

# The Use of Computer Simulation as Technological Education for Crisis Management Staff

Jiří Barta, Josef Krahulec, Jiří F. Urbánek

**Abstract**—Education and practical training crisis management members are a topical issue nowadays. The paper deals with the perspectives and possibilities of "smart solutions" to education for crisis management staff. Currently, there is a large number of simulation tools, which notes that they are suitable for practical training of crisis management staff.

The first part of the paper is focused on the introduction of the technology simulation tools. The simulators aim is to create a realistic environment for the practical training of extending units of crisis staff.

The second part of the paper concerns the possibilities of using the simulation technology to the education process. The aim of this section is to introduce the practical capabilities and potential of the simulation programs for practical training of crisis management staff.

**Keywords**—Crisis management staff, computer simulation, software, technological education.

## I. INTRODUCTION

THE emergency management is a discipline of dealing with and avoiding risks. It is the creation of plans through which communities reduce vulnerability to hazards and cope with disasters. Emergency management is sometimes called disaster management. It is a discipline that involves preparing for a disaster before it happens, disaster response (e.g. emergency evacuation or mass decontamination), and finally supporting and rebuilding the society after a natural or a human-caused disaster occurs. In general, any emergency management is a continuous process in which all individuals, groups and communities manage hazards in an effort to avoid or ameliorate the impact of disasters resulting from the hazards [1].

Effective emergency management relies on thorough integration of emergency plans at all levels of government and non-government participants. The activities at each level (individual, group, community) affect the other levels. It is common to place the responsibility for governmental emergency management on the institutions for civil defence or within the conventional structure of the emergency services. Important role in emergency management plays an educational and practical preparation of intervening units and verifying emergency plans. These are verified through practical

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exercises and simulations.

Process management is a field of combining management and technology focused on aligning organizations with the requirements and needs of clients [2]. It is a complex management approach that promotes effectiveness and efficiency while striving for innovation, flexibility, and integration with technology. Process management attempts to improve processes continuously [1]. It could therefore be described as a process optimization process of dealing with emergencies and crisis situations.

## II. PROBLEM DEFINITION

The issue of emergency management is focused on the actual problem of computer simulation, communication and information changes in extraordinary events and crisis situations. Large-scale crisis situations and accidents caused by natural disasters and some hazardous chemical substances are known as extraordinary events. These events are manifested by uncontrolled flows of energy (fire, explosion), leaks of toxic substances and extensive damages [3], [4]. These events are partially or totally uncontrollable. Time and space-bounded event, which has occurred, or which is imminent may lead to immediate or delayed serious damage or threatens life and health of people, livestock, environment or damage to property [3], [5].

Information systems, computer simulations, and new technologies can be used in both public administration and the private sector. They can support successful solutions of extraordinary events and crisis situations. One of the areas, where these technologies are used, is preventing and preparing for dealing with extraordinary events and crisis situations. Prevention and preparation for dealing with emergencies is linked to education, which also use these technologies for training of the crisis staff and emergency services of Integrated Rescue System of Czech Republic.

The focus is set to the systems of analyzing, planning, and solving extraordinary events and crisis situations. The aim is to improve the effectiveness of emergency management processes using of computer simulation. A significant problem in defining requirements for information and communication interfaces is caused by legislation of the Czech Republic [4], [6]-[8]. Disunity and lack of unification of concepts of information systems eliminates simple and efficient functioning of the interface.

The law of cyber security [9], the legislation decrees on the security measures, cyber security incidents [10] and legislation decree about major information systems and their criteria [11] brought necessary changes. The norms define basic concepts

in the area of cyber security and data protection. Concurrently laws determine the rights, obligations, and responsibilities of particular entities.

### III. APPROACHES AND METHODS

Process Management is the ensemble of activities of planning and monitoring the performance of a business process. This process is combining management and technology focused on aligning organizations with the wants and needs of clients [2]. It is a complex management approach that promotes business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology. Process management is the application of knowledge, skills, tools, techniques, and systems to define,

visualize, measure, control, report and improve processes with the goal to meet customer (legislative) requirements.

#### A. Process Framework for Emergency Management

It is a new progressive view on process support of organizations in the private and public sector [1]. It is created for the purpose of better understanding of issues that are connected with process deployment in the specific area of interest (e.g. emergency management, education). The general purpose of the model is given by two main views, which are Methodology view and the global Architecture view, see Fig. 1 [1]. Fig. 1 shows that education, simulation, and practical exercises are the main elements of the emergency management processes.

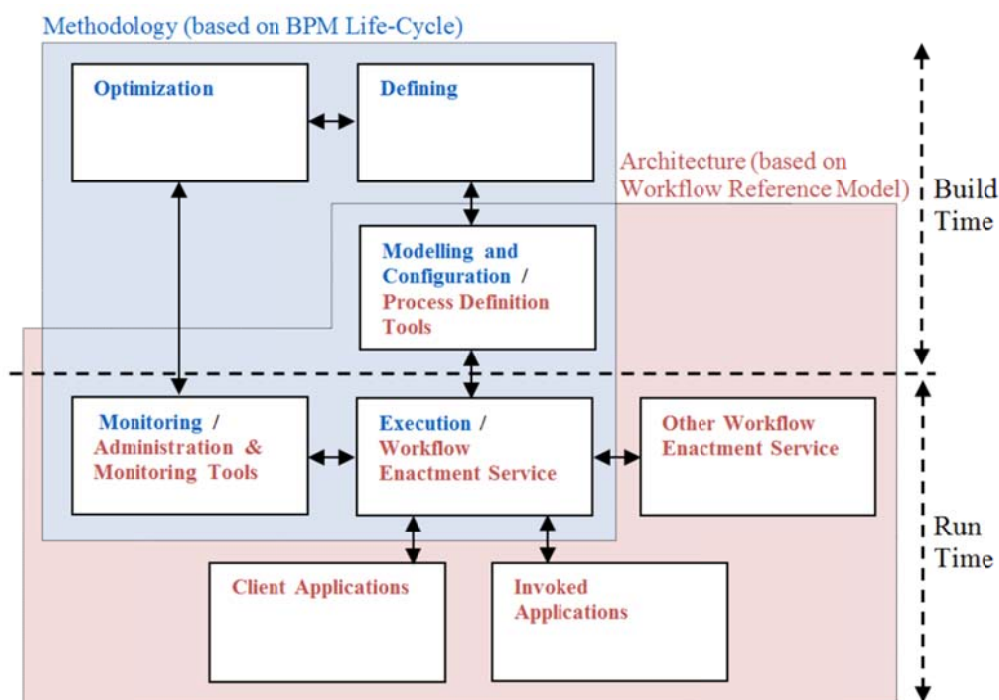


Fig. 1 Process Framework for Emergency Management

#### B. Unified Modelling Language

Unified Modelling Language is a standardized modelling language used in the field of software engineering. Two diagrams are especially suitable for process modelling: Use Case Diagram and Activity Diagram [5]. Unified Modelling Language terminology is very large, therefore, the chosen method Dynamic Vector Logistics of Processes, which is based on Unified Modelling Language.

#### C. Dynamic Vector Logistics of Processes

The Dynamic Vector Logistics of Processes method was chosen to process support in the research project [12], [13]. The Dynamic Vector Logistics of Processes is friendly computer assisted language for the analysis, evaluation, heuristics, modelling, simulation, scenarios, and engineering of any entity's relationships in a Blazon on a scene [13]. It is created for the purpose of better understanding of issues that

are connected with process deployment in the specific area of interest (e.g. emergency management, education). The general purpose of the model is given by three main views, which are the emergency management, the participating Entities and the Processes [13].

### IV. PROGRAMS OF COMPUTER SIMULATION

In the area of education and training of rescue services there are several software tools which use computer simulation. In this chapter are selected simulation software tools that concentrate primarily on education and training crisis staffs and units components in the civil sector [14].

From a large number simulation programs which were analysed from tools concentrating on the education and practical exercises were selected to the final selection of three programs.

### A. Masa Synergy

The company Masa Group manufactures a wide range of products for emergency response. Its products in the field of crisis management and emergency preparedness are Masa Sword, Masa Synergy and Masa Life [15].

For the needs of technological education is the most suitable program is Masa Synergy which main tool is an advanced simulation platform which enables to public and private organisations prepare and practically train their management and other staff. Masa Synergy is a training simulation that enables tactical and strategic high-level decision makers from organizations to efficiently prepare emergency management scenarios, rehearse procedures and validate emergency plans.

Participants and their teams give orders to the subordinate levels using their standard communication means. Subordinate level is replaced by the operator who projects these commands into actions and activities in the frame of the simulation. Simulation is started automatically according to the orders of the trainees into actions and activities at all subordinate levels.

Artificial intelligence then determines the impact on the situation and what is the progress of the scenario of solution. Operational reports from the area of the simulated emergency event are sent back up through all levels of command of the organisation. This results in fresh news about the condition at the level of emergency event which communicates with new situation of the trainees and their teams. There is a dynamic interaction between the orders of the trainees and continually developing environment of the simulated emergency event or crisis situations.

Due to its variability, Masa Synergy is well suited for the training of rescue teams and other employees taking part in dealing with natural disasters and operational accidents as are floods and tsunami, threats related to terrorism, widespread outbreak of serious illnesses and subsequent evacuation of inhabitants [15].

The aim of the simulation is to provide trainees with knowledge and experience for mastering emergency situations. System for the support of decision-making process during serious emergency event enables to the control system to pass information in real time via simulation. Due to it, simulator can count the progress of the emergency event much faster and more precisely than people as well as provide prognostic data about the result of the event using scenarios "what if?"

Via simulator Masa Synergy, it is possible to verify procedures, equipment and emergency plans. Particular plan can be prepared in simulation. Use of current procedures and equipment provide results. The same scenario can be simulated again with a single change in equipment or procedure. Results will show the efficiency and after-effects of this change.

### B. Virtual Reality Training Software for Safety and Security

The application Virtual Reality training software for safety and security (XVR) consists of several programs. They are: XVR Crisis Media, XVR Resource Management, XVR On Scene and XVR Toolkit (Fig. 1). These programs serve to the resolvers of emergency or crisis situations in preparation and practicing practical abilities [16].



Fig. 2 XVR Platform

With the XVR Crisis Media module, educators can create their own online and social media messages through a secure online portal. This can be prior to as well as during a (live) exercise. XVR Crisis Media serves for training how to correctly and quickly inform the public about emergency situations. They can also enter their own posts in simulated

social media channels like Twitter and Facebook.

The environment of the program XVR Resource Management aims at operational and strategic level of command. One of the components is a map with the survey of all already occurred situations and after the click on it, it is possible to determine the number of forces and means

necessary for the intervention. Later the transportation of the patient into the hospital follows, where it is possible to set the possibilities of treatment.

XVR On Scene serves the purpose of the individual components intervening in emergency situations and can practice the progress on the predefined scenarios. This programs module provides 3D views of an incident scenario. The instructor can easily build the scenario and has full control over the course of events in the scenario. Thanks to this program, it is possible to model a great number of emergency situations which can be dealt with subsequently as if the trainees were present at the place of accident.

The XVR Toolkit expands the XVR Platform for tailor made uses, often in combination with other software. This toolkit comes with technical training and support. Its features are only available for certified XVR Implementation Partners to guarantee full functionality. The Software Development Kit allows us to link up other software to operate items within

XVR On Scene and/or XVR Resource Management [16].

This program is also used by professional teams in several countries as is Netherlands, Great Britain, New Zealand, Australia, Taiwan, China, Slovakia, as well as Czech Republic. It is well suited for the practical training of the intervening units.

### C. WASP Simulation System

To meet the increasing need to coordinate or manage first responder response to emergency events and crisis situations, VR Group developed a crisis management training solution. The technology uses contemporary advanced simulation and visualization technologies for training safety and security professionals at tactical and strategic levels. This training solution provides a cost-effective and efficient means of training a large number of personnel without the travel and expenses of live training. Fig. 3 shows a user interface simulation system WASP [17].

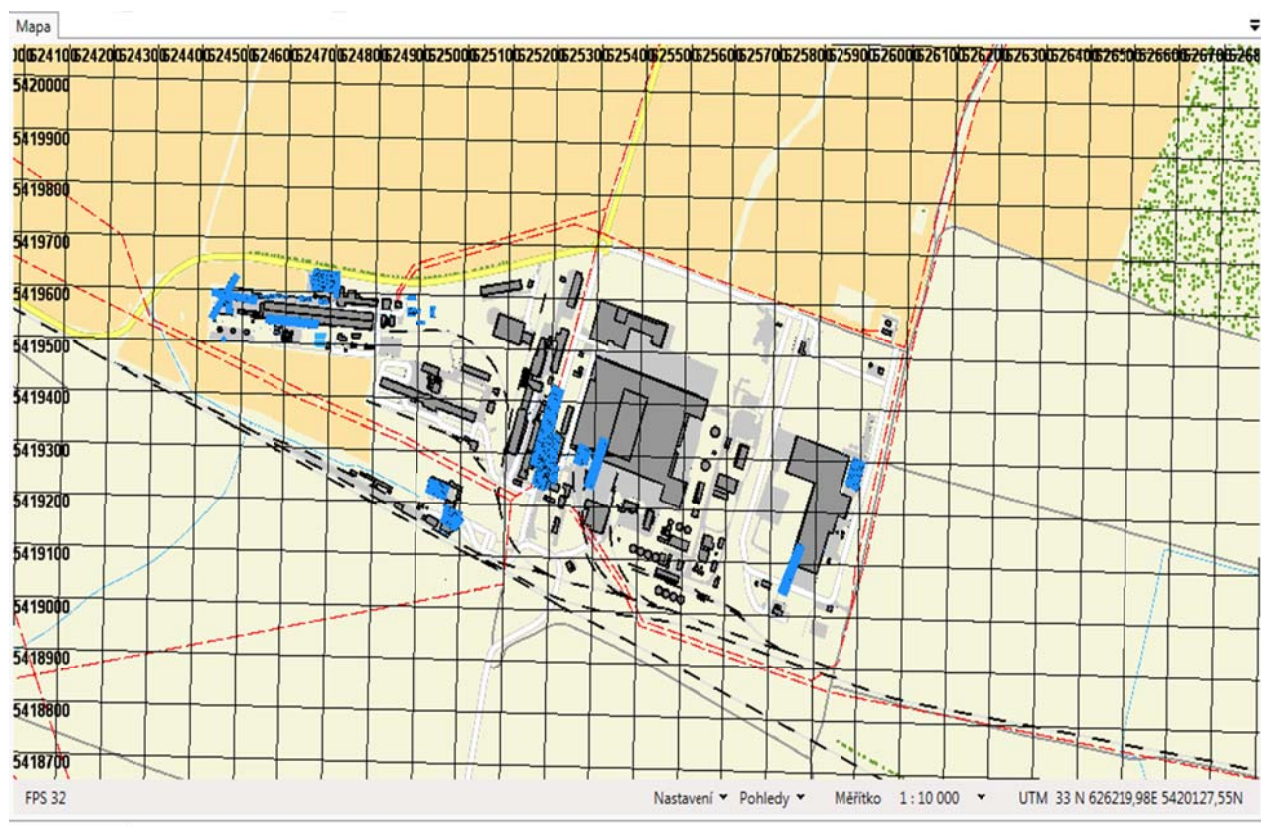


Fig. 3 Overview the Interface of Simulator WASP

It represents a system of constructive simulation for the computerised generation of forces and creation of synthetic environment. Originally, it was designed for the use of army but the version for the components of the Integrated Rescue System called WASP-C has been developed as well. The

simulator enables to practice management on the tactical (Fig. 4), operational (Fig. 3), and strategic levels. Modelling of various emergency situations and their solution is possible in this environment [17], [18].



Fig. 4 Overview the Interface of Simulator WASP

Environment in the simulator is ensured by the combination of terrain database created from the detailed geographical data, model of weather and other dynamic environmental models. Terrain database contains all common objects in the countryside (bodies of water, roads, built-up areas, vegetation, relief, type of soil and other objects). Individual objects have predefined features influencing simulation of their own entities in relation to their purpose. Weather editor enables to set basic parameters (date and time, air temperature, velocity and direction of the wind, type and intensity of precipitations, humidity and pressure of air, type of cloud cover, light intensity etc.) [18]. Some of the parameters are mutually interlinked based on the actions happening in the atmosphere known from meteorology. Dynamic models of environment enable to modification the countryside with objects and phenomena which can change their form in the course of time. There are accidents simulated in great detail as well as a vast

database of forces and means. Program puts more emphasis on the correct execution than on graphic output and it is aimed at the group of trainees as well as at an individual.

Concept of the program is suitable for the use in practical training of solving emergency events with the mutual cooperation of the intervening units.

#### V. SIMULATION TOOLS FOR EVALUATION

From the simulations programs which were analysed in detail it seems that tools concentrating on the education and practical exercises. From the evaluation of the results as can be seen from Table I, it is clear that right these programs are suitable as computer simulation as technological education for the practical training of the solution of emergency events due to their variability and simulation capabilities [8], [14].

TABLE I  
 POSSIBILITY OF SIMULATION PROGRAMS

Simulators Properties	MASA SYNERGY	XVR	WASP
Technological education for crisis management staff	YES	YES	YES
Practical training of the teams	YES	YES	YES
Practical training of the individuals	NO	YES	YES
Possibilities of editing scenarios	YES	NO	YES
Integrated communication system	YES	NO	NO
Terrain database	YES	NO	YES
Possibility to import maps (GIS)	YES	NO	YES
Environmental changes over time	YES	YES	YES
The simulator enables to practice management on the tactical level.	NO	YES	NO
The simulator enables to practice management on the operational level.	YES	YES	YES
The simulator enables to practice management on the strategic level.	YES	NO	YES
Practical training of more activities	YES	YES	YES
Recording exercises	YES	YES	YES
Automatic evaluation exercise	-	NO	NO

From the tools for simulations, modelling and support of education and practical training processes in crisis management only those programs which are available in Czech Republic.

Criteria for evaluation of computer simulators have been determined based on the needs of education and practical training crisis staffs and intervening units of the integrated rescue system. The criteria were: functionality, usability in

solving emergency events, practical training of the teams and individuals, possibility of implementation of outputs from other tools and possibilities of editing scenarios. Other important factors which influence the usability of software applications and simulation programs for education and practical training are their own functionalities which enable practical training of more activities which are later integrated into the course of the simulation. Individual education utilities extend usability of the simulators and their application range.

The most appropriate computer simulation as technological education for crisis management staff, according to the evaluation (Table I) is a simulator for practicing WASP simulation system operating management level. For training at the strategic level, it is not fully compliant. At this level has improved utility properties Virtual Reality training software for safety and security.

## VI. CONCLUSION

Information on the extent and impact of emergencies and crisis situations gives the basic framework of information for members of the crisis staff. On the basis of this information may be precautions, prevention and then education and practical training to deal the crisis situation.

The aim is to find out all necessary functions that the simulation tool should obtain for cooperative training of emergency management actors at subjects of critical infrastructure. In definition of simulation interface, there were defined broad spectrum of information and monitoring systems for technological risks that could be used for creation and processing of real simulation scenarios that will subsequently be validated by training of subjects.

For an overall understanding of the described issue, it is also appropriate to familiarize with the Process Framework for Emergency Management [1]. This contribution emphasizes the importance of the perspectives of education and practical training in the process of emergency management. It should be noted that the computer simulations itself is not sufficient for the emergency management processes. It should be supplemented by the methodology that defines how to proceed with process education and deployment.

It should be noted that the proposed computer simulation is suitable for the education and deployment of emergency processes of emergency management in the Czech Republic. Thus, the defined process education allows reflecting any changes in emergency events quickly and also creating new scenarios for educational purposes based on real examples. The resulting conception allows students to model emergency scenarios.

Finally, it is necessary to say that all computer simulators represent the function of crisis manager helper in his decision making. All computer programs are only "lifeless" products. The crisis manager is featured, especially his knowledge, abilities and acquirements, and many times also his improvisation.

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