# Computer-supported Education of the Reserve Officers of the Armed Forces

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***Abstract* - The modern environment of warfare and the development of technology, which are changing faster than ever in the history of mankind, require of members of the armed forces to acquire completely new and constantly develop and reshape the existing competencies (knowledge, skills, independence and responsibility). Current models of competence acquisition, especially for reserve officers, which are carried out according to the old model in which "ex catedra" is almost the exclusive form of teaching, do not ensure the achievement of competences for the implementation of tasks in a modern environment. The paper will propose a new concept of education for reserve officers - computer-supported education. This new model implies a significantly greater application of modern education methodologies and can be adapted to different levels of education, lengths of time as well as forms of education, not only for reserve but also for active officers. In the paper, components of the education process are specified and described, with the fact that the preparation and implementation of the two-week final Computer Assisted Exercise (CAX), which is essential for achieving the desired learning outcomes, is specially elaborated.**

***Keywords - planning, military operations, computer-supported education, learning outcomes, Computer Assisted Exercises - CAX, e-learning, teaching strategies.***

## I. INTRODUCTION

The fourth industrial revolution, the so-called digital revolution, which began at the beginning of the third millennium, will, according to everything, change society, the way that people live, and also the way of warfare more than the past three industrial revolutions. The cause of these changes is not technology per se, but the principles of modern warfare, some of which are: multidimensionality, unpredictability, surprise and comprehensiveness [1].

Although the end of the digital revolution and all its consequences on the conduct of military operations and warfare is not certain, it is already clear that the current competencies of individual members of the armed forces, as well as the military capabilities of units (Functional components - DOTMLPFI: Doctrine, Organization, Training, Materiel, Leadership Development, Personnel, Facilities, Interoperability) that they achieve through current education and training processes, should be changed to a large extent so that the military organization, as well as the security services, can carry out their tasks in accordance with the strategic defence and security documents of an individual state. Accelerating the digitization process of education and training of members of the armed forces, as well as members of other components of the defence and security system, is one of the possible answers to this problem. Drafting of the officers' competences of the armed forces of the countries: NATO 2011 [2], and the current drafting of the competences of military officers in the EU and the first five standards of military occupations in the Republic of Croatia published on December 21, 2021 showed once again that the digitization process is increasingly important and actually unavoidable in the process of reshaping education and training for the needs of the armed forces. The adoption of the National Security Strategy of the Republic of Croatia (*Official Gazette No.* 73/2017) [3] and several other documents from the field of defence in the Republic of Croatia have partially created the prerequisites for the formation of a high-quality and sustainable training system for the reserve component of the Croatian Armed Forces (CAF). Computer-supported education, unlike the current one, can use a whole series of "tools", for example: distance learning, e-learning, different simulation models (virtual and constructive simulations) [4], Geographic Information Systems - GIS [5], virtual and augmented reality [6] etc.

## II. COMPUTER SUPPORTED EDUCATION CONCEPTS AND LEARNING OUTCOMES

The new model of education will be explained through the description of a two-month course for reserve officers of the armed forces - "Military Operations Planning Course" with the aim of acquiring competencies in the field of staff work and/or command. The course is organized in two parts (Figure 1): A - theoretical part (lasts six weeks) and B - practical part (lasts two weeks), totalling eight weeks. A - the theoretical part consists of a part that is carried out in the classroom (twice a week - the first and fourth week) and the second part that is carried out by e-learning (twice a fortnight - the second and third and the fifth and sixth week).

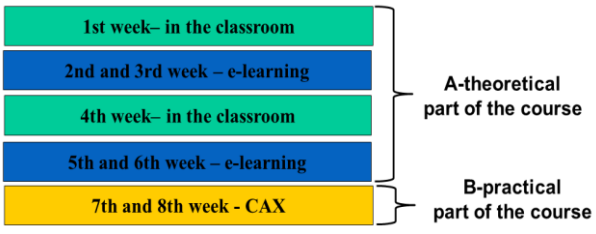


Figure 1. Course schedule by week

The practical part of the course is a Computer-Assisted Simulation Exercise - CAX and lasts two weeks (the seventh and eighth week).

The most significant learning outcomes that each student should achieve after completing the training are the following:

• state and analyse the reasons for new approaches to operations planning from the aspect of finding answers to poorly structured non-linear problems

• evaluate the interrelationships of the elements of national power in the approach to creating a response to a crisis situation

• plan a military operation with application of the prescribed methodology, current documents and procedures and the use of theoretical knowledge from operational skills

### A. *Teaching strategies and methods*

The last listed learning outcome is the most comprehensive in terms of theory and, according to Bloom's taxonomy, is the highest level of the course itself.

Of the teaching strategies for achieving the given learning outcome, the teaching strategy, cooperative learning strategy and situational learning strategy would be applied [7]. Situational learning (situational cognition) [8] would be carried out through the context of problem solving activities. Collaborative learning [9], based on constructivist theory, implies the joint work of military trainees in a group working on the joint task of planning a military operation. At the same time, the overall success of the group depends on individual contribution of each member of the group (and vice versa). The course would be conducted by alternately engaging the participants through lessons in the classroom (campus-focused), online teaching (online focus) [10] and through preparation and implementation of the CAX exercise. Of special importance in this phase is the so-called - Brainstorming. During the last two weeks (CAX), collaborative [9] and situational learning [8] would prevail. In the seventh week, it is advisable to use the "Jigsaw" method of teaching (teaching that uses the puzzle technique), because all participants as a whole in that week (and the last week) would be in the role of command/headquarters of a battalion/brigade level unit. Therefore, the task that would be given to all together as battalion/brigade headquarters should be divided into components or functional units (battalion/brigade headquarters). When implementing a war game - during the creation of an operation concept and deciding which course of action (COA) to choose for a particular operation, artificial intelligence (AI) and Big Data technology can be used. Before that, participants will conduct a tour of the terrain where the planned operation will be carried out ("Command Reconnaissance") using real and virtual means (GIS, virtual reality, maps...).

## III. COMPUTER ASSISTED EXERCISE – CAX

### A. *Stages of CAX preparation and implementation*

1. Concept & Specification Development
2. Planning & Product Development
3. Execution
4. Post Exercise Analysis & Reporting

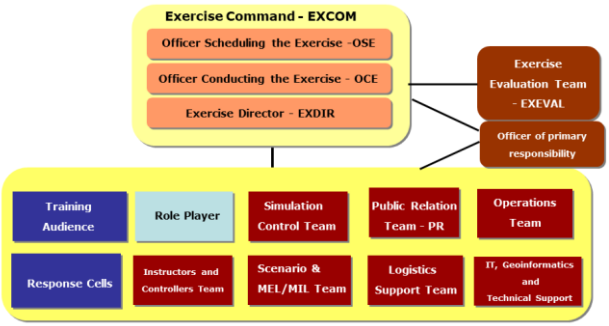


Figure 2. CAX organizational structure – concept

### B. *Management of information systems in CAX*

In the case of preparation and implementation of the CAX system components from Figure 3 [11], they consist of:

**Management**

In the exercise (Figure 2), management is divided into "senior" and "operational" management. The management group (EXCOM) of the exercise belongs to the senior management (Manager, Commander and Director of the exercise, who are supported by the Officer of primary responsibility in communication with other teams), and the members of the individual teams from the exercise belong to the operational management. In order to understand the functioning of Management, it is good to distinguish the phases of exercise implementation: development of the specification and concept (Concept & Specification Development), planning and preparation of the exercise (Planning & Product Development), implementation (Execution) and analysis and reporting after the exercise (Post Exercise Analysis & Reporting).

**Organization**

Shown in Figure 2, it consists of the teachers and employees of the Simulation Centre and officers undergoing training. The components of the exercise are:

- **The Exercise Command** is the most responsible management or "senior" management in the exercise. It manages all teams and other components. The command of the exercise consists of: the Manager, the Commander, and the Director of the exercise, who are supported in communication with other teams by the Officer of primary responsibility.
- **Scenario and MEL/MIL** (Main Events List / Main Incidents List) **Team:** creates a scenario, i.e. incidents and events for the exercise, the implementation of which will ensure the achievement of the goals of the exercise, i.e. achievement of the learning outcomes of the education/training. In our case, it is a constructive simulation model JCATS. TABLE I shows the data that are components of the exercise scenario.

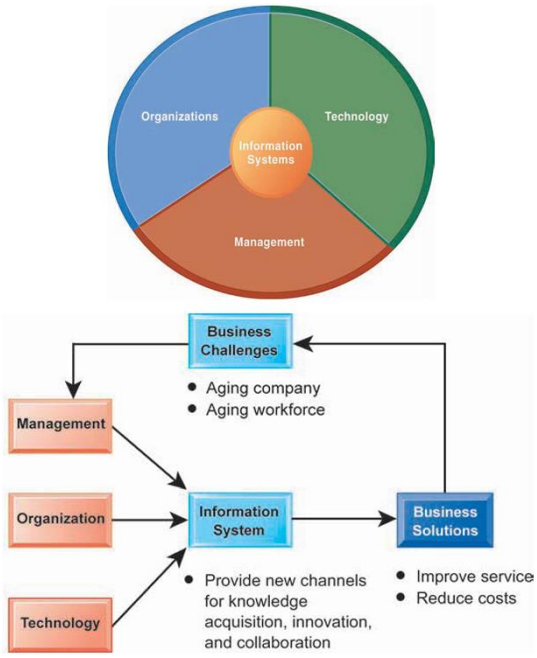


Figure 3. Information system, management, organization, technologies [11].

- **The Role Player** is responsible for making the exercise as realistic as possible. In accordance with the scenario, based on incidents and events that are created in advance and that they receive from the MEL/MIL team, using the JCATS system and simulating, in the best possible way, everything that happens in reality (civil organizations, police, "situation forces" international governmental and non-governmental organizations, media, protection and rescue, fire-fighters, etc.) they initiate events towards the training group and monitor actions of the training group.
- **Team of Instructors and Controllers** (IC Team) supervises the regularity of the training group as a whole and all components of the training group. This is done in coordination with the MEL/MIL team, the role player team, as well as the simulation systems monitoring team. In accordance with the elaborated scenario, incidents and events, before the start of the exercise, it prepares forms for evaluation or monitoring of the achieved results of the training group.
- **The Training Audience** is, as a rule, the participants of the training, in this case, the Operations Planning Course. They make up the headquarters of the battalion or brigade (25 to 30 trainees), and in the case of international and NATO exercises, the headquarters are often at higher levels. Often, the training group does not have the opportunity to see the simulation model at all but receives information from the simulation model (in this case, JCATS) from the operators of the JCATS system (Members of the Workstation Team), through information and communication systems.

TABLE I. COMPONENTS OF SCENARIOS AND MEL/MIL

| Modules | Sub - Modules |
|---|---|
| Geo – Strategic situation | Map |
| | Historical background |
| | Political, military, economic, humanitarian, legal condition |
| Theatre of Operation | Map dataset |
| | Theatre data |
| | Country books |
| | Friendly and enemy order of battle |
| Strategic Initiation Module | Road to crisis |
| | Strategic Military assessments |
| | Initiating directive |
| | Strategic Planning Guidance |
| Crisis response planning information | Intelligence summary |
| | Friendly forces |
| | Civil/Military, environmental assessments |
| | Reconnaissance reports |
| Force activation and deployment information | Allied force list |
| | Force balancing results |
| | SOFA/MOU/TA |
| | Deployment plan |
| | Intelligence summary |
| | Joint Target list |
| | Rules of Engagement Authorization |
| Execution information | Road to war |
| | Intelligence summary |
| | Assessment reports |
| | Order of battle |
| | Situation reports |
| | Common operating pictures for C2 system |
| | MEL/MIL database |

- **Response Cells -** this is the only team that directly interacts with the simulation model (in this case JCATS). So, the members of that team are at their workstations - computers where they observe what is happening on the simulation model and transfer to the simulation model the decisions made by themselves and/or the superior level, i.e., the headquarters of the brigade/battalion, or the Commander of the brigade/battalion.
- Based on the information provided, **The Simulation Team** creates databases before the start of the exercise (completes the scenario of the exercise and creates individual incidents or events in the exercise, etc.) and enters doctrinal models of behaviour (of all participating parties - it is not necessary to include only two so-called "red" parties and "blue", as a rule, there are several sides in the simulation model). In addition to the simulation model used in the preparation and implementation of the exercise, there is also GIS (Geographic Information Systems) support [5]. In addition, artificial intelligence (AI) can be used in the development of possible "versions of action" as well as in some other phases

of the preparation and implementation of the exercise [12].

- **PR** (Public Relations and Information), the team responsible for simulating the media: written media - press, television, radio, internet (social networks...), i.e., participates in the exercise as "Role Players".
- **EXEVAL** - The evaluation of the exercise is always carried out by persons from a higher hierarchy than the one that is the "training group" in the composition of the EXEVAL team and there are always different experts, depending on the topic/scenario on which the exercise is carried out. As a rule, EXEVAL teams also include experts who deal with technical support and simulation models (Figure 4: Transfer of information to CAX).
- Other teams are not specified because the name of the team itself suggests the task they have.

After implementation of the exercise, there is a (first) analysis after the exercise (First Impression Report - FIR). During the exercise, all communications (telephone, mobile phone, VoIP, internet, e-mail...) between the exercise participants are recorded/memorized and at the end of the exercise, what was planned, what happened during the exercise and how and why the differences arose are analysed.

**Technology:**

Here are listed only the most important components of the system that support the preparation, implementation, and analysis of the exercise (NATO concept).

- Joint Exercise Scenario Tool (JEST)
- Map Unit Builder (MUB)
- Database Development System (DDS)
- Terrain Modification Utility
- Joint Theater Level Simulation (JTLS)
- Joint Contact and Tactical Simulation (JCATS)
- Joint Multiresolution Model (JMRM)
- Web Hosted Interface Program (WHIP)
- Tool for operational planning, force activation and simulation (TOPFAS)
- Allied deployment and movement system (ADAMS)

- The simulation system on which the exercise is carried out is, as a rule, a constructive simulation model JCATS
- In addition to the above systems, the "e-learning" system ILIAS (or MERLIN in the Republic of Croatia) is also used in preparation for implementation and analysis.

*Information system components*

The exercise command or exercise director is the person who, to the greatest extent, from the beginning of the preparations for the exercise to the final analysis of the conducted exercise, creates the information management system during the preparation and implementation of the exercise and coordinates with all information systems that support the exercise.

- Four components of the information systems in CAX:

1. Information system for exercise planning and management. These tools can be used to automate the process, manage and share information for the preparation of exercise specification (EXPEC) and exercise plan (EXPLAN) documents. They can help prepare scenarios as well as major events and incidents (MEL/MIL - list). Through these interfaces, the data collected during the planning process of the exercise can be directly entered into the simulation, as well as into the command and control software (Command & Control - C2).

2. Constructive Simulation Systems (JCATS) and Support Tools: These are the simulation systems and software required to run the simulation, e.g. database preparation tools, user interfaces, etc.

3. The information system that connects C2, the operational planning system and the simulation system (JCATS) on which the exercise is conducted. The training group (training participants) has only the systems it would have in a "real situation", i.e. in the actual implementation of the operation.

4. Tools for experimentation and analysis: These are programs used to design and manage experiments using CAX data and to compile and present data collected by the simulation system as well as derive information from this data.

- The training group (training participants) can only use the second and third information systems. The training is focused on the headquarters, as a rule, of the battalion/brigade and the components of that unit.
- EXCOM and other teams in the exercise (which are not the "Training Group") can use all information systems, but they mainly use the first, second and fourth information systems and, as a rule, only monitor the third

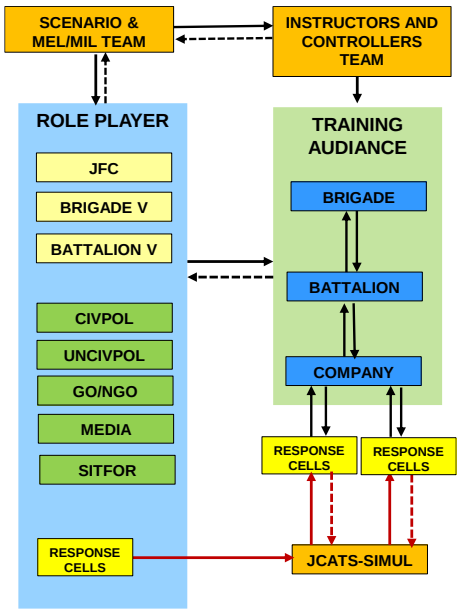


Figure 4. Transfer of information in CAX

system used by the "Training Group". Only the members of the Management Staff of the exercise have access to all information, and they, together with members of the other teams, manage and moderate the exercise.

Before the start of the training/CAX, the organizer of the exercise creates all essential elements for the exercise, so that the databases can be formed on time. All this needs to be done for the "opposite side" - that is, more "sides" if the scenario of the exercise foresees that. To carry out an exercise like this, you need a minimum of: 40 workstations for JCATS, 30 VoIP phones and 15 "Admin" computers.

- Management of the information systems in CAX

For successful management during the preparation, implementation and analysis of the exercise, it is necessary to design a joint information system for managing the CAX exercise (Joint CAX management system - JCMS), the basic components of the JCSM database are (Figure 5):

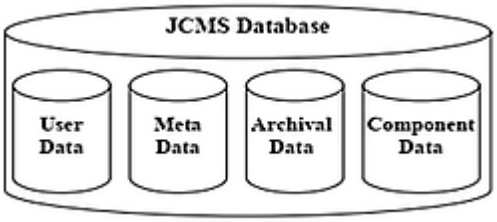


Figure 5. JCMS database

- User Data - defines users, user data and their user rights
- Meta Data - Data that define characteristics of the data available in the database in JCSM. For example, the name, type and size of the scenario that is stored in the database and which may correspond to creation of a new scenario.
- Archival Data - these are all possible data from the preparation, implementation and analysis of past exercises.
- Component Data - these are the data needed to implement the planning process of the exercise. These data are in generic form. They may include: field data, information about individual countries (political system, military, economy, culture, humanitarian and legal issues, significant persons from political life, etc.), events and incidents (MEL-MIL list) that were created in in accordance with the scenario, data on different types of units, weapon systems, logistics and supply systems, forms on all other data for the planning process of preparing the exercise.

## IV. ASSESSMENT OF KNOWLEDGE

"If you want to change how students learn, change the methods of knowledge assessment, and keep in mind that the learning objectives, chosen teaching strategy, teaching methods and context determine which method and which tool is most suitable for knowledge assessment." [13]

Bearing in mind: the learning outcomes at the course level that the participants must achieve (p.2), the duration of the course, the structure of the participants (reserve officers, aged between 30 and 45), in the first six weeks to achieve the learning outcomes of the most important subjects in the course (tactics, operations planning, joint operations, crisis response operations,..) the emphasis would be on formative assessment, through: forums, "on line" discussions, short tests and essays and seminars. Teachers act as moderators of discussions, conduct critical reviews of test results, and choose the most adequate knowledge assessment methodology to achieve learning outcomes. In the last two weeks of the course, the summative assessment would be applied, which would rank the participants and provide a formal assessment of the quality of the learning outcomes. In the last two weeks during the implementation of the exercise - CAX teachers are mostly in the role of supervisors and those who manage the exercise.

## V. CONCLUSION

A new concept of education for members of the armed forces is proposed in a brief description, which is based on computer-supported education with an emphasis on the preparation and implementation of a computer-supported simulation exercise - CAX, through which, at the end of the training, participants synthesize all the knowledge they have from planning operations and should achieve the given learning outcomes. In this form of training, computers are used in almost all phases of training implementation. This work proposes a modern approach, a new model, and methods of training reserve officers in the armed forces, which will help solve one of the most pressing problems in the field of defence and security in the member states of NATO and the EU in a better and faster way, which is education of the reserve components of the armed forces.

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