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USE OF THE JTLS SIMULATION SYSTEM AND JEMM APPLICATIONS IN CONDUCTING EXERCISES WITH ARTILLERY UNIT COMMANDS

Abstract. The article answers the question of the possibilities of preparing and conducting computer assisted exercises with artillery unit command. The author discusses the capabilities of the JTLS simulation system and of JEMM applications used by CSiKGW in the context of their potential to create exercises designed for an artillery unit command. The article describes the basic tasks of the artillery and the method to simulate them in a virtual reality. The author presents the tangible benefits of using simulation in the training of troops, especially when it comes to reliable assessment of exercises conducted with the use of both tools. Such an evaluation using system analysis presented in the article constitutes an added value of the exercise and describes the decisions made by the training audience in the most objective manner. And last but not least, the article discusses the costs of exercises showing in this context the superiority of computer-assisted exercises over conventional map exercises.

Keywords: JTLS, simulation, artillery.

1. INTRODUCTION

Progress in IT in the late decades of the 20th century and at the beginning of the 21st century brought about many opportunities to apply advanced solutions in the process of training troops. Mathematical simulation models are commonplace now and using them is one of the key forms of training troops in the modern world. The advantage of simulation is that the exercise can be repeated many times with changed parameters, and the effect of these changes can be observed and analysed. The performance of devices, models that do not exist yet in the real world can be studied, as well as that of historical models and events. Computer simulation, as it is developed, creates conditions that become increasingly similar to the real ones.

The most appropriate for training commands are constructive simulation systems. In such a system the operating environment, equipment and people are modelled by means of mathematical algorithms, whereas the command of regular structure is real and the decisions it makes are input to the simulation system by participating teams, receiving in return reports on task execution.

2. JTLS SIMULATION SYSTEM

One of the constructive simulation systems used by most NATO armies and possessed by the Polish Armed Forces is JTLS (Joint Theater Level Simulation).

JTLS is an interactive system that models the operations of army, air force, navy, and special forces. The system is designed to train commands of the brigade (regiment) level and above.

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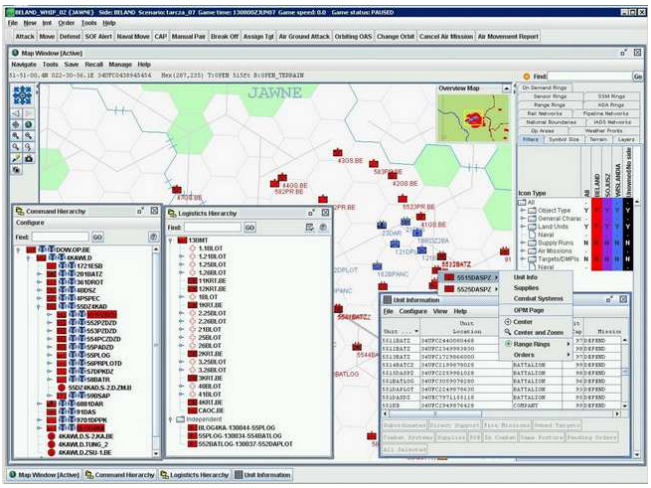

Fig. 1. JTLS user interface

The system enables forming coalitions of joint forces with account taken of non-military entities. JLTS enables simulating up to ten force sides (nations), and each side can be divided further into an any number of force sub-groups, called factions. The operations of units of the same branch of armed forces (army, air force, navy, special forces) or of the same type of troops (mechanised, armoured, rocket and artillery, chemical, engineering, logistic, etc.) can be modelled as factions. It is possible to model critical infrastructure and non-military entities, such as police, border guard, medical service, civilians - refugees. The assignment of factions can be changed in the course of a simulation. This enables creating multinational units commanded by one of the sides, and also the joining of one of the combat sides by the units of neutral sides. Relationships between the sides are non-symmetrical and can change during the game.

The concept of simulation in JTLS is based on the application of a number of partial models which define the scope of functionalities and the suitability of the model. Air operations may be controlled as aggregated operations, which the system treats on the level of individual partial target, with probability of kill factors used for each element. Air to ground operations are modelled at the object level with the use of probability of engage factors. Losses are estimated from stochastic calculations, depending on weapons used and type of target. The results of air to ground, ground to ground and artillery fire (as well as fire support from the sea) are modelled at the object level. Adjudication of precision-guided munitions is stochastic and area weapon results are deterministic.

The land warfare module uses Lanchester attrition methodology to aggregate the effects of direct fire from combined arms subunits and artillery subunits as self-defence. Adjudication is deterministic.

There are three ways of using artillery subunits in JTLS:

- in accordance with actions based on Lanchester equations, as an element of self-defence that involve attrition of combat assets and lack of ability to conduct indirect fire;
- as an element of defined Direct Support or Reinforcing relationship;
- execution of other fire task (other relationships) or engagement with enemy artillery (Counter Battery).

Each of these three ways of reproducing the use of artillery establishes many possibilities of creative use of this combat arms branch. The above ways of using artillery cover all artillery tasks that are adopted as primary tasks in the doctrines of the use of rocket and artillery forces. Conducting close support fire is performed using the "Direct Support" command. Conducting deep support fire, command and control warfare and suppression of enemy air defence is made by using the "Fire Artillery" or "Fire Missile" command (in General Support and General Support Reinforcing relationship), depending on whether the fire is performed by barrel artillery or rocket artillery. Combating enemy artillery is effected by using the "Counter Battery" command. Missions of artillery troops can be planned and stored in the system memory to create an artillery use plan. The standard database[1] includes a limited range of artillery only and it lacks many models used by the Polish Armed Forces. For the purpose of conducting computer assisted command post exercises at CSiKGW all types of weapons in service with the Polish Armed Forces have been input. The same applies to the resources of artillery ammunition included in the simulation scenario database. Reconnaissance for artillery fire can be effected using technical means of identification (sound reconnaissance stations, radar reconnaissance stations, UAVs) and by visual reconnaissance carried out by reconnaissance detachments.

In JTLS it is also possible to parameterise selected partial models and enable thereby modelling of phenomena of general nature, such as changes in weather conditions, modelling of the behaviour of indicated personnel or of the effect of psychological impact on the morale of the troops.

3. JEMM APPLICATION

Preparation and conducting an exercise is a complex process which is labour intensive and requires proper combat management. In order to promote this process, NC3A (NATO Consultation, Command and Control Agency) created the JEMM application (Joint Exercise Management Module) to facilitate the entire process of programming and conducting exercises, as well as of analysing the attaining of the objectives of the training through a well prepared information provision plan. The interface of this application is divided into two parts: one for the administrator and one for the users. The main page of this application comprises 11 tabs[2] (Fig. 2). When starting work on the preparation of exercises with the use of JEMM, key processes executed by the exercising staff are defined in the first place and then training objectives are adapted to these processes. Afterwards training problems are formulated to attain the individual training objectives.

[1] Standard database – exercise scenario created by the manufacturer and delivered with the software.

[2] In JEMM version 3.1

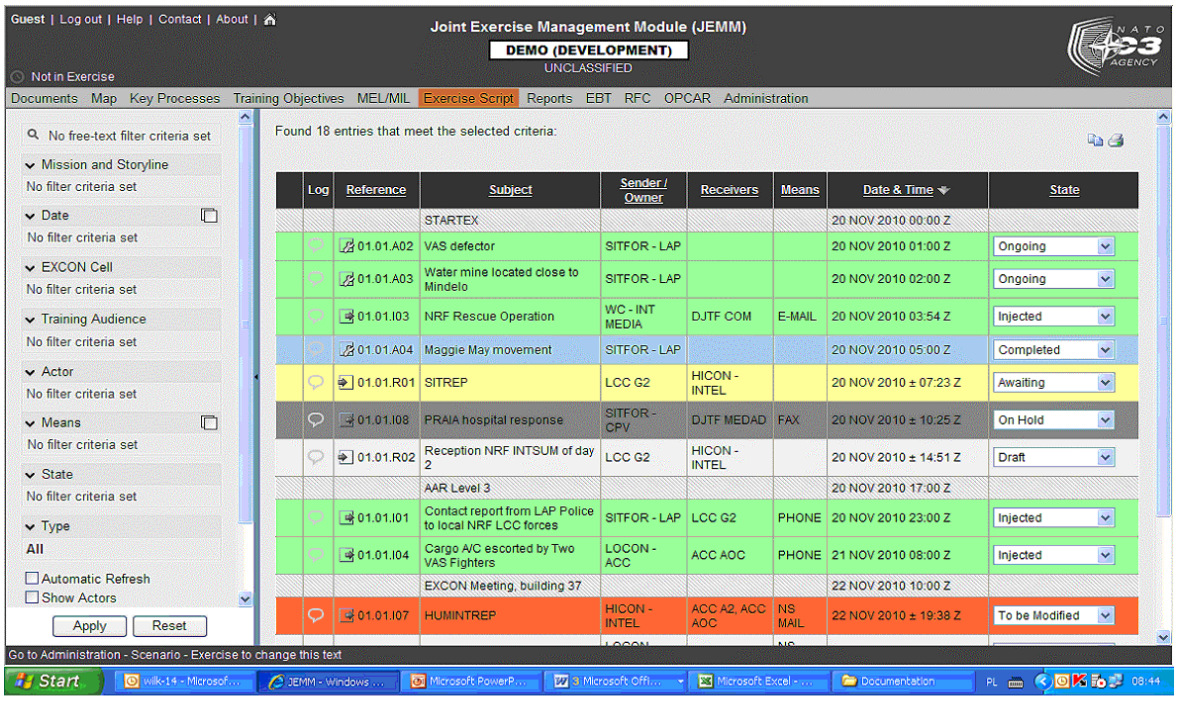

Fig. 2. JEMM application interface (Source: Example of a JEMM database)

Individual events, incidents and episodes, the relationships between which are shown in Fig. 3, are then assigned to the thus prepared exercise framework.

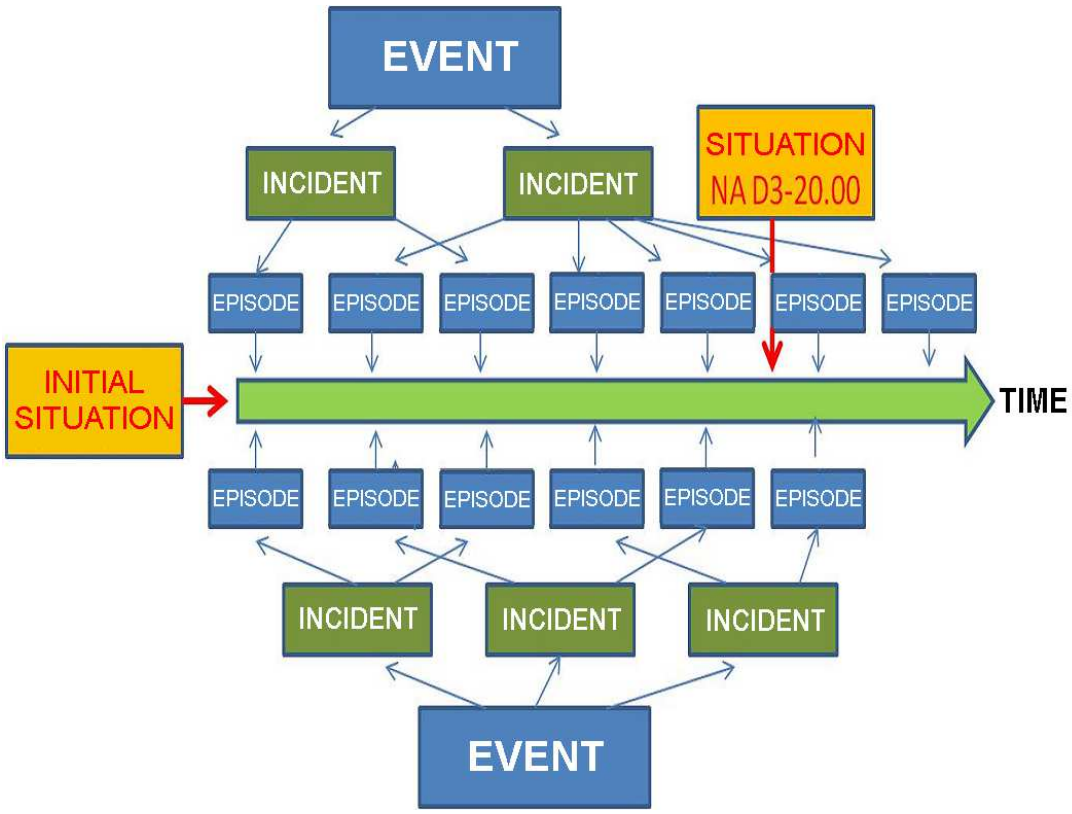

Fig. 3. Relationships between events, incidents and episodes

All data prepared before the exercise for JEMM are entered into the database. Elements of injecting teams, according to the time schedule, are responsible for the individual incidents, have access to the database.

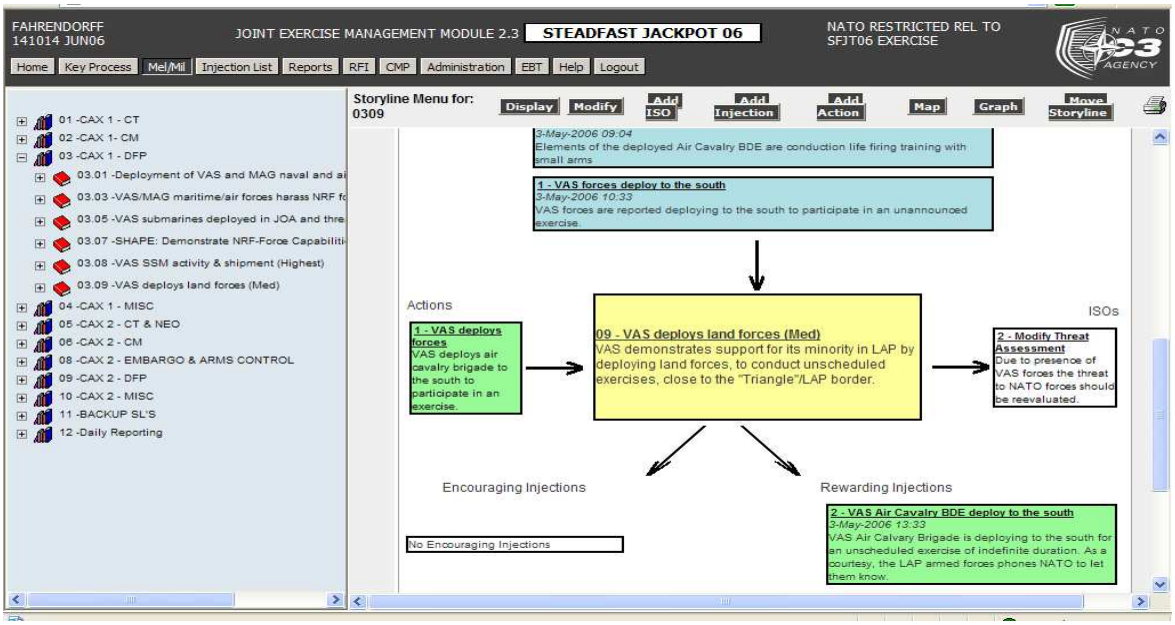

Fig. 4. Graphical representation of an event (Source: Exercise database)

When all events and incidents are developed, the Core Planning Team can use the "Reports" tab to generate reports (Fig. 5) on:

- incidents load on training audience;
- involvement of individual injectors;
- number of incidents that include defined problems;
- arrangement of individual incidents in time;
- activity levels required of players in individual incidents and displayed as a function of time;
- tasks for observer groups.

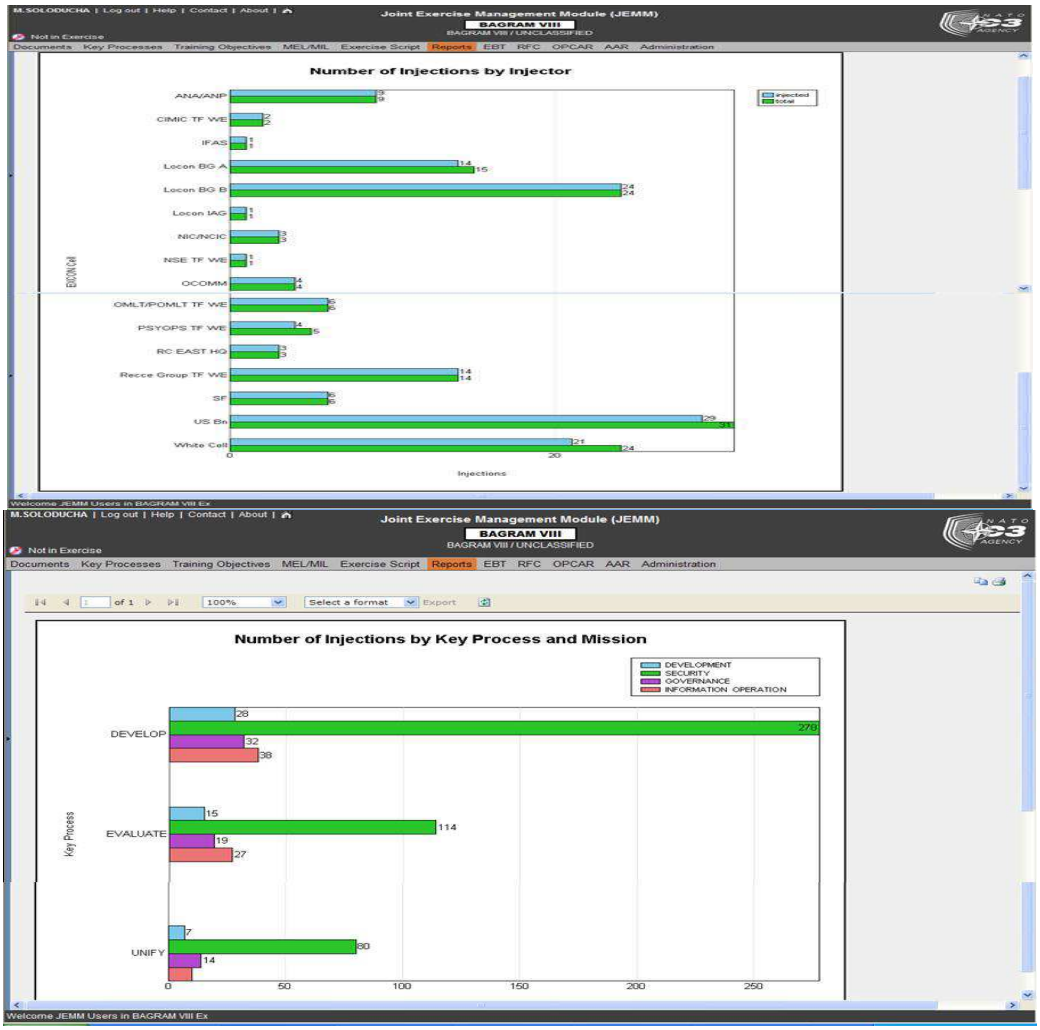

Fig. 5. Examples of reports generated after entering events and incidents into the database (Source: BAGRAM VIII exercise database)

These reports enable verification of the synchronisation of the individual days of the exercise depending on the adopted concept of conducting the exercise.

At the exercise review stage JEMM enables precise assessment of the actions during the injected episodes at any moment using a panel designed for observers. The exercise director can monitor the progress in episode completion by observing the colour-coded[3] evaluation and in descriptive manner by the control team. The exercise director may, if necessary, require the repetition of the problem or preparation of a similar one to attain the same or similar training objectives.

4. SIMULATION OF BASIC ARTILLERY OPERATIONS IN A SIMULATION SYSTEM

Practical execution of artillery operations during computer assisted command post exercise of artillery troops is one of the main objectives to be attained.

[3] Evaluation colours: green – correct execution; amber – procedures executed with some flaws, red – incorrect execution, requires repetition.

The artillery unit executes its tasks within the adopted structure of the command post. In computer assisted command post exercises of artillery troops, the Core Planning Team which develops the exercise scenario must take into account the adopted structure of the command post and prepare the information provision plan. The names of individual cells of the command post (Fig. 6) will play an important role in JEMM, as these will have mail addresses assigned for sending episodes.

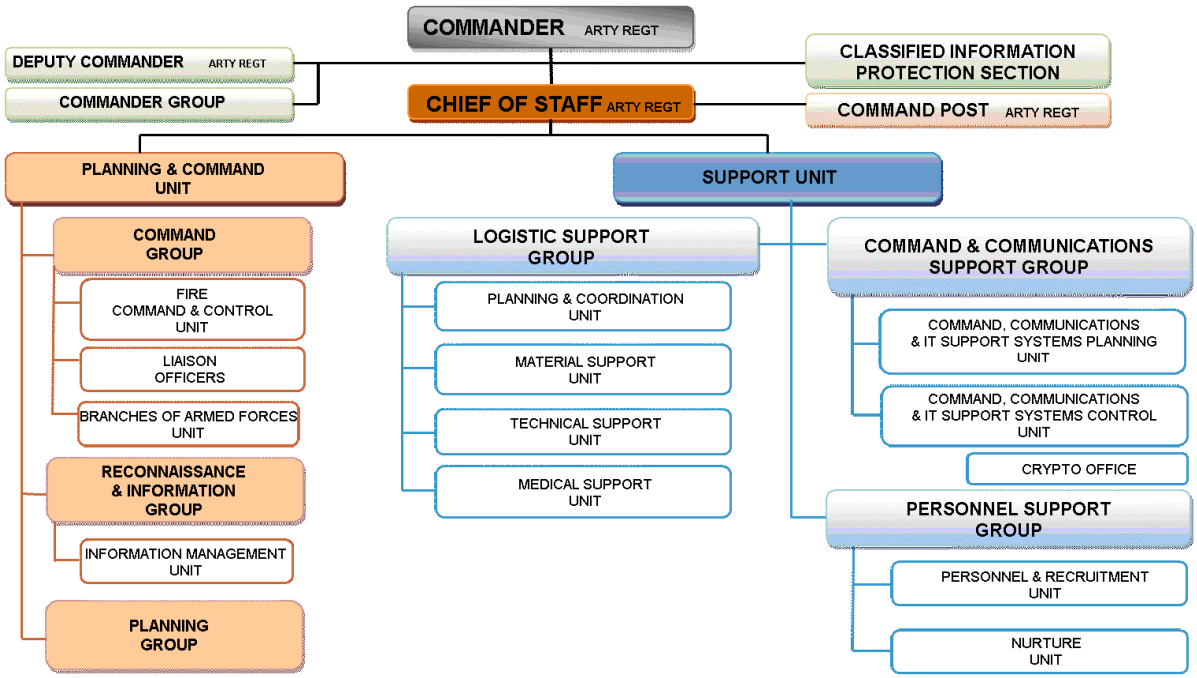

Fig. 6. Command post structure – an option

The main tasks of artillery troops in the concept of simulating them were divided into three groups that have similar flow of information during their execution. The first group comprises tasks associated with conducting close supporting fire (Fig. 7). Depending on the support relationship between artillery unit (subunit) and combined arms unit (reinforcing R[4] or general support and reinforcing GSR[5]), the decision on fire operations can be made at the artillery unit command post (GSR) or without the participation thereof (R). In a situation of allocating battalions for the combined arms unit under the general support and reinforcing relationship, the decisions on conducting fire are made at the artillery unit command post. The information provision plan should provide for the execution of this type of tasks by drawing up a request from the combined arms unit for artillery support. The planning and command team cells develop the decision which, after approval, is transmitted to the fire and reconnaissance units for executing the fire mission.

[4] R – reinforcing

[5] GSR – general support and reinforcing

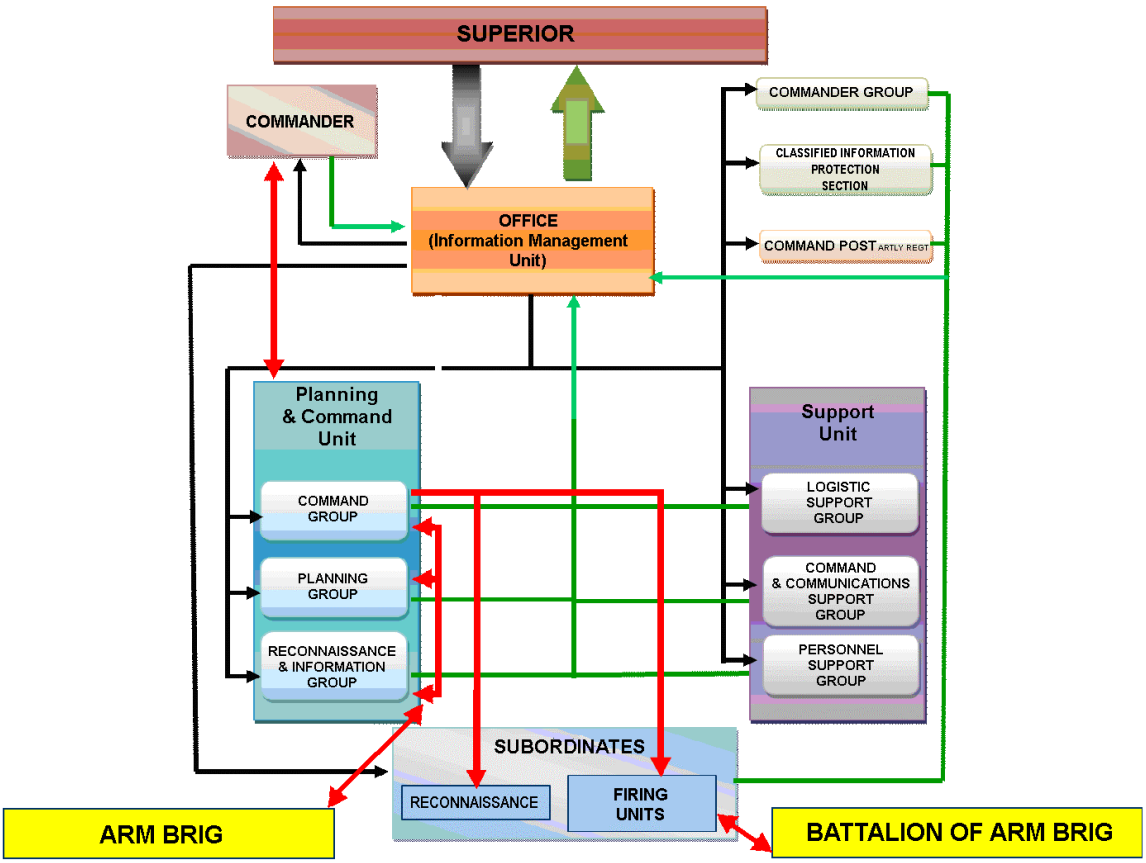

Fig. 7. Execution of a close supporting fire task – an option

The second group comprises the tasks of deep support fire, command and control warfare and suppression of air defence. In this type of tasks the grounds for taking action by the artillery unit command is an order from a superior. The superior, depending on the concept of combat conduct, may be the command of either a division or of land forces component. The tasks of deep support fire may often be specified beforehand, and execution thereof may depend on confirmation of target coordinates by reconnaissance detachments.

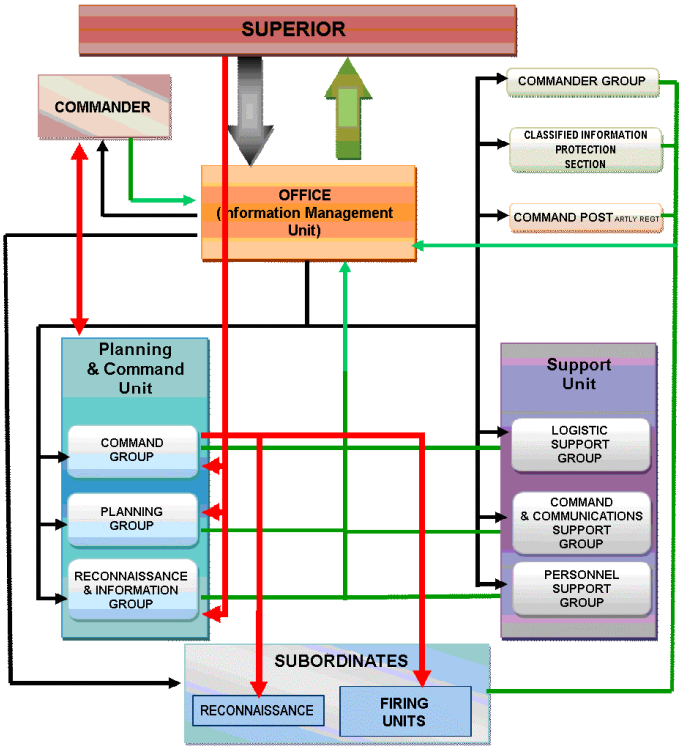

Fig. 8. Execution of a deep supporting fire task (command and control warfare and suppression of air defence)

The last group of tasks comprises combat with enemy artillery. Under current circumstances of combat conduct, allocating a unit or units only for engaging enemy artillery seems unjustified. In view of the limited artillery resources in the organisational structures it is more sensible to leave the decision on attacking the firing enemy artillery to the command of the artillery unit.

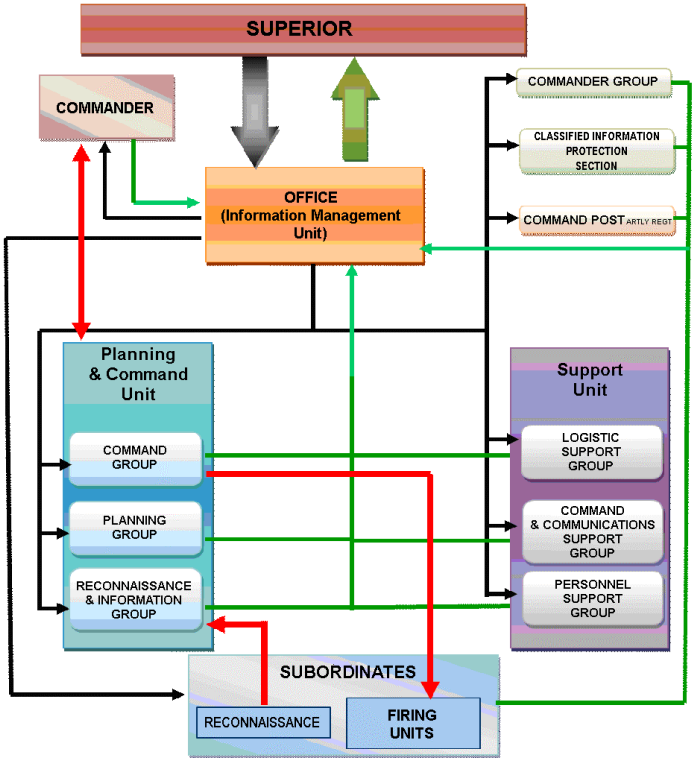

Fig. 9. Execution of an enemy artillery engagement task – an option

Information on detecting enemy artillery fire is transmitted from the reconnaissance detachments (technical reconnaissance battery) to the command post where it is decided which artillery division is to conduct fire. In this decision making scheme it is important to take into consideration the time of artillery response, which may be crucial for the purposefulness of the operation. This option of enemy artillery engagement task execution should be trained often to minimise the response time. This option, on the one hand, provides more flexibility for the commander in assigning the firing unit, on the other hand however, it implies loss of time required for decision making. The studies conducted during computer assisted command post exercises at CSiKGW have shown that the artillery response time was treated marginally. Operational groups of artillery units have not reacted properly to reconnaissance reports and often (21% of all targets) the target was hit as late as one hour after its detection.

The above options for action in the performance of the main tasks of the artillery can always be modified during exercise, depending on the manner of their execution.

Depending on the problems dealt with during the computer assisted command post exercise of artillery troops, it is possible to check procedures for performing other tasks arising from the specificity of the given unit or from the tasks assigned by the superior for the given year of training, such as: training of artillery support procedures during operations of peacekeeping missions.

5. DISCUSSION OF COMPUTER ASSISTED EXERCISES

The last stage of exercise conduct is the discussion of the exercise. It comprises initial and detailed discussion followed by drawing up of reports. The goal of this stage is to make the most of the effort and expenditures made during exercise preparation and conduct. Analysis of this process includes the assessment of the individual exercising teams at subsequent stages of the exercise. Indication of the strengths and weaknesses of player actions enables determining the level of training of the given unit and the unit's capability to accomplish assigned tasks. Conclusions drawn at this stage should be included in guidelines for further staff training.

During the initial discussion between the participants of the exercise conducted immediately after the exercise, comments and proposals are collected from all training participants. Discussions are held about the quality (methods) of accomplishing tasks in the course of exercise, particularly in relation to the adopted objectives of the exercise, and also the possibilities of implementing the experience gained and lessons learned are indicated. To acquire a reliable image of the exercise, observer teams are established, the tasks of which are defined during JEMM database workshops. Each of the observers records observations and assigns them appropriate status:

- green – correct execution;
- orange – procedure executed with some flaws, repetition probable;
- red – procedure executed incorrectly, requires repetition.

The exercise director can view the status of training problems execution during exercise conduct (Fig. 10) and can respond accordingly. During the initial discussion it is sufficient to just review the observations recorded in the JEMM application.

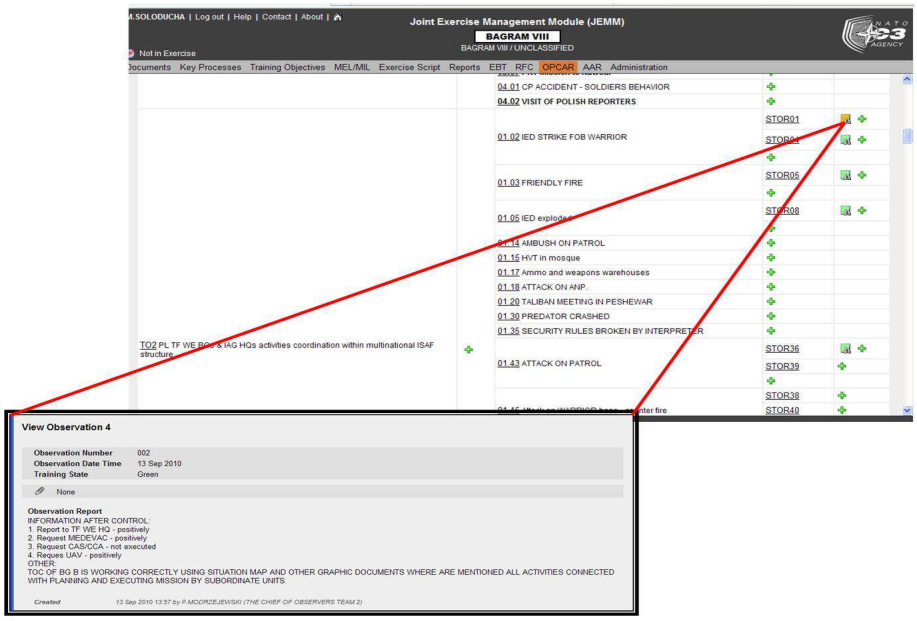

Fig. 10. Report on the course of exercise conducted with the use of JEMM (Source: BAGRAM VIII exercise database)

The detailed discussion of the exercise has the form of a briefing, and the corresponding document is sent to all exercise participants.

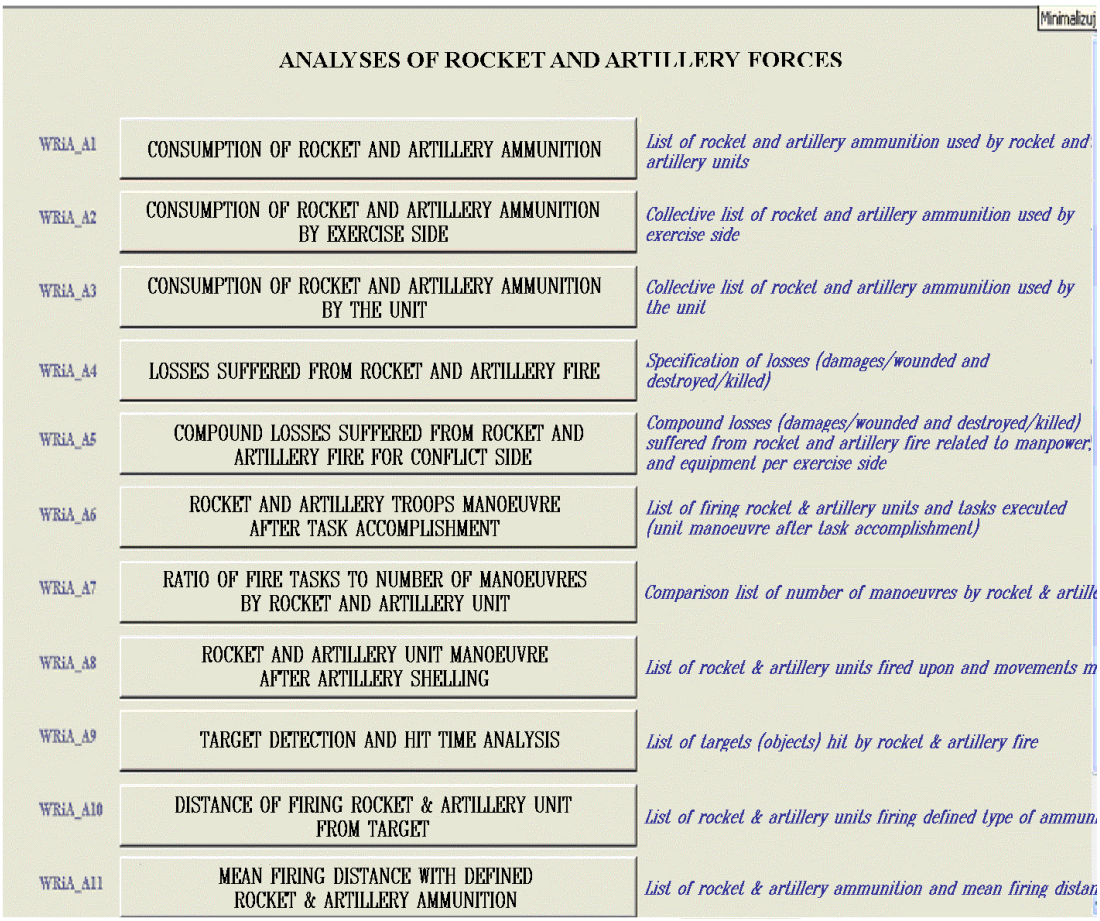

Fig. 11. AAR team application for assessing artillery unit commands

When preparing this detailed discussion, analyses provided by the "Exercise Analysis and Review Team" should be taken into consideration. Conducted studies show that it is possible to make a detailed list of data on activities performed (simulated) by units of rocket and artillery troops. In the course of research on the possibilities of using a simulation system to conduct exercises with artillery commands, a software application was created at CSiKGW that allows conducting such analyses (Fig. 11).

11 detailed analyses that have been set up in the application presented above enable evaluation of selected tasks executed by artillery troops. The first three of them cover extensively the ammunition spent by artillery (sub)units. Analyses 4 and 5 enable the estimation of the degree of target destruction by artillery fire, taking into account the type of ammunition used. Three further analyses deal with artillery unit manoeuvres made immediately after completing fire and with manoeuvres of subunits fired on by artillery. Extremely important analysis performed during command post exercises is analysis number 9. It determines the fire response time of the artillery unit command from the moment of receiving a report on detecting a target to be fired at. During the exercises the participating group has the ability to identify targets and send a reconnaissance report to the artillery unit command which makes decisions about conducting fire. Time is measured from the moment of detection to the opening of fire. The last two analyses are used to assess the distance at which artillery fire was conducted using different kinds of equipment (ammunition). This enables consideration of the adequacy of the types of ammunition used in relation to firing distance.

Data collected in the course of the computer assisted command post exercise conducted at CSiKGW revealed a number of cases related to the settlement of the set limits of artillery ammunition. Capturing such data during map exercises would not be possible. Conducting artillery operations requires of the exercising command extreme scrupulousness in keeping the records during dynamic activities. The soundness of the use of different types of ammunition for fighting different types of targets also requires analysis. The artillery has been used irrationally many times. An example of that is the shelling of tank units by BM-21 rocket artillery battalion with 960 missiles, which only resulted in the destruction of one armoured vehicle and 7 other vehicles. Therefore the conclusions drawn from computer assisted exercises can effectively conduce to rational use of artillery in combat operations.

6. COST OF THE EXERCISE

Comparison of the cost of exercises carried out at the artillery unit and of the estimated cost of computer assisted command post exercise indicate that these are similar. Field exercises generate much higher costs due to the high price of artillery ammunition fired during fire control training.

Table 1. List of costs of exercises carried out with artillery command

Exercise/training type	**Duration (days)**	**No. of persons**	**Cost (K PLN)**	**Notes**
Range training of an artillery regiment including artillery ammunition firing	8	320	2172	
	12	289	1059	
	11	164	2742	
	15	297	1560	
Computer assisted command post exercise (at premises of CSIKGW)	3-4	90	25	
Computer assisted command post exercise (distributed)	3-4	90	13.22	
Command post map exercise	4	80	9	
	4	86	6.5	
Staff training	3	80	1.1	

The use of simulation in command post exercises will allow, at much lower cost, achieving results similar to those achieved with exercises conducted with troops under real environmental conditions . In addition, it will provide incomparably greater realism in relation to that of the traditional command post map exercises. The use of simulation in exercises also allows an in-depth analysis of the effects of the impact of the fire, as well as of the appropriateness of the use of artillery in a given situation, which results in a more comprehensive preparation of artillery commands to tactical operations conducted within contemporary operating environment.

7. SUMMARY

In the past three years collaboration between the author and the officers of WZiD AON[6] Col. Dr. Tomasz Rubaj and Lt. Col. Dr. Tomasz Całkowski and the use of JTLS as required by the rocket and artillery troops created two types of exercise for armed forces branch specialists. The first one is the TARGETING exercise, wherein the officers responsible for targeting in the Polish Armed Forces at various levels of command, have the opportunity to verify decisions on strikes against selected targets in the course of an episodic computer assisted exercise. The effect of that exercise and of conclusions drawn was the development of a doctrine on targeting procedures in the Polish Armed Forces.

The second exercise carried out at CSiKGW was the SUPPORT exercise dedicated to artillery officers participating in the courses on integrated fire support in joint operations conducted by CDKO[7]. This aim of this exercise was to illustrate the many dimensions of the use of artillery in modern operations. It also allowed to verify the hypotheses about the possibility of preparing and carrying out this type of exercise with artillery commands. Exercises comprising elements of computer simulations are becoming a standard feature in the training of troops of the Polish Armed Forces and soon their number is likely to increase.

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