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## **Application of research laboratories of the university science park in research of crisis management and protection of critical infrastructure facilities in the transport sector\***

### Introduction

Human society in recent years its development has become much more complex. High proportion of that has scientific and technical progress, which constantly brings new technologies. However, on the other hand they are source of risk and human being is threatening by them. Safety is the state of a system which allows in the specific conditions the fulfillment of functions and their development in the interests of man and society when risks are removed or minimized.

In the introduction we define simulation laboratories of crisis phenomena and systems for the protection of critical infrastructure facilities in the world in order to demonstrate the uniqueness of both planned laboratories in their area within university science park, the Slovak Republic, the EU and the world. We will consider the intent and application of two of the many laboratories that arise under the auspices of the University of Žilina in University Science Park to improve safety in the study areas.

The main purpose the of laboratory for modeling and simulation of crisis phenomena in transport for improvement of efficiency decision-making is to create a center of expertise for analysis, diagnosis and quantification of external influences on human – computer interaction and to improve the quality and effectiveness of training decision-making processes. Simultaneously of the research activity is also expertise on the

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situation in the real environment as well as the environment of simulations focusing on crisis phenomena in the field of transport systems.

The main purpose of the laboratory research systems of property protection of critical infrastructure in the transport sector is to design concepts and functional diagrams original equipment of laboratory (called polygons) which allows you to perform experimental research durability, efficiency and reliability of technological protection measures implemented of safety systems, or proposed in transport objects. The results of this research will be used in the context of the developed software tool to quantitatively assess the security level of the selected object.

## 1. Simulations laboratories of crisis situations and research of systems protecting facilities of critical infrastructure in the world

On the market there are a large number of software tools for crisis management, which are part of the cycle of crisis management designed for different kinds of emergencies. Laboratory for modeling and simulation of crisis phenomena that seeks to integrate these software tools and to create a unified simulation environment in which it will be possible to model, simulate and analyze the causes, reactions and consequences of crisis phenomena, as well as to model, simulate and analyze the behavior of individuals, or small groups (e.g., crisis staffs, emergency and rescue units, organized group of intruders).

As regards similar laboratories for Research systems of protection critical infrastructure facilities in the transport sector can be observed that the amount of the market does not exceed the number of laboratories focused on modeling and simulation of crisis phenomena. Currently Czech Republic and New Mexico in the United States deal with similar issue.

## 2. Laboratory of simulation a crisis phenomena in the world

**The European Crisis Management Laboratory (ECML)** acts as a research, development and test facility for ICT focused solutions which integrate devices, applications, and crisis management related information sources to support crisis management needs, such as threats analysis, common situation awareness, and collaborative decision making. The Laboratory also allows distributed crisis management training across relevant services of the European Commission, as well as with partners in the EU Member States and others engaged in crisis management, thereby enhancing their awareness and

confidence in the application of technological solutions to strengthen their functions in crisis management (JOINT, 2014).

**Emergency Management Institute (EMI)** mission is to support the Department of Homeland Security and FEMA's goals by improving the competencies of the U.S. officials in Emergency Management at all levels of government to prepare for, protect against, respond to, recover from, and mitigate the potential effects of all types of disasters and emergencies on the American people. EMI is the emergency management community's flagship training institution, and provides training to Federal, State, local, tribal, and volunteer, public, and private sector officials to strengthen emergency management core competencies for professional, career-long training. EMI directly supports the implementation of the National Incident Management System (NIMS), the National Response Framework (NRF), the National Disaster Recovery Framework (NDRF) and the National Preparedness Goal (NPG) by conveying necessary knowledge and skills to improve the nation's capability (FMEA, 2014).

As you can see in the world are located many simulation laboratories of simulation modeling and simulation of crisis phenomena. However only a small number of laboratories in the world are in which it would be possible to perform simulations of mass traffic accident with consequent of leakage dangerous substance into the surrounding environment with consequent of severe danger to life, health, property and the environment. Based on these facts, we can argue that a laboratory that will be built on the premises of the University of Zilina in a University science park aimed at the scientific research of modeling and simulation of crisis phenomena in transport for increasing the efficiency of decision-making becomes unique in the simulation of bulk traffic accident with consequent leakage of dangerous substances.

### 3. Simulation laboratories of research systems to protect critical infrastructure facilities in the world

Currently the Faculty of Applied Informatics for promoting teaching in the field of safety technology and management systems are built **laboratories “mechanical security systems” and “laboratory of advanced safety technologies”**. While in the laboratory of advanced security technology they use central control desk, infrared cameras and access control systems to teach subjects. Science and research staff of the Institute focuses mainly on the areas of biometric identification, access control systems,

advanced authentication features and systems, last but not least investigation of psychosomatic personality (FLCM, 2014).

**Sandia National Laboratories** works with other government agencies, industry and university institutions, and has determined to meet its strategic objectives in areas such as nuclear weapons, defense systems and their evaluation, energy and climate, and as a last international, internal, and nuclear safety. To effect these goals using different methodologies in different areas. The most frequently used methodologies in the area of nuclear safety are ASSESS (Analytic System and Software for Evaluating Safeguards and Security), EASI (Estimation of Adversary Sequence Interruption), SAVI (Systematic Analysis of Vulnerability to Intrusion) and many others. One area which is interesting for us given the focus of the planned laboratories in USP is a secure national critical infrastructure against physical disruption or harmful (Garcia, 2008, p. 273-274).

It can be concluded that in view of the uniqueness of instrumentation in laboratories of research systems of secure critical infrastructure facilities comes to commercially available and used equipment, which will be in combination (called polygons) used for research activities that are unique of its kind in Slovakia, but also in the EU. It will be mainly on research activities relating to measuring the probability of detecting an intruder alarm systems and alarm systems of measurement reliability in changing operating conditions. In part research activities will focus on measuring and evaluating breakthrough resistance of mechanical barrier devices (e.g. locking systems).

#### 4. Intention of research laboratories of university science park

Simulation technologies allow portray an environment for simulating facts that represent the real world, which brings to crisis and safety management dimension of “safe” environment. Simulation technologies are supported by a wide range of applications and technologies, but their development is always open and looking for new ways to their best use in different emergency situations. Initially there had been available technologies used in the military field, later in the field of computer games, medicine and other fields. Currently constructive simulation is able to prepare simulated scenarios for most areas dealing with crisis and safety management during dealing with emergencies situations and security incidents incurred.

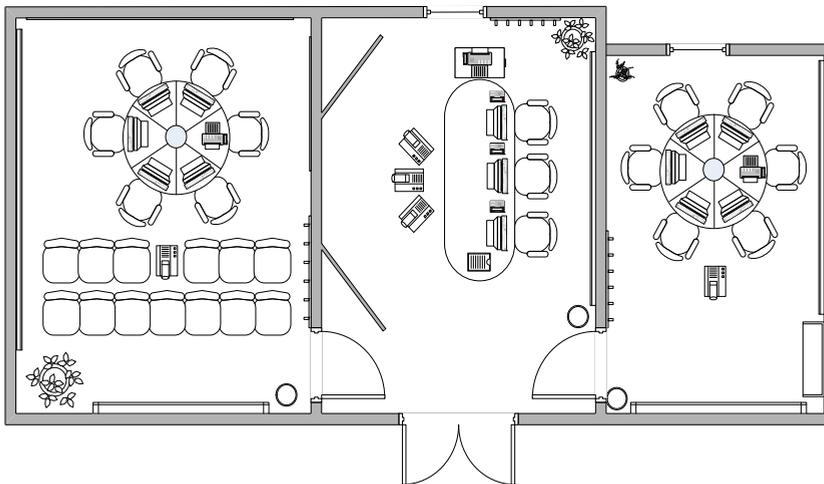
Among resulting security incidents might include the threat of critical infrastructure elements. In those circumstances, it is necessary to ensure the protection of critical in-

infrastructure elements and minimize security risks. The definition and the notion of critical infrastructure in the territory of the Slovak Republic to clarify the definition in the Act no. 45/2011. Critical infrastructure under this law means assets that are necessary for the functioning of society and its economy as a consequence of major natural or technological disasters, terrorist attacks, extreme weather and many other factors. Preparation to ensure the protection of critical infrastructure elements can be done using experimental research into the effectiveness and reliability of the technical means of protecting the security systems in transport (Law no. 45/2011).

## 5. Modeling and simulation of crisis phenomena in transport to improve efficiency of decision-making

Constructive simulation is also known as vast simulation, because it resembles in particular on strategic war games. Entities are simulated which represent individuals, plant and equipment in a virtual environment.

**Fig. 1.** 2D model of simulation laboratory of crisis phenomena



**Legend:** laboratory consists of three rooms, the first from left is a simulation room prepared for the meeting of the Crisis Staff Headquarters with possible use as a presentation room. Second, the evaluation room is a room where the evaluation will be carried out. The third room is the same as the first simulation room but without the possibility to present in this room.

**Source:** own processing.

The aim of constructive simulation is incorporates stochastic model to simulate the behavior of forces and resources in a virtual world. The simulation is performed on the basis of defined parameters and algorithms that provide the behavior of the system according to the standards and principles.

The main objective of the laboratory for modeling and simulation of crisis phenomena in transport to improve efficiency of decision-making is to create a laboratory of simulation crisis phenomena, which will enable us to:

- improve the quality of training and efficiency of decision-making in crisis management,
- increase mental endurance of emergency managers working under constant stress,
- model and simulate crisis phenomena in social, technical, technological and natural environment,
- collection, processing and evaluation (analysis, synthesis) gathered data, and
- increase the efficiency and reliability of the decision-making of the human factor of the focus for crisis phenomena in transport,
- to model and simulate the behavior of an intruder in a guarded area,
- to model and simulate the tactics intervention force in eliminating intruders.

Preparation of the future solutions by using simulation technology is one of the major challenges of today. Through modeling and simulation in the field of crisis management can improve training to cope with stressful situations and decision-making opportunities for training future managers. The objective of practice with help of simulation technologies are:

- verify the operation of the governing bodies of crisis and security management,
- verify the feasibility of processing emergency plans for dealing with emergencies situations,
- verify the functionality of the processing of documentation (e.g., contingency plans and disaster recovery plans of the organization),
- verify the functionality of actual information system (civil protection) to form emergencies situations,
- verify the assessment of the situation, calculation, capabilities and resources necessary to ensure the protection of the population in areas threatened or affected by the consequences of an emergencies situations,
- comprehensive training of the future professionals for crisis phenomena and security incidents in study programs,

- verify the accuracy of intervention force in eliminating intruders,
- to gain time of transfers intruder in the protected space and time response intervention unit from the time of initial detection of an intruder.

This type of simulation for teaching and training with support of computers is referred to as the “computer-aided exercises – CAX (Computer Assisted Exercise)”. Computers simulate processes and phenomena in real time or in a generic environment and to achieve at the participants impression of the actual implementation of the operations and activities as if they were performed in real environments and real terms. Given these facts, we can use constructive simulation in the current phase of the project to propose the following learning tasks:

- release of hazardous substance,
- release of radioactive materials,
- mass transport accident.

## **6. Simulation laboratories of research systems to protect critical infrastructure facilities**

Given the focus of article we will focus on the goals of simulation laboratories of research systems to protect critical infrastructure facilities (e.g., airport, railway junctions, tunnels, terminals, ports, line structures, etc.). The major objective is to design concepts and functional diagrams original equipment of laboratory that will carry out experimental research into the resistance, effectiveness and reliability of the technical means of protecting the security systems in transport facilities. Specifically the subject of research is the measurement and evaluation:

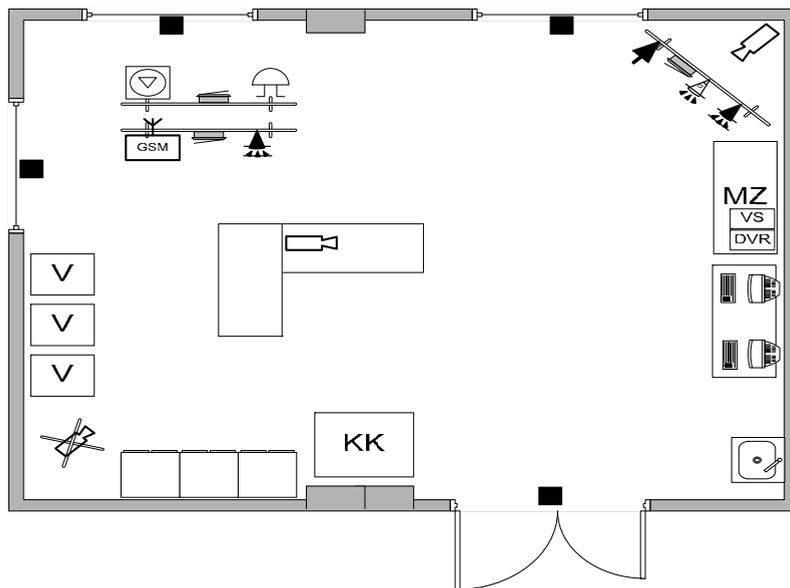
- the probability of detecting an intruder by active protection elements (electric security systems, CCTV security systems, including thermal imaging, access control systems, electric fire alarm, alarm transmission equipment for alarm signals),
- breakthrough resistance of passive protection elements (e.g. opening fillings, locking systems, storage units),
- measure and evaluate the reliability of governing and security features of comprehensive intelligent protection systems of transport construction.

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**Fig. 2.** 2D model of laboratories of research systems to protect critical infrastructure facilities



**Legend:** laboratory consists of one room in which you will find machines and equipment such as simulator for electrical security systems, trainer for camera security systems, trainer for alarm transmission systems, equipment for testing and functional analysis of smoke detectors and glass break detectors, equipment for measuring electrical quantities of alarm systems components, means for forming a fundamental changes in the physical properties of the environment, instrumentation for meting breakthrough resistance, tripods and brackets kit, training pads and polygon trainer.

**Source:** own creation.

## 7. Application of research activities in simulation laboratories of university science park

Provided services will be carried out in particular by means contract research, modeling and simulation in environment surrounding transportation systems, analysis and synthesis of data collected for the purpose of increasing the efficiency and reliability of human decision-making factor with emphasis on solving crisis events and critical infrastructure protection in transport.

Outcomes of the technologies for modeling and simulation of crisis phenomena in transport to improve efficiency of decision-making and outcomes of the research systems to protect critical infrastructure facilities in the transport sector will be unique not only from the perspective that will be performed on a unique facilities of its kind, but also because it will performed by personnel specially trained in this area.

## 8. Application of modelling and simulation of crisis phenomena in transport to increase the effectiveness of decision-making

Outcomes of the products will be developed simulator of crisis phenomena dealt with crisis and safety management, where the basic environment will simulate the movement and behavior of the entities on digitized environment. Allowing us to analyze risks in social, technical, technological and natural environment such as floods, earthquakes, landslides, spread of chemical and radioactive substances, mass traffic accidents related to the transport of dangerous substances and industrial accidents, terrorist attacks, demonstrations, sabotage, etc.

In the social, technical, technological and natural environment will be created models, procedures, methods and methodology for examining the interaction of the human factor and crisis phenomena. Those outcomes will subsequently applied in practice. Potential application of research results in practice we can use to:

- training center for crisis staffs of towns and villages, district offices, district offices at the county level,
- training center for units of the Integrated Rescue System, fire and rescue departments, chemical control laboratories of civil protection, or the local fire departments, industrial fire departments, industrial fire brigades,
- training center for Nuclear Power Plant Mochovce and Nuclear Power Plant Bohunice,

- training center for emergency medical service providers, the SEVESO enterprises, objects of special importance and other important objects, national and European operators for transport and energy critical infrastructure,
- risk analysis and creation of emergency plans for municipalities, provincial cities and regional capitals,
- legal persons for need of simulating, testing, investigation and development of new forms within the risk assessment,
- teaching vocational subjects of specialization Crisis management and scientific research activities at the University of Žilina.

## 9. Application of simulation laboratories of research systems to protect critical infrastructure facilities

The outcomes will be the original values of parameters of technological protection measures required as outcomes in quantitative software tools for the design and evaluation of systems for the protection objects of research Technology to protect critical infrastructure facilities in the transport sector which is important to protect national security of the Slovak Republic. Therefore outcomes of the activities are also directed to legal entities aiming at testing, exploration and development of elements of protection objects, or to prove in court proceedings. Potential consumers of outputs are:

- Departments of ministries and central government authorities – creating input data for security policies and studies to protect property in processing legislation to define and assess the level of protection of critical infrastructure facilities:
  - o operators of critical infrastructure facilities - teams and departments to ensure the protection of critical infrastructure facilities,
  - o the Ministry of Interior and Ministry of Defense from the perspective of the protection of state assets,
  - o the Ministry of Transport, Posts and Telecommunications in terms of asset protection transport infrastructures and transport persons and property,
  - o the Administration of State Material Reserves – protection of immovable property,
  - o the Nuclear Regulatory Authority – information about the breakthrough resistance of elements protection of any nuclear fuel and wastes and studies of the safety devices,

- authorities of local government – for the needs creation of security policies to protect property,
  - o the Office for Personal Data Protection – for the assessment and development of security projects,
- government authorities – for creating and designing security systems of municipalities,
- administrator of the toll system – commissioned a study on the protection of buildings and installations toll system,
- natural and legal persons in testing the technical elements used to protect objects,
- proof in legal disputes between insurance companies and the owners of the premises in the event of theft and property damage,
- legal and natural persons testing, examination and development of elements protection facilities,
- teaching vocational subjects of specialization security management and scientific research activities at the University of Žilina.

## Conclusion

University Science Park at University of Zilina will, among other encompassing a laboratory for research of modelling and simulation of crisis phenomena in transport to increase the effectiveness of decision-making and simulation laboratories of research systems to protect critical infrastructure facilities in the transport sector.

Laboratory for research of modelling and simulation of crisis phenomena in transport to increase the effectiveness of decision-making will be used to simulate the movement and behavior of ground and aerial environments entities on digitized 2D and 3D views, allowing modification algorithms and implementation of new modules. Laboratory will be compatible with DIS and HLA protocols and allows Real -time simulation.

Simulation laboratories of research systems to protect critical infrastructure facilities will be rare department of its kind in Slovakia and the EU, where it will be possible to precisely measure and verify the values of input and output parameters (e.g. break-through resistance, probability of detection, response time), quantitative and qualitative tools to appraise technical efficiency and reliability of existing or projected systems to protect critical infrastructure facilities in the transport sector (e.g. airports, tunnels, highway and railway networks) and energy (entities providing distribution and storage of

gas, electricity, oil and heat). By means of technology laboratory equipment can be developed and tested various polygons of electrical and mechanical control and comprehensive security features of intelligent protective systems used in carriage of passengers and transport of various types of energy and raw materials.

## References

- Garcia M.L. (2008): *The Design and Evaluation of Physical Protection Systems* :Sandia National Laboratories. 351 s. ISBN 978-0-7506-8352-4,
- (FLCM) Faculty of Logistics and Crisis Management, Tomas Bata University in Zlín, Laboratory of Crisis Management (2014): <http://www.utb.cz/flkr/laborator-kri-zoveho-rizeni>
- FMEA USA Emergency Management Institute (2014): <http://www.training.fema.gov/EMI/>
- JOINT RESEARCH CENTRE European Crisis Management Laboratory (2014): <https://ec.europa.eu/jrc/en/research-facility/european-crisis-management-laboratory-3475>
- (FAI) Faculty of Applied Informatics, Tomas Bata University in Zlín Research Areas (2014): <http://www.utb.cz/fai-en/structure/dse-research-areas>
- Law no. 45/2011 Coll. of critical infrastructure, as amended

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**Abstract**

The article focuses on two research laboratories at the University of Žilina in University Science Park under the names “Modelling and simulation of crisis phenomena in the transportation to increase the efficiency of decision-making process” and “Research systems for protection of critical infrastructure objects in the transportation”. Respective parts identify the main goals of the research, research focus and the uniqueness of respective laboratories as well as practical application within University Science Park of the University of Žilina, the Slovak Republic, the EU and the world.

**Key words:** *simulation technologies, critical infrastructure, transport, research*