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# PLANNING AND PREPARATION OF COMPUTER ASSISTED EXERCISES

*The article states rationale for conducting computer assisted exercises and analyses their integral parts. Combat modeling, military simulation, CAX planning, and execution related issues are elaborated.*

***Keywords**: simulation, computer assisted exercise, model, training audience.*

## Problem statement

Military education is defined as the permanent process of examining the staff, units, and force components with regard to their capabilities to conduct a given mission or task effectively and efficiently. It also investigates the validity and reliability of systems, procedures, programs, and objectives. It includes analysis, assessment, feedback, and lessons learned. Military exercises prepare commands and forces for operations in peace, crisis, and conflict. Therefore, the aims and objectives of military exercises must mirror current and anticipated operational requirements and priorities [1].

The execution of training, which demands the movement of units, is more expensive not only because of transportation costs but also because of costs for military activities on the training area, consumption of fuel, and maintenance of the training equipment. The need for response forces is often given on short notice, which is a critical factor of a quick response. This factor is especially important for the countries that are sending forces to areas with complex emergencies. Military, police, and civil components can use the same information technology (IT) and communication techniques to decrease training costs and support unity of preparation for the peace operation. All these reasons contribute to the decision for using simulation models to support command post exercise. Whenever computer simulation modeling is included in the exercise process, planners are conducting computer assisted exercise (CAX), which does not deal with environmental risk management. The main training area is a synthetic environment where all planned units are displayed by a simulation model.

## Objective formulation

The article is aimed at examining rationale for conducting computer assisted exercises and analysis of CAX planning and execution related issues.

## Main part

***Definition of CAX.*** A CAX can be defined as a type of synthetic exercise (SYNEX) where forces are generated, moved, and managed in a simulation environment based on the commands from the exercise participants. Therefore, CAX support is often thought to be limited to installing and running a military constructive simulation during a CPX. In this example, CAX support is used to replace or to help response cells, higher level commands (HICON), and lower level commands (LOCON) to evaluate the possible outcomes of the decisions or requests coming from the training audience (TA) by running a set of stochastic processes. However, CAX is in essence a CPX where electronic means are used as follows:

- to immerse the TA in an environment as realistic as possible;
- to help the exercise planning group (EPG) and the exercise control (EXCON) staff to control the exercise process so that it achieves the objectives as effectively as possible.

Therefore, the definition of CAX should not be limited only to the usage of modeling and simulation. CAX ensures the high quality of individual and collective training on decision-making processes on tactical, operational, and strategic levels. The application of simulation models on CAX represents an educational method, which dynamically introduces the operational conditions of real systems in a synthetic environment. A dynamic training system consists of digital terrain and equipment that allows the exercise participants to gain new knowledge, skills, and behavior. Each CAX is also a research method, because it introduces and instructs the following lessons:

- novelty of the problem;
- Importance and applicability of solutions for the practice;
- level of interest in problem-solving processes
- available equipment and other research conditions;
- actuality of research results;
- possibility to find solutions for the decision-making problems by research.

Through the process of CAX, we are undoubtedly optimizing current staff procedures and decision-making processes in synchronization with all other stakeholders in the area of responsibility.

Simulation justifies itself, perhaps the best for military, because it reduces the cost of training considerably. Simulation is also the only way to test and train for some special environments, such as nuclear events, biological and chemical contamination, and operations that require large-scale mobilization and movement. Creating and maintaining such environments is simply impractical in real life without interfering with natural life. These hostile environments also imply casualty risks even within training. Therefore, simulation is not only a cost effective approach for military training but also is the only practical and safe way for testing and training in special and hazardous environments. Military constructive simulation system constitutes the core of a CAX [2]. The definition of constructive simulation states that the people operating the simulated systems are also simulated. However, real people enter the commands to stimulate these simulations. Constructive simulations are designed to find out the possible outcomes of the courses of action taken by the real people. They are constructed by many models, and often stochastic processes calculate the results of interactions between the entities or units in a theater.

***CAX Rationale*** Computer Assisted Exercise is a way to train commanders and staffs in military maneuvers. In basic terms, a CAX is a computer war game.

To perform a CAX, a computer model imitates conditions requiring military action. The commander and the staff direct the actions that take place within the game just like a chess player strategizes moves on a chessboard.

*Purpose of a CAX*

The basic purpose of a CAX is to train staffs.

During a CAX, the staff focuses on:

- performing procedures;
- decision making;
- applying doctrine, tactics and techniques.

A CAX provides operational staffs with events to improve Command and Control (C2) skills.

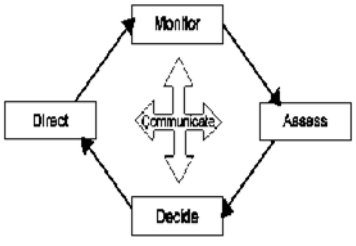


*Fig. 1.* **Command and Control Process**

The two primary benefits of using a CAX for training are:

- realistic staff training in a "stressful" environment;
- lower training costs. (e.g. less troops in the field, planes in the air or ships at sea).

Training Method

The following conditions help determine if a CAX is the correct training method.

- *Training audience* - Who needs to be trained?
- *Training objectives* - What are the expected outcomes of the training?
- *Scenario* - What is the situation that needs to be trained?
- *Area of Operations* - Where are the operations to take place?
- *Location* - Where are the people that need to be trained?

The components needed to conduct a CAX are:

- Modeling and Simulation (M&S);
- Command and Control (C2) Systems and Architecture;
- Communications Systems.

A computer model uses a database of land, air, and sea activities to depict military operations. All of the wargame "playing pieces" and the "game board" are stored in the computer model.

Computer controllers manage the information in the database. The controllers move the "playing pieces" in response to orders from their headquarters. They also react to events occurring in the simulation.

Modeling and Simulation information is displayed to the training audience on various C2 systems. The C2 systems used by the training audience in a CAX should be the same systems used by the training audience participants in real world operations. Information shown on the C2 systems is relayed up and down the chain of command by various communication tools. The communications system is made up of the cables, wires, equipment, and procedures. This system or network allows exercise participants to "talk" to one another. Examples include: phones, computers, webpages, email, secure transmissions, video teleconferencing.

The people that play in the war game are known as the exercise participants. There are two types of exercise participants:

- training audience participants;
- EXCON participants.

The EXCON structure should provide training conditions and deliver training operational content. It has both direction and control functions that allow it to establish the conditions necessary for achievement of the exercise aim and objectives and training objectives (TOs) by the TA. As the chief of EXCON the exercise director (EXDIR) may steer exercise play – in both direction and tempo – as necessary to enhance learning opportunities, reinforce key lessons, and achieve objectives. He or she also has the authority to terminate,

modify, or suspend an exercise or parts thereof if concerns for safety of participants or others dictate. In the event that the TA is established in dispersed locations, it may also be necessary for EXCON to disperse its elements to provide the most suitable coverage, assistance, and control.

Within NATO, an Exercise Control Group/Directing Staff (EGG/IISTAFF) performs the exercise control function:

-provides realism to the exercise;

- ensures simulation and scenario are presenting the same picture;

- tracks completion of scenario events and training objectives;

- steers the scenario to make sure training objectives are completed.

The ECG/DISTAFF manages the presentation of a CAX simulation. Main tasks performed by the ECG/DISTAFF are:

- building the scenario;
- controlling the flow of events;
- recording exercise data;
- managing the CAX models.

The training audience is the focus of an exercise. The training audience is made up of commanders, staffs, and subordinate forces working as part of a joint, combined, or multinational force.

The training audience is divided into two groups, primary or secondary. The primary training audience performs roles and responsibilities that are linked to the exercise objectives. The secondary training audience helps the primary training audience complete their exercise objectives.

The friendly forces Commander and staff playing in a CAX have real opponents. The opponent or opposing force (OPFOR) is made up of actors or role players. During a CAX, Commanders and staffs execute operations plans and orders against a "thinking" OPFOR. The "opposing force" may be natural disasters (e.g. famine, drought, hurricanes, etc.) or hostile forces seeking to prevent the friendly forces from accomplishing their mission.

Fundamental elements are basic tools necessary to conduct a CAX. The CAX fundamental elements are listed below.

- scenario;
- computer models;
- technical architecture;
- common operating picture (COP) ;
- Master Events List/Master Incidents List (MEL/MIL) ;
- control plan;
- documented procedures;
- AAR.

The main tool for providing training conditions on a CAX, as described previously, is a realistic scenario, which is a description of fictitious conflict developments and all involved parties. The scenario enables data for computer modeling. Thus, the main focus of the exercise scenario is artificial conflict or unstable interactions among societal security dimensions of a synthetic environment, which leads to war. A CAX revolves around a scenario. A scenario script or storyline sets the location, identifies the players, and describes the events leading to this situation. It describes a situation that requires a military action. The scenario is based on training and exercise objectives.

A computer model gives life to the written script. Models allow exercise participants to perform the activities and movement of friendly, neutral, and opposing forces. The model stores all of the objects necessary to play the wargame in a database. The reaction and results to the activities and movements are sent to the training audience by real-world C2 Systems. The kind of training and the resolution of the training determine what computer model is used in a CAX. Once the model is selected, the database must be built. Database building is a time complex task, yet critical to the conduct of a CAX. Database objects and a deadline date need to be identified early in the CAX planning phase. Every object that can be used in the selected scenario must be built into the database. Examples of objects are troops, weapons, supplies, equipment, and vehicles. However, database objects also include roads, bridges, railways, land masses, and bodies of water.

The technical architecture is all the equipment and communication connections needed for all locations to "play" in the wargame. Usually, a CAX is run from a base facility. The information from the base facility is sent out to remote facilities. To allow exercise participants at the remote facilities to interact in the wargame, model information must be sent to their location. This is done through C2 systems and Communications systems. The remote locations and the base facility must be connected to the model. Wiring and equipment must be acquired and placed at both locations. The C2 systems must be connected to all locations. Each site must also have all the communications tools they need to "talk" to each other within their own location and with other locations. The communication system includes all the wires, cables, and equipment.

A Common Operating Picture (COP) is a tactical picture. It can be in the form of a map with attached symbols or an electronic display. The images displayed on the COP depend on what position you are playing in the wargame. If you are friendly forces, you will see where you are, what you are doing, and what you think or perceive the opposing force is doing. If you are the

opposing force, you will see where you are, what you are doing, and what you think or perceive the friendly force is doing. If you are the ECG/DISTAFF, the ECG/DISTAFF COP shows exactly where both sides are and what actions they are taking. The ECG/DISTAFF's COP is the real truth of the situation. The ECG/DISTAFF watches the actions and movements of both forces. Watching the actions and movements of forces allows the ECG/DISTAFF to adjust the wargame, if necessary.

The Master Events List/Master Incidents List (MEL/MIL) is a list of situations designed to cause a reaction from the training audience. The MEL/MIL is an Exercise Control document, which the training audience will not see. The events in the MEL/MIL guide the training audience to accomplish their objectives.

Training objectives are determined during the CAX planning phase and capture what the training audience wants to **know, do,** or **improve** during the CAX. These objectives determine what events need to take place in the scenario.

The training objectives guide the observer/trainers and analysts in their data collection efforts and serve as the main areas addressed in post exercise reports.

The next step is to develop a concept for CAX processes in terms of planning, preparation, execution, and analysis.

Qualitative and timely planning and preparation of the exercise are origins for execution of all kinds of exercises in particular for CAX [3]. Planning has to take in account logic of planning procedure; the following actions must be performed by exercise planners:

- study and analysis of the concept and conditions for the exercise execution;
- definition of purpose, exercise, and training objectives;
- determination of exercise participants;
- production of EXPLAN;
- planning of logistic and financial support.

Although the planning is a separate activity of planning teams, it has to be synchronized with the four exercise training phases. The Exercise Process consists of following four stages: exercise concept and specification development, exercise planning and product development, exercise operational conduct, and exercise analysis and reporting.

Important milestone in the planning process is the main planning conference (MPC). A working methodology consists of syndicate discussions, where participants from all exercising HQ exchange their views on developments of organizational and conceptual preparations for the execution. Usually, the MPC is an opportunity to finalize most supporting exercise plans and planning products. After MPC, the EXPLAN and products should be finalized. The final coordination conference (FCC) is dedicated to the final confirmation of readiness for exercise execution from an organizational, conceptual, and documentation point of view. This conference is the last opportunity for the training audience to express additional interests and proposals for influencing the exercise design before the start of the CAX. Following FCC, The Chief master events list/master incidents list (MEL/MIL) is organizing with the event managers, scenario group, and CAX simulation experts at the MEL/MIL incident development conference and the MEL/MIL scripting workshop. Both events are dedicated to the development of MEL/MIL, which represents future developments of the exercise scenario and provides appropriate conditions for achieving training objectives during execution of the CAX. The STARTEX validation is basically the transfer of exercise incidents to the simulation model and the synchronization of CAX data bases with a desirable chain of exercise incidents.

The Exercise scenario provides conditions for computer simulation modeling of natural and societal processes in a holistic way. The entire process should ensure the timely recognition of societal deviations, correct procedures for their stabilization, and objective analysis of affected society. CAX ensures that training audiences can observe the effects of their own decisions and can improve or adjust the exercise decision-making process to the circumstances of the artificially affected society. Proper computer simulation of a contemporary operation demands common understanding of the international security environment, characteristics of the area of complex emergency, and peace force procedures in rebuilding the local society in the area of responsibility. Modern national security is a part of wider international environment, where security, beside states and their alliances, is more and more in the domain of a global security system. The contemporary security is in wider sense multidimensional and consists of political, economic, demographic, social, and environmental dimensions. International peace operations are a functional part of both national and international security planning, which means inevitable cooperation with the structural elements of UN is required. Thus, exercise scenarios need to cover all the above-mentioned dimensions and the interactions among them. The international community has to perceive, in timely manner, the critical circumstances in certain region, to understand the root causes of the conflict and to decide and plan the intervention with the peace forces as a security instrument. Recent crises in the world suggest that the UN is still the main security provider for the crisis areas. The Exercise should explain social economical unevenness among social groups, violation of political and human rights, demographical pressures, legitimacy of political authorities, distrust among ethnical groups, absence of

independent media, and other societal issues. The most important condition for the CAX is to use the security information about the affected society in the physical environment with the geographical location. The geographical conditions for execution of the operation have a crucial impact on peace forces' preparation and also on the establishment of a common understanding on the history, habits, mentality, and culture of the affected local societies. With the respect of previously described information the origins for peace operation scenario in an artificial environment are in place. The scenario provides the initial conditions in simulation model, which requires a transfer of all stakeholders in the area of peace operation, to synthetic environment, where we can simulate and control interactions among them. Theoretical development of a scenario is not focused on 'what will happen', but rather 'what are the necessary and sufficient conditions for a given result to be obtained?' [4] In practical terms this means, that the CAX is more focused on the outcome of the coordination processes, which leads to the desirable end state in the area of operation. The natural progression from the initial exercise scenario is MEL/MIL development process.

The MEL/MIL development process has been established because of the technological underdevelopment of simulation models. Most models are primarily focused on cold war, pure combat warfare, or kinetic engagements. But the real life does not care about simulation model weaknesses. Contemporary operations deal with the society in its entirety, and in particular with the kinetic warfare. Thus, the MEL/MIL has been used as a tool for covering automatic event generator gap, which uses the scenario as its basis MEL/MIL should include all injects provided to the TA, from the initiating directive that starts the crisis response planning phase, the situation updates prior to the command post exercise, and through to the end of the exercise (ENDEX). Thus, the key requirements of those drafting the MEL/MIL will be the approved EXSPEC, the scenario outline, and the approved training objectives. The scenario and MEL/MIL groups will usually hold their meetings during the exercise planning and product development stage [5].

Combat models are generally fixed, which means that they are not modified for each exercise. However, combat model data needs to be populated, then carefully verified and validated for each exercise. This major effort requires the involvement of both technical and operational staff from various parties. It is not always necessary to change the data in all of these categories for every exercise. Model data are rarely modified for exercises. Environment data is also typically fixed, as long as the geography for the exercises does not change (Table 1). Prototype data are relatively dynamic, prototype data is generally limited. The most dynamic data are the exercise data, which need to be populated almost from scratch for every exercise.

*Table 1*

**Combat model data**

| Category | Sub-category | Example data items for sub–category |
|---|---|---|
| Model data | Modeling parameters | – Random number seeds and distributions<br>– Model-related parameters |
| | Lethality data | – Point hit and kill probabilities<br>– Area kill probabilities<br>– Lanchester coefficients |
| Environment data | Terrain data | – Terrain features<br>– Elevation data<br>– Obstacles, buildings, etc. |
| Prototype data | Prototype data | – Unit types<br>– System, (i.e., equipment and combat systems and types) |
| Exercise data | Unit and system data | – Individual systems<br>– Individual units<br>– Command hierarchy<br>– Logistics relations |
| | STARTEX data | – Initial unit and system locations<br>– Initial unit and system status<br>– Unit and system arrival times |
| | External event data | – Types and times for external events |
| | Weather data | – Weather fronts<br>– Weather conditions<br>– Sun set and rise times |

***Execution*** The exercise process begins with

Phase I – Academics, where the training team provides requested lectures on procedures for participation of the military forces in Crisis Response Operations and on the Operational Planning Process. Phase II – OPP follows the theoretical preparation of the TA. During the mission analysis of a certain area of complex emergency, the TA performs operational planning process activities to create a concept of operation (CONOP) and operational plan (OPLAN) [6]. OPLAN is important for the Phase III – Execution, because it offers content for a joint coordination order (JCO) or coordination directives for TA during CAX. For Phase III, the CAX has to have a proper exercise functional elements or structure. The TA is the center for all activities, where the exercise director (EXDIR) and exercise control (EXCON) provide requested exercise conditions. The TA will conduct activities in accordance with the appropriate policies, doctrine, and processes as well as directives and their standard operating procedures (SOPs). So CAX has main elements (Figure 2), which help to activate the TA to fulfill TOs, which include:

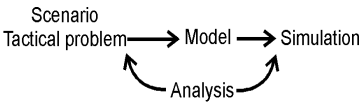


*Fig. 2.* **Elements of CAX**

scenario, injects as a tactical problem, model, simulation, and analysis. As was described previously computer simulation support, with its hardware and software, is essential for the preparation, execution, and analysis of the exercise. During execution, the simulation model presents interaction among entities, individuals, and structure in a synthetic environment. At the same time, it ensures data stream for communications (text, picture, and sound) between the TA and EXCON in real time. The generic execution process of CAX starts with the preplanned inject from injector, which is received by the TA. A serial of injects should create an operational pattern for the decision-making process and provide enough information for the TA campaign as well as an operational and tactical assessment of the situation. Training teams observe joint coordination processes on the remote site, and together with the Exercise Centre observations, the teams provide a concise picture to the EXDIR, which includes what happened and what needs to be modified to steer the CAX toward desirable TOs. For the analytical purposes, the simulation model saves all initiated activities and exercise data for the quantitative and qualitative analysis of TA reactions on different exercise injections. At the end, it is possible to run comparative analysis of exercise events, with the TA decisions in exercise time and space. The primary goal of CAX is interaction among TAs during the decision making process and their exercise products (JCO, FRAGO, analysis, etc.). The entire working process on CAX is connected to the theoretical origins of the decision-making process and its practical application. The simulation model presents the quality of TA decisions through the interaction among terrain databases and operational components, and integration with the assessment of the EXCON.

***Analysis*** The exercise analysis is Phase IV in the overall exercise process, and it is the most important phase. The main task for this CAX activity is to provide to all CAX participants the observations and information in the form of an after action review (AAR) support package (Figure 3).The exercise analysis begins with the collection of observations and conduct of evaluations as well as assessments compiled throughout the exercise process [7]. It includes post exercise analysis and reporting by the TA to the Officer Conducting the Exercise and supporting organizations in accordance with requirements and procedures established in the EXPLAN.

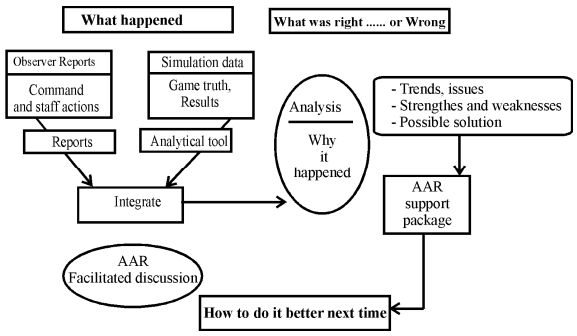


*Fig. 3.* **After action review process**

Three categories of data and information should be used to support exercise analysis and reporting as described below. The EXPLAN should set the requirements, timings, and responsibilities for collection, archiving, and appropriate distribution of each category. There are two major categories of exercise analyses and reports – those that address the performance and accomplishments of the training audiences and those that address the planning and execution of the exercise, analyses of specific objectives, or experiment aims. Throughout all the training phases of the exercise, the TAs should be making, collecting, and processing observations in accordance with their command lessons learned program. The messages, decision briefings, video teleconference (VTC) tapes, records, and reports that are produced by the TAs during the course of the

exercise should be archived for exercise analysis and reporting purposes. These documents may also be examined by analysis and evaluation teams in pursuit of identification and justification of potential recommendations for improvement of doctrine, SOPs, and so on. The command diaries and battle logs of events and decisions are an essential tool for the preparation of the TA first impressions reports. Data from command and control as well as from common operational picture systems should be periodically copied and archived for post exercise analysis and reporting purposes. The requirements for back up and archival of the operational data should be laid down in the TA HQs' OPLANs. The EXPLAN should establish the specific requirements for EXCON staff together with evaluation, analysis, and experimentation teams to collect data and information as well as record their observations and comments throughout the entire exercise process.

At the end of each exercise day, the daily results should be added to the analytical model. The total sum of all capability indexes at the ENDEX shows TA's efficiency in the given exercise time and space.

## Conclusions

The use of simulation models:

- permits decision makers to determine nearly all the outcomes of the war game;
- enables the effects of plans, tactics, or doctrines to be tested in a variety of environments by repeating and replaying the scenario;
- ensures improvement in the decision-making skills of TA;
- decreases expenditure;
- increases security for participants;
- protects the natural environment in the long term.

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**ПЛАНУВАННЯ ТА ПРОВЕДЕННЯ КШН ІЗ ЗАСТОСУВАННЯМ СИСТЕМ ІМІТАЦІЙНОГО МОДЕЛЮВАННЯ**

Р.В. Казмірчук, Є.В. Рижов, О.М. Совгар

*У статті надано аналіз командно-штабних навчань із застосуванням засобів імітаційного моделювання й етапів їх проведення. Також розглядаються їх основні компоненти та особливості планування.*

***Ключові слова**: командно-штабні навчання із застосуванням засобів імітаційного моделювання, імітаційне моделювання, модель.*

**ПЛАНИРОВАНИЕ И ПРОВЕДЕНИЕ КШУ С ПРИМЕНЕНИЕМ СИСТЕМ ИМИТАЦИОННОГО МОДЕЛИРОВАНИЯ**

Р.В. Казмирчук, Е. В. Рыжов, О.М. Совгар

*В статье приведен анализ командно-штабных учений с применением средств имитационного моделирования и этапов их проведения. Также рассматриваются их основные компоненты и особенности планирования.*

***Ключевые слова:** командно-штабные учения с применением средств имитационного моделирования, имитационное моделирование, модель.*