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Use of a Tactical Decision Support System within the Ground Unit Commander's Decision-making Process

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Abstract:

The article presents an experiment performed in the MasaSword version 6.17.1 environment in evaluating the effectiveness of an attack on ground targets within a close air support mission to an opponent on the march or in a defensive position, or in an attack. The ground unit commander has performed an analysis of available firepower based on aerial reconnaissance and he decided to use the allocated aircraft with different types of ammunition. The key element is the effect of selected weapons and ammunition on the enemy's targets according to the required level of target elimination. The article also evaluates the possibilities offered by the use of MasaSword in the decision-making process of the commander when making decisions.

Keywords:

assigned means of air force, close air support, effect of ammunition on the target, experiment, MasaSword, simulation, tactical decision support system

1 Introduction

Simulation is one of the main tools for army training, where modelling the real activities of units becomes necessary for training commanders of all levels. Training and preparation of personnel is exactly the area where the possibilities for simulation technologies are (and still going to be) endless [1]. The program allows to model the planning process, combat activities, and evaluation of combat activities based on existing military doctrines. The authenticity of the simulation is supported by the use of geographical characteristics of the territory, which have an impact on the troop's movement, range, and visibility of optical elements of armaments.

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MasaSword is a simulation tool enabling the war-gaming implementation, where it is possible to use all factors influencing the planning process and stages of combat. Its structure will make it possible to train soldiers in planning, and resolving a whole range of conflicts, from stabilization operations, to responding to terrorist threats and resolving humanitarian crises.

At present, we will use not only the geographical environment of the Czech Republic, but at the same time, we will use the Czech Armed Forces (CAF) armament with all the armament details, and equipment. The program allows to actively influence the following factors: urban, supplies, and resource network; launchers, weapon system, sensors, transmitters, active protection, breakdowns, fire, CBRN, and equipment. Performing fixed/rotary wing indirect fire operations require detailed integration between all units supporting the commander's efforts. Close Air Support (CAS) can successfully contribute to the commander's efforts in proper planning and implementation. The goal of the fixed/rotary wing is to control the defined area through the Tactical Air Control Party (TACP) and to successfully support counter-land operations. *The main problem of aircraft safety is addressed to aircraft critical systems as helicopter transmission system monitoring, aircraft system integration, and system redundancy. The research is based on experimental methods and case studies* [2].

The concept of "supported and supporting commanders" is closely connected with the concept of command of individual components. Support is an activity performed by the forces of one or more components for another army part. The Supported Unit Commander shall send his requirements for the performance of the support tasks to the Supporting Unit Commander. The supporting commander shall fulfil these requirements according to the capabilities of the forces and means subordinate to him.

The supporting commander uses common or agreed coalition rules to do the task. The relations of support between the supporting and supported commanders are set out in the Joint Forces Commander's Directive and must include a definition of at least:

- forces and resources allocated to support,
- times, places, levels and lengths of support,
- priorities for the supporting commander,
- powers delegated to the supporting commander.

2 Decision Support Model for CAS

The main function of the decision support model is to know the characteristics of the target, the characteristics of the available air capacity, the method of identifying the target, and the commander's need to eliminate the target. When planning an air attack, we define three basic target groups: people, military equipment, and building elements. The ground unit commander defines the requirement for the level of elimination of the target according to the nature of the target, the ground unit task, and the information support. Target elimination is defined on two levels – lethal and non-lethal effect.

The immediate CAS decision support model implements information from the areas – target analysis, aircraft adaptability analysis, and aircraft distribution. Each goal can be defined by the following five characteristics: physical, functional, cognitive, environmental, and temporal, which help define the properties of the goal.

The choice of means to carry out the CAS is based on the armament and ability of the aircraft to carry out the mission and return to the safe zone behind RBFA (Rear boundary of forward area). The decisive CAS planning process can be divided into

several logically consecutive stages, which describe the structure and concept of the planning process of the CAS. The planning process consists of sub-activities focused on the tools necessary for the activity performance and the effective use of air force capacity as follows:

- target analysis,
- aircraft analysis,
- JTAC / TAC level analysis,
- target elimination analysis.

Only selected areas of the target characteristics were used to process the article: mobility, resilience, and size. Target identification provides essential information for selecting the proper type of aircraft and ammunition, which is given by the resistance of the target.

The size of the target and the level of air defense are important planning factors. Risk analysis is a prerequisite for CAS planning. The first risk of the planning process is the assessment of the threat to the aircraft used in the target area. The second risk factor is the distance of the target from Forward Line of Own Troops (FLOT) or from Forward Edge of Battle Area (FEBA). The safe area for the attacking aircraft is above 5 NM. At a distance from the target of 10NM, the level of risk is low. A necessary evaluation criterion is also the use of airspace around the target, i.e. the number of aircraft in a given place; therefore, it is necessary to create a recognized air picture. The recognized air picture includes aircraft, helicopters, and unmanned aerial vehicles, as well as artillery projectiles.

The next step in the analysis is to evaluate the probability of success of the mission. The probability of success of a mission depends on the speed of target identification, the type of CAS, and other aids, including data link, FAC activity, and mission time. Visibility is directly dependent on the weather when completing the CAS mission. Tab. 1 expresses the probability of detecting a target by pilot eyes on a scale of 0 to 1 as used in MasaSword calculations. A large target that the pilot easily and practically 100 % identifies is assigned a number one. A small target, almost unidentifiable, is marked as 0. For example, heavy and medium targets are assigned a value of 0.8 compared to a person who is only 0.15.

Tab. 1 Target detection by size

Sensor	Detection Range [m]	Heavy	Medium	Small	Personnel
Helicopter pilot eyes to ground	4 000	0.8	0.8	0.4	0.15

Another important factor of probability of success of the mission is the time needed to carry out the attack. With military tactical data link called Link-16 the time required for an attack, with the JTAC guiding the aircraft to the target and ensuring fast and accurate identification of the target can be reduced.

The air ammunition used has a small, medium, or high efficiency, depending on the nature of the target.

The article presents the results of simulation and practical shooting at ground targets to find out which ammunition is the best for conducting and maintaining the capability of CAS in different weather conditions and with different experience of pilots

in the conditions of the Czech Air Force. Air Force aircrafts perform ground operations by being able to provide fire support in the short-term through direct air support.

We performed an analysis of the helicopter Mil Mi 24 and tactical aviation ammunition used in planning the CAS mission. For performing the analysis, we used CAS definition from regulation 3-09.3, where direct air support is defined as: "air action by fixed-wing and rotary-wing aircraft against hostile targets that are in close proximity to friendly forces and requiring detailed integration of each air mission with the fire and movement of those forces" [3].

In the area of targeting, in the next phase, the enemy's capabilities depend on the means of air defense, means of command, control, communication nodes, and the enemy force location. In the targeting planning process, the effective range of the weapon, the target resistance, the effect of ammunition in the target, and the commander's requirement for the level of elimination of the target are evaluated.

The aircrew calculates the following (see Fig. 1):

- time to leave the control point to cross the initial point (IP) at the proper time,
- distance and time from IP to turn point (TP),
- degrees to turn at TP and direction of offset, if not directed by the joint terminal attack controller (JTAC),
- distance/time to pull-up point (from TP or IP, as required),
- pull-up angle (as applicable),
- apex/roll-in altitude (as applicable),
- release altitude (based on threat, friendly fires, and ordnance).

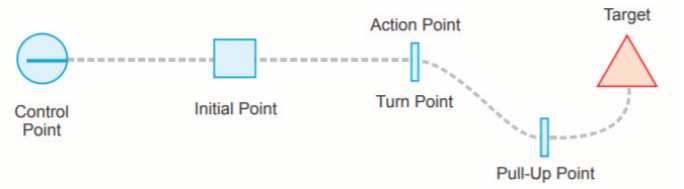

Fig. 1 Fixed-Wing Low Altitude Close Air Support Attack Phase [3]

This study suggests a method with aircraft suitability for immediate CAS decision support system. The method consists of 3 steps.

The first step was to analyze the target characteristics. The second step was to analyze the effect of ammunition on the defined target. The third step was to evaluate the success of the mission.

The proposed decision-making method, based on a quantitative analysis of the target and air capacity, will shorten the decision-making process and increase the effectiveness of the effects of ammunition on the target.

Currently, three types of CAS missions are used: pre-planned CAS, pre-planned on-call CAS and immediate CAS. Fig. 2 shows the coordination process between ground forces and air forces at battalion level. It also illustrates the cooperation between the battalion liaison officer (BALO) and the air liaison officer (ALO), where ALO communicates directly with the air defense unit, the helicopter unit and the forward air controller (FAC).

A prerequisite for the success of the CAS mission is the selection of the right type of aircraft and the ammunition used for the effective destruction of the target. A successful CAS mission also requires a short reaction time and a fast decision-making process.

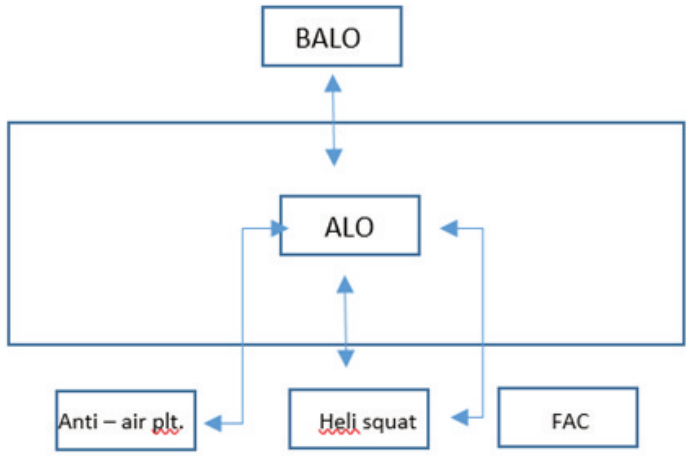

Fig. 2 Coordination process at the level of a mechanized battalion.

Close Air Support is based on the continuous transfer of data between the Air Support Operational Centre / Direct Air Support Centre (DASC) and the Air Operation Centre (AOC) / Tactical Air Command Centre (TACC). Target recognition is the first stage in starting the CAS planning process. The process ends with an attack on the target with the desired effect of ammunition on the target.

The whole process could be briefly summarized as follows:

- unit detects target,
- commander decides to request CAS,
- unit notifies to TACP (Tactical Air Control Party),
- TACP passes request to AOC,
- TACP monitors and coordinates CAS request,
- AOC coordinates with senior ground HQ (Headquarters),
- AOC calls WOC (Wing Operation Centre),
- CRC (Control and Reporting Centre) sends aircraft to a control/contact point,
- JTAC, TAC, FAC briefs aircraft,
- aircraft departs from IP,
- desired effect of ammunition on the target.

3 Experiment

The experiment was carried out virtually in MasaSword in the Military Training Area Jínce, where a company tactical exercise with CAS operation was performed. Mil Mi-24 helicopters were used with different types of weapon systems, the firing was led by operators, where the level of stress and fatigue was low.

Mil Mi-24 were used in the experiment because we assume that in the real life situation, the helicopter air force would be deployed as a matter of priority due to the low reaction time and the ability to coordinate closely with the ground forces.

The adversary of the company at the company tactical training were two platoons of tanks and infantry fighting vehicle, which moved through the space on a designated communication network.

Target 1, a bridge, is a permanent part of the transport network. Targets 2, 4 and 5 are moving targets and target 3 is a permanent point (Tab. 2). None of the targets is marked. Each of the targets has a different air defense. For example, heavy air defense artillery (ADA) and many RPG-7 missiles are assigned to the Command Post.

Tab. 2 Desired effect on target and its Air Defense

TGT	Description	Desired Effect	Air Defense
1	Bridge	Damage	None
2	5 Tanks	Destroy	2 Small Missiles
3	CP	Neutralize	2 Heavy ADA Many Missiles
4	Infantry	Destroy	2 Small Missiles
5	8 Tanks	Destroy	1 Small ADA 2 Small Missiles

For a successful attack on the defined targets, available aircraft and their equipment with suitable ammunition should be used.

3.1 Target Analysis

Target characteristics are the basic parameters for selecting the type of aircraft and ammunition when planning a CAS mission. The basic characteristics of the target are category, movement, location, CAS type, weather, enemy threat and target marker. The size of the target is defined in four categories – small (4-9 m), medium (10-20 m), heavy (21-40 m) and personnel. The level of defense ability of the target is evaluated as yes/no (Tab. 3).

Tab. 3 Target analysis

TGT	Mobility	Air Defense	Size
1	Fixed	No	Heavy
2	Mobile	Yes	Medium
3	Fixed	Yes	Medium
4	Fixed	No	Personnel
5	Mobile	Yes	Heavy

Reconnaissance means identified targets, their characteristics and distance from FEBA/FLOT. Target number 1, the bridge, is a well-identifiable target with a low level of anti-aircraft protection and a distance of 12 NM from the FLOT. Therefore, it is not possible to assume the conduct of intensive anti-aircraft fire during the mission.

3.2 Target Identification Level

Target identification is performed in 3 areas, as shown in Tab. 4. Example for target number 1 “bridge”. The target is heavy and has a score of 3 from 10 possible. The bridge is not camouflaged and has a score of 3 on a scale from 0 to 10. The bridge is

not marked JTAC and is rated 1 point from 10 points possible. Target number one has a total score of 7 points (Tab. 4). These values are used in the calculations in the simulation program MasaSword. The location of targets is shown in Fig. 3.

Tab. 4 Target ID rate

TGT	TGT size	Covered/ Camouflaged	TGT Marker	Target ID
TGT 1	3	3	1	7
TGT 2	1	3	1	5
TGT 3	2	3	3	8
TGT 4	3	3	3	9
TGT 5	3	3	3	9

Fig. 3 Target location map

3.3. Synthesis of Target Analysis

The analysis of target characteristics is the first part of the CAS decision support process. The obtained target attributes were evaluated by combining the risk and the level of the target's own identification (Tab. 5).

3.4 Hypothesis

It is assumed that at the predetermined distances, a veteran pilot will have the greatest success in destroying individual targets and the most effective weapon against the targets is assumed 68 mm Rocket-Launcher. The greatest success of destruction is expected by all levels of pilot experience against infantry and the smallest against a unit of 8 tanks. The weather is expected to have a major impact on the success of the destruction.

Tab. 5 Synthesis of target analysis

TGT	Mobility	Air Defense	Size	TGT Risk
1	Fixed	No	Heavy	Low
2	Mobile	Yes	Medium	Medium
3	Fixed	Yes	Medium	High
4	Fixed	No	Personnel	Low
5	Mobile	Yes	Heavy	Medium

3.5 Calculation of Air Mission Suitability

The target characteristics and required target elimination level are confronted with available aircraft and ammunition. The results obtained from the analysis in this section will be used to calculate a probability of a suitable air mission. The results of the suitability of an air mission are the basis for a decision in the final phase. This phase of the analysis is crucial for mission planning.

In the MasaSword environment, a helicopter attack on the targets listed in Table 2 was simulated. Overall 120 simulations were carried out from three weapon systems, 12.7 mm cannon with 2 940 pieces of ammunition, 30 mm cannon with 1 500 pieces of ammunition and 68 mm Rocket-launcher with 8 rockets. The pilot was a veteran, and the conditions were VMC (Visual Meteorological Conditions). The percentage of destruction of targets by individual weapon systems is shown in Tab. 6.

Tab. 6 Results of simulations

Distance [m]	Weapon system	Bridge	5 tanks [%]	CP [%]	INF [%]	8 tanks [%]
200	12.7	X	0	30	35	0
	30	X	10	45	80	9
	68	X	28	100	100	15
400	12.7	X	15	X	X	0
	30	X	0	15	X	30
	68	X	15	50	70	9
600	12.7	X	X	X	X	X
	30	X	30	X	X	X
	68	X	15	X	X	X
1 000	12.7	X	X	X	X	X
	30	X	0	X	X	X
	68	X	15	X	X	X

The attack was always conducted at a predetermined distance and with a preselected type of weapon system. Only in two cases did the helicopters completely destroy the set targets and only, in these cases, i.e. the attack on CP and INF at a distance of 200 m, the helicopters were not destroyed. In all other cases, the helicopters were destroyed by the enemy. X in the field of results means that firing was not started.

We can see that the helicopter attacking with the 68 mm Rocket- launcher on the unit of 5 tanks from a distance of 400 m up to 1 000 m had the same efficiency and destroyed the unit by 15 %. In general, the effectiveness of helicopter interventions on

specified targets was reduced by relatively small air defense (2-3 RPG-7) and made it practically impossible to attack effectively over a distance of 600 m.

In the specific case analyzed, when using defined ammunition, it was not possible to simulate attacks at a distance of more than 1 000 meters. It can be assumed that with a longer distance, the firing efficiency would be around zero and therefore this option is not programmed (the same applies to shorter distances when the helicopters also did not open fire). Only with a 68 mm Rocket-launcher weapon system it was possible to attack from greater distances. At the same time, in the MasaSword program, it was not possible for helicopters to attack the bridge and therefore it is not included in the other tables.

68 mm Rocket-launcher was the most effective weapon system overall and only with this weapon system it was possible to destroy the target completely (CP and infantry from a minimum distance). At a distance of 400 m, the weapon system in the attack on CP decreased the efficiency by 50 % and in the attack on infantry less equipped with air defense systems it was by 30 %.

The variety of reaction time was counted mostly by the first movement or by the time when covering forces open fire on enemy. The simulation showed that at the current level of air defense, the helicopter is destroyed in the majority of cases; according to the results, the helicopters survived in only 6.25 % of cases.

The effectiveness of firing is mostly affected by technical parameters of the used missiles, for example their calibre, dispersion of individual missiles and their number, etc., though we have to consider also the human factor [4]. In other simulations, we examined the influence of the level of pilots' experience on the effectiveness of shooting at targets from previous simulations (Tab. 6). From the point of view of physiological parameters, the influence of mental state of aviation personnel on the pulse frequency and change of the heart rhythm is the most often investigated one [5]. A total of 72 simulations were performed and the helicopter attacked the targets using various weapon systems. Experience of the pilots was during these simulations defined as veteran, experienced, or novice. The veteran had the highest shooting efficiency, while a novice was not able to damage a unit of 8 tanks at a distance of 200 m at all, and he managed to damage only 15 % maximum of the unit of 5 tanks (Tab. 7).

In other 60 simulations, a veteran was selected as the pilot and the weather conditions were modified (Tab. 8). The fog had the greatest impact on the effectiveness of the shooting, because in these simulations in 7 cases the helicopter did not attack

Conclusion

The planning process of direct air support uses various planning characteristics. Selected characteristics of the target, aircraft and ammunition are a prerequisite of an effective action on the enemy's targets. Simulations are the important element able to fully contribute to the formation of skills of crisis managers making non-standard decisions in non-standard situations which are in line with the needs of the most effective protection of lives and property of citizens.

The article proposed the use of the MasaSword simulation program in the ground unit commander's decision making process. With the development of computer technology and therefore computing power, not only are the possibilities for more complex simulations opening up, but simulation software is nowadays no problem to run on a regular personal computer, making simulations accessible to a wider range of users [6]. The result of the simulations allows the ground commander to choose the most proper means to eliminate the target and it also helps commander of the ground unit

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Tab. 7 Results of simulations with changing experience of the pilot

Experience	Distance	Weapon system	5 tanks [%]	CP [%]	INF [%]	8 tanks [%]
Veteran	200	12.7	0	30	35	0
		30	0	45	80	9
		68	28	100	100	15
Experienced	200	12.7	0	25	0	0
		30	5	50	73	9
		68	25	100	100	15
Novice	200	12.7	0	0	10	0
		30	10	40	20	0
		68	15	75	80	0
Veteran	400	12.7	15	X	X	0
		30	0	15	X	30
		68	15	50	70	9
Experienced	400	12.7	0	X	X	0
		30	0	X	X	20
		68	15	70	70	20
Novice	400	12.7	0	X	X	0
		30	0	X	X	15
		68	0	64	20	20

Tab. 8 Results of simulations with changing weather conditions

Weather		Distance	Weapon system	5 tanks [%]	CP [%]	INF [%]	8 tanks [%]
Partly Cloudy	No rain-fall	400	127	10	X	X	0
			30	0	X	X	30
			68	15	75	70	9
Partly Cloudy	Rain	400	12.7	0	X	X	0
			30	15	15	X	15
			68	20	75	70	25
Very Cloudy	Rain	400	12.7	0	X	X	0
			30	15	X	X	9
			68	17	75	67	25
Cloudy	Rain	400	12.7	8	X	X	0
			30	10	15	X	18
			68	15	75	70	20
Cloudy	Fog	400	12.7	X	X	X	X
			30	0	X	X	0
			68	15	65	X	30

decide between the capabilities of the Air Force and Artillery in order to eliminate the enemy's firepower and reduce to a minimum the threat to their own troops.

Our hypothesis has been confirmed and for CAS when using the Mil Mi-24 helicopter, it is necessary to choose veteran or experienced pilot with a 68 mm Rocket-Launcher weapon system for the successful destruction of targets and at the same time the survival of the helicopter crew. The probability of success of the mission decreases rapidly in case of stronger air defense of the enemy or worsening weather to other than VMC (Visual meteorological conditions).

The analysis result of the characteristics of the target and the required target elimination degree is a factor that is used to decide on the type of ammunition that is going to be used or if the mission will be carried out at all.

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