlefield simulation.
- *Time* is a very significant factor which introduces dynamics into battlefield operations. In a conventional command post exercise, time is presented mainly in the form of time periods. In a computer supported exercise, simulated time which can equal real time is used. It some cases the simulated time can be sped up. Thus, we can make jumps in time to skip the less interesting action in the battlefield. Time can also be stopped and moved backwards to a particular point in time.

If we compare a conventional command post exercise, a computer supported exercise and real combat, we can conclude that, in terms of similarity to a real situation, a computer supported exercise is half way between a conventional exercise and a live combat. The purpose of both conventional and computer supported exercises is to train commanders and their staff. The objective of these exercises is to acquire skills and knowledge which are needed for an action in a real combat situation. Table 1 gives a schematic presentation of combat situation factors in a conventional exercise (CLX), computer assisted exercise (CAX) and live combat (LC). (Savsek, 1997, 1998)

| | CLX | CAX | LC |
|---|---|---|---|
| Human factor | yes | yes | yes |
| Space | conv. map | dig. terrain | yes |
| Equipment | no | yes | yes |
| Time | no | yes | yes |
| Skill | objective | objective | fact |

Table 1. Factors of a combat situation

Computer supported exercises can be conducted as seminars, classroom and lab exercises or command post exercises. During most simulation based exercises commanders and staffs are located in real command posts (or in vehicles or shelters). Supervisors are situated in a simulation center where they work with computers. These supervisors represent subordinate, superior or participating units depending on the command undergoing the training. The communication is established through communication lines used in real action (telephones and radio communication) Based on defined regulations that are enabled by the computer simulation, the supervisors provide the staff with the feedback. This allows for more interaction between superior command and subordinated units, a higher level of reality and action in response to feedback than in a conventional command post exercise. Figure 4.5 shows a diagram of a computer assisted command post exercise.

The course of action during a battlefield simulation exercise can be reduced to the game of chess with the following features:

- the digital terrain is a chess board

- subordinated units are figures on a chess board. They can move and destroy the others in compliance with the rules of modern combat
- moves are made interactively
- "the players" cannot see the entire battlefield but only what terrain or intelligence allows them to see.

Both live and virtual (computer simulated) environments have advantages in terms of training. The live setting realistic, hands-on and physically exhausting, but it rarely provides realistic weaponry effects. The virtual setting lacks some realism, because of limitations in the ability of simulations to view the battlefield, but it allows training in activities and procedures that cannot be done elsewhere. In addition, major advantages of virtual simulations training include:

1. Flexibility: Simulation exercises can be tailored to meet specific training needs of particular units or to compliment events.
2. Battlefield simulations also greatly reduce the cost of training.
3. Unexpected outcomes during battlefield simulation exercises allow for the refinement of problem solving techniques and the close examination of a unit's staff procedures.

## 7 SLOVENIAN SIMULATION CENTER

The Slovenian government has a good cooperation with the American government. The Warsaw Initiative has made possible many opportunities, including the purchase of the JANUS simulation system, which is primarily designed to provide computer supported staff exercises at the battalion level for command and staff officer training. The American government offer includes not only the system itself (i.e. software) but also the appropriate equipment, training of system maintenance and operator staff and consultation in relation to the development of a simulation center.

As a result, more concentrated effort has been put into the development of a simulation center in 1999. In order to accomplish this, the following needs to be done:

- systematic organization of a simulation center under the auspices of HQ Military Schools - thus far, the entire area of military simulations has been dealt with on a project basis
- construction of a simulation center facilities
- designation and promotion of a simulation center.

The reason for our decision to locate the simulation center within the HQ Military Schools infrastructure is that we already have the HORUS system, from which we have gained valuable experience and insight into military models, battlefield simulations and computer supported exercises. HORUS is a battlefield simulator designed to monitor computer supported staff exercises at brigade-level and higher. Because this system is so open and so easily adaptable, it also functions as a strong analytical tool for carrying out operational research, planning and analysis. With these two simulation systems we will be able to cover both the tactical (JANUS) and operational (HORUS) training level areas for Slovenian officers.

## 8 CONCLUSION

Currently HQ Military Schools' greatest concern is how best to improve the level of education and training in our military education programs and the command and staff abilities of the Slovenian Armed Forces. There is no doubt that this can be achieved through the establishment of a simulation center, where, through battlefield simulations, a realistic training environment in the areas of tactics, operations and staff work can be created and made available to military school and command participants. In this way particular commands can test their battle plans and arrays and play out particular military scenarios on a battlefield simulator. Computer supported staff exercises are the most up-to-date form of training. Today many armed forces use this form of training at higher levels of command training in the coordination of joint alliance command work. Individual segments of such training are carried out "live" at lower levels. The development of a simulation center is clearly an important step in the direction of bringing military training and practice in the Slovenian Armed Forces up to modern standards. Locating the simulation center within the HQ Military School infrastructure would not be an accident of chance. Many centers of this type are located within the military educational infrastructure of other countries, because they stimulate both pedagogical and research work.

## 9 VISION

The simulation center which has been mentioned would primarily be used for training Slovenian Armed Forces officers enrolled in continuing education and training courses in the Command and Staff School. It would also be used for training Slovenian Armed Forces military units. Given the increased need for this form of training, new simulation centers will be developed within particular operational commands.

Our future efforts will be directed towards the formation of an international simulation center, which will make the following possible:

1. the inclusion of Slovenia into international computer supported staff exercises
2. the implementation of computer supported exercises for peace support operations staff and support from participants from neighboring countries and the region

Technically, this will be possible through the use of principles determined by HLA. Slovenia is following developments in this area closely in order to meet this objective. We have a permanent delegate to the NATO LG.8 group, which is involved in the issue of simulations interoperability and has been designated officially as responsible for HLA standards development for NATO, STANAG HLA. This will make it possible to carry out developments in this area, because it will assist us in the planning and development of military

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