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# **DEVELOPMENT OF CONSTRUCTIVE SIMULATION IN SLOVAK REPUBLIC ENVIRONMENT – TRANSITION FROM MILITARY TO CIVILIAN SECTOR AND ITS ACQUISITION TO SCIENCE AND PRACTICE**

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## **ABSTRACT**

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The use of simulation in training staffs and personnel (primarily military) had already begun in the seventies of the last century, yet only in developed countries. Slovak Republic, even as non-NATO member (year 2000), has fully implemented standard simulation tools for constructive simulation into staffs' training environment. Training and preparation of personnel is exactly the area where the possibilities for simulation technologies are (and still going to be) endless. 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 civil sector is looking for ways and possibilities of effective preparation due to changes in the security environment and the consequent necessity for active education of crisis managers. The article discusses the use of simulations and simulation technologies in the process of preparation and training from the military to civilian sector. The quality of training of crisis staff at both individual and collective level determines the real ability of action and the standard of coping with crisis and emergency situations. This article also presents actual results and

the contributions of experimental crisis management computer assisted exercises and also defines the area of training and points to the fact that simulations are optimal alternative solutions of the training process linked to theoretical as well as practical knowledge.

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## INTRODUCTION

A bipolar dividing period of time when the world was divided in two clearly determined blocks with their own military and industrial interests and structures is irretrievably over now.

The end of the Cold War, the fall of the Berlin Wall, the terrorist attacks in 2001 are milestones which play their important role in a forming process of security strategy not only in our country.

Changes of the former social structure and entire atmosphere in Europe have inflicted decomposition of old previous security systems and units. The forming period of new ones denotes difficult long term process.

Potential causes of crisis and conflicts origins are being changed as well as the rate of quantity of the vast local conflicts. The causes of their origin and ways of their solution or duration are being changed as well. The peoples' opinions and attitudes are also being changed, the autonomous organizational units are being founded so as to be prepared to offer a relevant solution.

It appears, that the formation of the new isolated state units or other groups is inconvenient solution in this situation, but on the contrary, it is necessary to build up subjects being able to cooperate and be involved operatively in solution process of crisis situation and combine efforts according to the particular range and character of threat.

Analysis of the current security environment of the Slovak Republic and assumed development of political-military aspects reveals that the probability, variety, unpredictability and severity are increasing especially of non-military threats. The combined threats occurrence probability is being currently increasing, especially in mass migration through states, international ter-

rorism and organised crime and in recent period of time natural disasters, industrial or technical accidents or ecological catastrophes.

In pursuance of mentioned facts a permanently valid task emerges within preparation and training of crisis management bodies- crisis management<sup>1</sup>. The twentieth century was the period of time of computer technologies installation into several areas of human activities. Various ways of usage of information and communication technologies were developed hand in hand with their facilitation and improvement. One of the forms of using computers was and still is- playing computer games. From simple computer games people have gradually moved to difficult ones. The specific game type was developed to imitate some activities and character of various types of means, so-called simulation<sup>2</sup>.

Initially there were elementary simulations of fighting means, aircraft, etc. Then there appeared simulations of wars with the option to simulate the activities of the whole formations and units. Those game types exactly served as the mean of program development for simulation of real fighting units in battlefield. Gradual simulation development has helped to extend the scale in terms of usage options for civil authorities. Yet, the simulation program had to meet the civil authorities usage needs.

In the present the number of potential types of non military threats is increasing. Even the Slovak Republic faces the possibility of non military threat. On the basis of given reason it is necessary to pay more attention in preparation and necessity of ensuring a solution of crisis situations.

A crisis management authorities training in the field demands higher financial support. The various simulation types usage can be the potential form and method of crisis management authorities preparation. A simulation of activities of crisis management authorities solving the crisis situation is effective form of preparation of crisis staff members. The sole simulation effectiveness lies in the simplicity and availability of supported computer exercises and in financial demandingness as well in comparison with exercises carried out in the field.

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<sup>1</sup> D. Kollár, *Strategický a krízový manažment: trendy a koncepcie*, [in:] *Interpolis '14: zborník vedeckých prác*, Vydavateľstvo Univerzity Mateja Bela – Belianum, Banská Bystrica 2014, p. 230–234.

<sup>2</sup> F. Adamčík, *The simulation technologies in a computer based training of flying personnel*, [in:] *Trans & MOTAUTO'06*, vol. 13, International scientific-technical conference: 25–28. 10. 2006, Varná, Bulgaria, Scientific-Technical Union of Mechanical Engineering of Bulgaria, Sofia 2006.

## 1. CRISIS MANAGEMENT

Crisis management is an inseparable part of state governance, state and municipal authorities, organizations and institutions.

It is necessary to comprehend the entire crisis management system in sense of realisation of activities relating to the managing, elimination, and minimization of crisis impacts as well as activities aimed at minimization of uncertainty, increasing of security level, civil protection with comprehensive support of participating crisis management components.

Well prepared/not only in theoretical level/crisis staff is an indispensable element for a crisis manager so as to be able to respond swiftly and efficiently on striking situation and to receive and analyse effectively new pieces of information from various sources and to sort out problems emerging from crisis situation.

In this staff everyone knows their own duties and is aware of the fact that prompt and right decisions are inevitable, especially under the conditions of time pressure. Precisely from this reason it is necessary to ensure regular and effective preparation and education of state administration workers and self-governing authorities in the area of crisis management.

The mentioned education is one of the important elements for achieving necessary professional knowledge, technical and technological preparedness for solving potential incidents and crisis situations.

The solution should consist of the integrated conception of preparation to ensure preparation of persons in area of crisis management systematically and conceptually, as well as to ensure population protection, state protection, industrial and other measures for states of crisis of interior security and public order, fire protection and integrated rescue system/IRS/Preparation and education should be executed within close cooperation with academia, professionals with practical experience and specialised work positions as well. The current preparation status of municipal bodies and particular rescue units of crisis staff reflects certain ambiguity of underlying assumptions. There are more subjects as it is common in comparison with other countries in the EU which participate in coordination of particular components.

In a broader sense the complicated and long term transformation of public administration has brought only basic framework for gradual activation of crisis management components. The components of the crisis management/rescue – executive/demand individual preparation. The preparation

of the fire and rescue unit components and quick emergency medical assistance, police force preparation is contemporary organised at high professional level using its own training resources. Training and preparation of members of rescue organisations should be long-term process which does not end in recruitment of new members and their appointment to work functions. On the contrary, through this measure a new member/a rescuer, a fireman, a medic, etc./should be integrated in the permanent preparation and training system which the goal is to achieve the desired level of preparedness of the system as entity destined for sorting out potential crisis phenomenon.

Many forces and subjects participate in troubleshooting of incidents consequences which have various fields of activity. They should be coordinated by one headquarters – crisis staff.

The various simulation type usages is one of the potential alternatives of effective component training because collaboration exercises, which goal is to coordinate management and executive units, are difficult to be effectuated in real conditions. While solving a crisis situation, the IRS units' activity simulation, and the simulation of crisis staff components decision are undeniably an effective form of education and training. The simulation effectiveness lies in simplicity and availability of computer supported exercises usage and also in financial demands in comparison to exercises executed in real conditions.

## 2. CONSTRUCTIVE SIMULATION IN DISTRIBUTED ENVIRONMENT

Research, education and training of professionals in the area of training and crisis management relies on information technologies and areas based on modelling and simulation technologies, such as modelling of objects, simulation of communication or risk analysis.

In this area we can also include the medical assistance in the field, the integrated rescue system, crisis staff activities, stress management and economic, traffic and reconsolidation of communication and infrastructure.

An application of sophisticated work place destined for crisis situation simulation enables to model a particular crisis situation that supports optimal solution search and consequently defines particular steps aiming to minimize negative phenomena and eliminates consequences during crisis.

On the basis of model situations it is possible to verify real life experience and gain an optimal result of particular model situation, process an optimal variant solution methods as well.

Usage of suitable hardware and software equipment enables to model several characteristic model situations of crisis, such as floods, fire, a land contamination, terrorist attacks, a toxic waste transport, an epidemic, a pandemics, etc.

Primarily we are dealing with constructive and partially with virtual simulation with an emphasis placed on the necessity of ensuring a balance of essential features of simulation and corresponding human decision support options. The constructive simulation is applied for staff and commanders training in the Armed forces of the Slovak Republic. An idea of constructive simulation implementation in training arose on international military exposition in 1999.

The Slovak Republic, as the first of NATO non-member states, decided to implement the full-valued constructive simulation system which had been installed only in modern countries that time. For this purpose the simulators of combat operations, staff models and computer war games are used as well.

These tools can be also used for staff and commander training, for tackling with OOTW tasks/operation other than war/and for the crisis management unless there is another specialised tool at disposal. Financial, technological and operational demandingness of constructive simulation tools demands their centralised installation and running. Usually it does not use components of the virtual simulation because a staff is not aware of its own presence and an eye view at real situation. However, the objects of virtual simulation can be used as components of battle in aggregate form. Due to the steep application development trends in the constructive simulation area are divided in short-term or long-term trends<sup>3</sup>.

Unification of the constructive simulation tools of the individual command levels and military units types and their integration, usage of synthetic environment and battlefield (terrain, weather, period of time, electronization of battlefield), aggregation of models, models functions improvement, facilitation of trainee activity evaluation criteria, evaluating activity tool refinement, general training staff restrictions in terrain and quantitative switch to the simulated environment, integration of virtual and life simulation tools in the constructive simulation through standard protocols.

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<sup>3</sup> L. Tomášeková, *Bezpečnostné prostredie Slovenska*, [in:] *Interoperabilita 2012*, Akadémia ozbrojených síl gen. M.R. Štefánika, Liptovský Mikuláš 2012, p. 38–42.

A purpose and main aim of constructive simulation usage during exercise especially consists of:

- an improvement of staff decision and managing process,
- a cooperation training of staff members,
- staff training for carrying OOTW tasks out and handling crisis management tasks,
- gradual and repetitive exercise execution with emphasis on important exercise parts,
- monitoring of exercise results and execution of their measurement through given exercise goals,
- verification of staff ability,
- enhancement of interoperability and compatibility,
- protection of natural environment,
- reduction of significant exercise costs.

A training utilising the constructive simulation system enables effective preparation of commanders, staff and crisis managers. It deepens work customs of staff, accordance of tasks in progress and their link during organisation and management of activity. It further enables to stabilize some more integration capacity of staff components, usage of assigned forces and units. It improves a share of individual persons on crisis in situation managing processes.

The constructive simulation system allows an intensive and flexible training with the option to change individual procedures in dependence on staff decision according to model exercise incident. Higher staff training level is accomplished by ensuring of objective exercise result evaluation which are achieved through the implementation of statistic methods.

### **3. SOFISTICATED CENTRES OF SIMULATED TECHNOLOGIES**

The Simulation Centre as specialised sophisticated department uses simulation instrument of constructive simulation One Semi Automated Testbed Baseline („OTB“) in OTB 2.5.1 International version which represents gateway to certain simulation types. Predecessor of this system – Modular Semi Automated Forces („ModSAF“) was launched in 2000 and in 2006 it was updated to OTB. OTB in its final version is an open system of hierarchically organised packages-libraries of the constructive simulation that are used for entities generation and their semi automated

generation behaviour. An entities activity is generated in a synthetic and dynamic environment which is shared by all simulators within one exercise. Each entity is a separate model of particular item of simulated units in its synthetic dynamic environment and it is related to other items acts self-automatically. It means that entity:

- a) simulates autonomously with physical rules together the lowest tactical level of behaviour and decision making,
- b) requires inputs from simulated units operator for an action requiring higher tactical decision making level.

Thanks to this manner it is possible to simulate entities in coordination with inputs from operators unit's activity carried out during particular exercise. Besides interactivity with operator it is also necessary to be mutually interactive for mutual cooperation. The cooperation of several hundred even thousands entities in procedures going in parallel in a real time is solved by distributed interactive simulation („DIS“)<sup>4</sup>. Entities within DIS do not share common database, each entity announces other entities a change of its status by sending a message in form of standardised DIS. Reception and enter processing by entities sent messages is an inseparable activities part of each entity. In such a situation own view of the entity on simulated world and procedures within it are created. Thanks to that, a creation of its own actions and reactions which are sometimes connected less or more and influence themselves within own synthetic and dynamic environment is enabled.

The standardised date protocol DIS (nowadays protocol High Level Architecture – HLA) is used within a distributed simulation for changing pieces of information between simulation applications, which defines united architecture, models protocol, standards and databases. The protocol DIS carries information about a units structure and an equipment, state, received tasks and its accomplishment, their position, information about terrain and its change due to weather conditions, a year and a day season, a status and changes due to the sunlight or the moonlight etc.

Thanks to the principle of DIS use, the virtual entities run by a computer can cooperate with the virtual entities run by the operators and with the live entities assuming the fulfilment of mutual interaction and correlation.

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<sup>4</sup> Distributed Interactive Simulation is a standardized protocol. It presents the platform for conduction of war gaming in real time via more host computers, and is used worldwide, primary for military use.

OTB is a system with hierarchy privileges according to particular groups. With assistance of users interface it is possible to carry out different operations according to authorisation level:

- a map scale change,
- a map data move while saving actual map scale,
- a switching over of units display on the map with an assistance of separate tools icons,
- a drawing point and line objects, drawing areas,
- a creation of different types of a chemical contamination,
- a terrain recognition,
- finding out a vehicles visibility as well as finding out an entities visibility in the terrain,
- an adjustment of meteo conditions in a synthetic environment.
- supplies refill (a logistic support) for units in action.

While simulating the operation, entities are handled in assistance with wide scale of tasks which are predefined for the certain entity and their differentiation depends on a type of units or on a type and a size of an units formation. Depending on situation these tasks might be corrected (varied) by a change of predefined parameters while assigning the task or during its accomplishment. There is also a possibility of finding out the state of the units supply damage as well as the detailed review of the state of the particular unit. In OTB system there is a possibility to choose alternative physical measure units (length, mass angle, volume, temperature) and greed system that are the most suitable<sup>5</sup>.

OTB is a system with open software architecture. This architecture enables a particular parameters modification. This quality enabled to modify OTB system for exercise of crisis management organs, which was confirmed in 2005 by carrying out for civil sector needs. It was a computer assisted exercise – CAX which was used for the crisis management. Nowadays, there are accessible modules that assist to simulate:

- a flood wave after breaking water dams,
- a contamination with different chemicals considering its characteristics and their reaction considering meteorological conditions and terrain jaggedness,
- an outbreak and spreading of epidemic,

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<sup>5</sup> L. Tomášeková, *Bezpečnostné prostredie Slovenska*, [in:] *Interoperabilita 2012*, Akadémia ozbrojených síl gen. M.R. Štefánika, Liptovský Mikuláš 2012, p. 45–47.

- a fire and its spreading,
- a landslide,
- a crowd and its specific behaviour etc.

During exercises, OTB enables to assign tasks and commands for technical equipment, entities or for all formations at one time. For a computer operator it displays in a clear form actual state on a 2-D digital map surface (according to the real visibility) as well as a course and a result of simulated situation.

For a 3D display to the simulated reality, simulated centres are equipped with special visualisation software. Actually, it is a 3D view to the action area. In a course of exercises it is mainly used to judge activities in the synthetic environment where exercising troops act or it is used as a recon helicopter view (under the condition that the subject disposes it in the real situation). During the exercise, pictures from this program might be used as photogrammetric pictures or intelligence information obtained by UAVs or drones.

#### 4. RESEARCH REALISED DURING CAX

Involved participants of the exercises improve the level of their knowledge by exercises supported by simulation technologies and also obtain needed practical experience for the tasks accomplishment. Exercises are able to examine abilities in line of particular situations. Each exercise contributes to next progress of components of IZS quality and mainly its current and potential operators.

During CAX the scientific research was carried out, in which were used different methods and forms such as questionnaires, interviews, observation of exercises as well as mathematic and statistic calculations and formulations<sup>6</sup>.

There are several relevant benefits as follows:

- Quantification of phenomena and procedures enabling their more accurate analysis and use of optimization in decision and planning activity of management organs turned out to be an essential factor, where management organs are able to evaluate figures from CAX and implement them into crisis plans.

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<sup>6</sup> P. Bučka, V. Andrassy, M. Grega, *Blended simulation – not only as an effective military training commanders and staffs in ICM operations*, [in:] *Výstavba, rozvoj a použití AČR2012: tvorba a rozvoj operačních koncepcí*, University of defence, Czech republic, Brno 2012.

- The possibility of modelling and simulation of generalisation of objects, procedures and phenomena at a different level that enables practising of all levels meaning tactical, operation and strategic.
- Objectivity of an expression of the influence of the terrain and other environmental factors, in which up to 90% of exercising persons underestimate these essential factors.
- An application of the influence of subjective factors of mutual interactions (especially their rational aspects) in planning and decision-making procedures of management organs that are able to be reiterated repeated and analysed anytime.
- A possibility of the realisation of exercises in the ongoing situation provided in a different geographical region, in different climatic and meteorological conditions with a different technical equipment according to existing or new operation processes. This benefit turned out not to be very effective and applicable as crisis manager knows the area of action.
- A low economic demand for realisation of exercises with use of contemporary infrastructure. The exercises represent financial saving comparing to real exercises and we may say and express mathematically that the ratio is 1:200. Carrying out of a real exercise in its basic model represents 10 000 Euros and its computer equivalent is only 500 Euros.
- A possibility of a good perception of the course of exercises and their application for more objective evaluation of the results and conclusion formations and recommendations for practice (a documentation of the solution course of the situation in the 2D and 3D display, a possibility of particular and complex statistic figures) these data are in a graph form, text, and are able to be expressed financially. These data are relevant sources for planning crisis situations and 100% exercising persons used them for the crisis scenario revision.
- A possibility of connection of constructive simulation systems with simulation systems of other categories, in which crisis staff may exercise in cooperation tasks.
- An information concentration for exercise analysis and further analysis and its application in next period.
- A possibility to look for optimal solutions in use of forces and means by continuous CAX scenario repeating and varied.
- A preparation of exercising persons to take risks as the result of their decisions. In this matter, it is possible to claim that only 25% realise im-

pacts of their decisions and do not realise seriousness of the crisis situation solution<sup>7</sup>.

## CONCLUSION

Continuous development of information technologies, a dynamic environment, unpredictable natural disasters with quick course and more difficult demands on crisis managers are essential attributes why we have to look for new and effective solutions of education and preparation of crisis management organs. It is obvious that current preparation and education based on traditional methods such as a lecture with the goal of explanation of crisis situation legislation, static expositions of technical equipment and tools, lectures on crisis phenomena cannot develop leadership abilities of crisis managers, do not enable coordination practice, a cooperation, a flexibility, receiving and analysis of information etc.

Considering financial capacities, the status of domestication of current system of constructive and virtual simulation results of carried crisis management exercises and brought benefits, the simulation centres tend to be the most suitable solution for the crisis staff preparation due to expert staff, the software and the hardware equipment.

In spite of the undisputed need of the change in a crisis staff exercises considering the responsibility to the population and above described benefits and conclusions, there are only few exercises carried out with support of simulation technologies.

A conclusive and solemnly accepted effective preparation and a conception of crisis managers and self-government education are missed when we speak about an implementation of the usage of modern information-and-communication technologies which can effectively prepare members of a crisis staff, lord mayors, mayors and other institutions of self-government and government management. Simulation centres enable IZS components and crisis staffs to carry out specialised and various training and preparation, in which crisis staffs may check correctness of operation procedures, information sources on horizontal and vertical level, timing of emergency plans and verification of a staffs coordination and cooperation as well. Variable exercises might be carried out as follows:

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<sup>7</sup> P. Bučka, V. Andrassy, M. Grega, *Blended simulation – not only as an effective military training commanders and staffs in ICM operations*, [in:] *Výstavba, rozvoj a použití AČR2012: tvorba a rozvoj operačních koncepcí*, University of defence, Czech republic, Brno 2012.

- first-stage exercises for the training of local crisis staffs of towns with a simulation of floods, landslides, wind disasters or chemical disaster,
- second-stage exercises for the cooperation training of local self-government components where relevant authorities would exercise,
- exercises with the complex subject on the state level run by one of ministries (or several ministries), according to the simulated situation,
- exercises for partial IZS components with the training focussed on solution of elementary crisis situations with a necessity of another units cooperation

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