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Technical Means for Implementing Simulation in the Field of Hybrid Threats

In general, exercises in a distributed environment represent the highest level of interaction and offer the maximum degree of reality, effectiveness and informative value. Distributed exercises for preparing crisis teams with the support of individual simulations can offer many analyses and experiments that cannot be verified or practised under normal conditions and circumstances. Therefore, the basic technical requirements for implementing distributed simulation using virtual simulators and constructive simulation tools will be presented below.

Reconfigurable virtual simulator

A reconfigurable virtual simulator (hereinafter referred to as "RVS") is a virtual simulation tool. It is primarily intended for tactical training of individuals, crews and operators focused on developing basic tactical and communication dispositions in command and control for training cooperation within the crew and unit. The simulator can be configured for different types of ground and air entities.[2] It has an interface for interconnections using standardised protocols, which guarantees compatibility with other simulation tools working with the same protocols and standards. The simulator consists of the following main parts – the simulator computer system and individual cabins, the configuration of which depends on the selected RVS modification. The simulator cabins represent one piece of equipment, and each is divided into three parts – the position of the intervention commander, the driver's position and, respectively, the position of a gunman. Due to the need to support training in various areas of crisis management, the RVS can be configured as any means of transport. At the AFA, the following possible configurations are involved.

1 Armed Forces Academy of General Milan Rastislav Štefánik.
2 VR Group 2022.

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– RVS in ambulance, firefighter, police modification
– RVS in modification of civil passenger vehicles, trucks, buses
– RVS in a helicopter, infantry fighting vehicle, T-72 tank, Land Rover modifications

The RVS in the modification of ambulance, firefighter, civilian vehicles, and police is intended to support the tactical training of the driver of the mentioned vehicles when it is necessary to supplement their tactical training with a vehicle – an entity for ensuring medical assistance, safety and for rescue and firefighting activities. In this case, the RVS modified and configured as a civilian vehicle can represent the population's evacuation group and is also intended as a supporting element of training. All these configurations are for trainees (driver and passenger), who can perform tasks of an informative nature, such as e.g. visual survey.

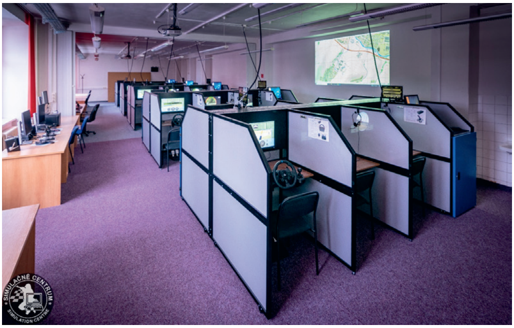

Figure 1: Reconfigurable virtual simulator
Source: Picture taken by the authors

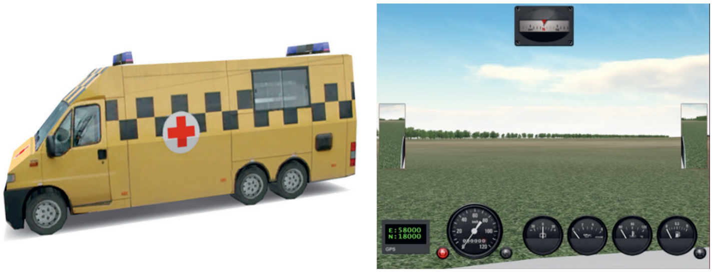

Figure 2: RVS Ambulance, visualisation in 3D space and the driver's view
Source: MÄK VR – Vantage s. a.

The RVS in the bus or truck modification is designed to support the tactical training of the vehicle driver when it is necessary to supplement the training with means for evacuation, transport, or material transfer. The bus and truck are intended for one trainee driver. All the RVS configurations mentioned above and their working positions have:

- sight available, with the help of which the trainee can see in front of the vehicle
- there are also rear-view mirrors in the field of vision, which complete the observation information
- the displayed dashboard of the given vehicle on which the devices with information on speed, engine speed, engine temperature and fuel consumption are shown
- there is the possibility of changing views and outlooks
- vehicle control is carried out similarly to the actual vehicle

The RVS in the helicopter modification is used for tactical training of the Mi-17 helicopter crew. It is a non-combat helicopter designed to transport cargo or people and is intended for a team consisting of a pilot and a co-pilot. It can also be used for possible fire extinguishing with the support of a Bambi bag. The Bambi bag is an integrated firefighting system designed to extinguish fires from the undercarriage of a helicopter.

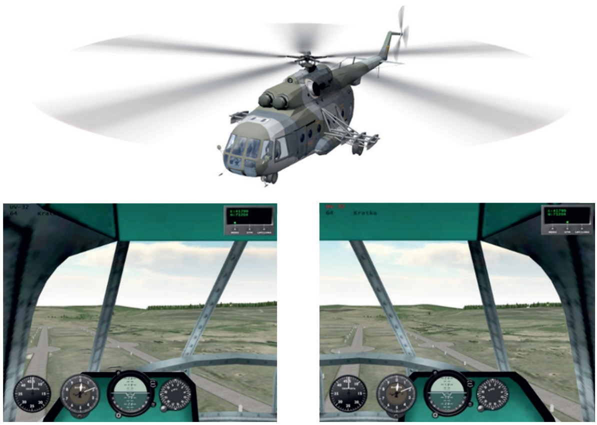

Figure 3: RVS Helicopter visualisation and 3D view of the pilot and co-pilot
Source: MÄK VR – Vantage s. a.

The controls of the pilot and co-pilot work positions allow for the following:

- starting and stopping the engine part with a sound effect
- helicopter flight by the standards
- change the display of views
- the co-pilot can overtake control of the helicopter from the pilot
- evaluate flight data from visualised devices (compass, altimeter, GPS locator, etc.)

The RVS in the infantry combat vehicle modification can be cited as an example of combat equipment. This modification is used for tactical training of the infantry combat vehicle crew. The configuration enables the function of all BMP-2 devices necessary for tactical training.

The configuration consists of 3 workplaces – driver, commander and operator gunner. The driver has devices that give him information about the vehicle's state; during the drive, he can "open" the hatch and drive the vehicle in a marching position where no devices obstruct his view. He can freely look around by tilting the steering wheel. The gunner can only change the turret's position after turning on the stabiliser. The turret stabiliser is turned on by setting the runner on the joystick; it is possible to fire with a weapon:

- rapid firecannon
- machine gun
- anti-tank guided missiles

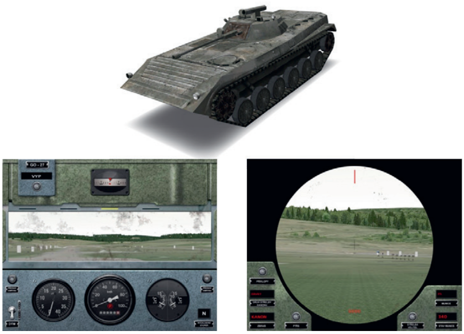

Figure 4: RVS visualisation of IFV[3] in 3D and the view of the driver and gunner
Source: MÄK VR – Vantage s. a.

[3] IFV – Infantry Fighting Vehicle.

The RVS in the Land Rover modification is used for tactical training of the combat vehicle crew. The configuration enables the function of all devices necessary for tactical training. The design consists of 3 workplaces – driver, commander and operator gunner. The driver has devices that give him information about the vehicle's state; the driver and the gunner (machine gunner) can change the weapon's position and fire. RVS in a distributed environment can simulate a large spectrum of model situations that real training entities perform; they can also implement training in a synthetic environment, all with high demands on specific activities. In an educational and training environment, these separate RVS are used to improve communication, practice tactical procedures when approaching an intervention, and check coordination skills when passing convoys. It can be concluded that their contribution to training is in the:

- coordination of procedures
- verification of specific skills
- improvement of the tactics of intervening technical entities, modules
- description of the logical sequence of events, activities and steps in the preparatory and executive phases of interventions

RVSs represent a specific alternative to real virtual simulators. During their construction, emphasis was placed on the financial solution and the system's modularity. The desired multifunctional use directly reflects the elimination of certain control elements in the equipment, and their independent use is sometimes limited. Therefore, they must be used with other simulators and constructive simulation tools in a distributed environment.

WASP constructive simulation tool

The WASP software application is a unique constructive simulation software tool that allows you to simulate human activity, technologies and events associated with human behaviour in an artificial (simulated) environment. It is designed for computer support of individual and tactical simulation of entities, technologies and events in a synthetic virtual environment. WASP is created to generate forces (Computer Generated Forces, CGF) and create a synthetic virtual environment to support individual and tactical simulation, creating scenarios and tasks. It is a fundamental building block for CAX support. During these exercises, the system enables interaction between all its users, displaying the situation and influencing the course of the simulation using user-controlled entities with semi-automatic behaviour located in the simulated environment. The system allows it to create scenarios with CGF and obstacles, control the course of exercises, control computer-generated forces and dynamically respond to training requirements.

WASP develops trainees' tactical skills, thinking, individual psychomotor skills, and cooperation of trainees in case of personal training with the help of a wide range of targets, used entities, and improvement in the command and control process during military and non-military situations.[4] WASP is a tool for stimulating "role-playing" and developing events, activities and accompanying events corresponding to actual conditions. The application software works under the Microsoft Windows operating system; the technical and software solution ensures ease of use, good reconfigurability and the possibility of expanding the system. The synthetic virtual environment of accurate terrains for the WASP system is created in the OTF ver. 8 format and allows the defining of extensive sets of terrain element attributes. Subsequently, a generic synthetic virtual environment is used to develop and prepare scenarios necessary to ensure the simulation. In contrast, a specific MDX format is used for the 3D visualisation of field databases. The graphical user interface enables the preparation and creation of scenarios, supports simulation management and displays the desired outputs corresponding to reality.

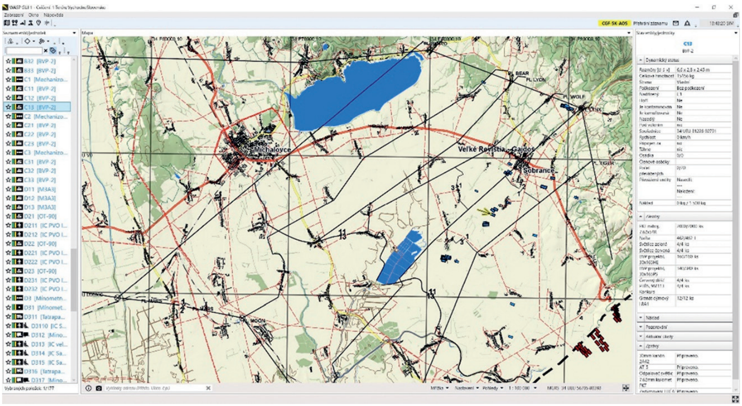

Figure 5: View of the WASP main window

Source: VR Group 2021

[4] VR Group 2022.

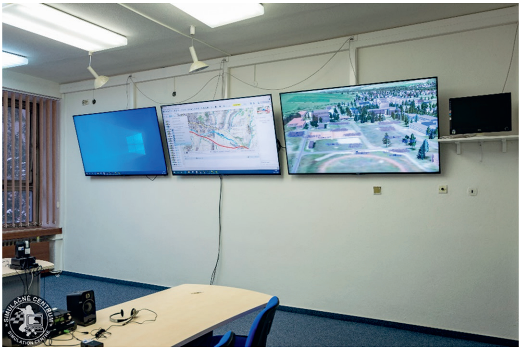

Figure 6: Control exercise room where the output from WASP and RVS is combined
Source: Picture taken by the authors

Integral components of simulation tools

Each simulation has two primary components, without which it would lose its validity. The first is communication, and the second is creating the "take-home package" from each completed CAX.

Communication system

Communication is one of the essential elements of all simulations. Without communication technology, providing any (not only) simulated exercise would be impossible. Communication technologies in the simulation environment must reflect the training subject's needs. The communication system must be configurable and flexible to the greatest extent possible to ensure all the needs of the training subjects. The configured communication system in the simulation environment is an integrated part of the simulation tools built based on commercial communication technology. This technology enables the operation of simulated communication radio networks (transmitters) and telephone sets with the option of conference selection and allows the simulation of local radio. The entire communication system is designed to communicate with individual simulation tools and to enable the forwarding of its data to the simulation network. This component allows recording the entire course of the exercise synchronously with the image (2D and 3D visualisation of the simulation), which enables the verification of actual performances with voice messages. Based on transmitted and received information in real-time, which takes place at the horizontal and vertical levels of management, the simulation's entire course unfolds or solves a simulated crisis. The communication system is designed to record individual communication channels and calls of individual participants independently of the simulation and export them to audio formats after specific sequences.

The use of the communication system and its applications enables the evaluation of communication and the submission of information of subordinate subjects to members of the training staff, as well as the submission of orders and information of staff members to subordinate subjects following the situation in the synthetic environment. Other uses of these applications include:

- evaluation of the reaction of subordinate subjects to the order issued by the staff
- evaluation of the time response of subordinate entities to orders from the staff
- evaluation of the management officer's timely response to the information obtained
- evaluation of the time response of subordinate subjects to the situation in the synthetic space

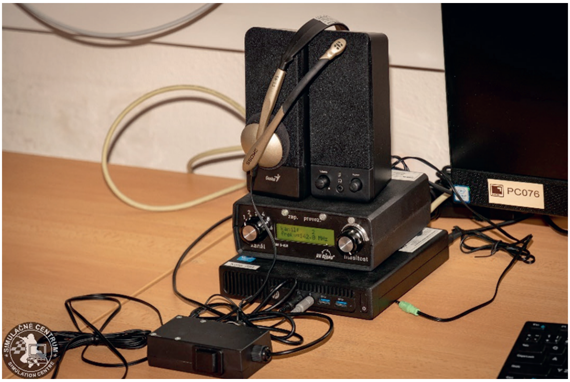

Figure 7: ASTRA communication system, present at every workplace
Source: Picture taken by the authors

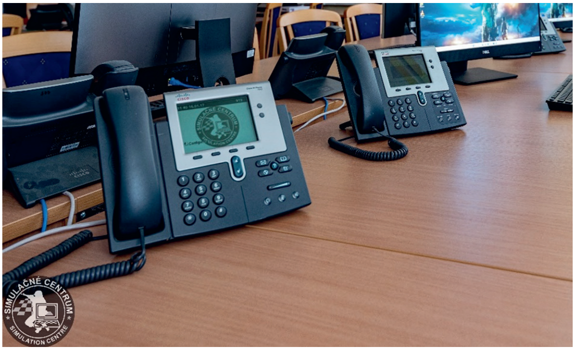

Figure 8: Phones with a fully configurable structure (Call Manager)
Source: Picture taken by the authors

"Take-home package"

The entire simulation course is recorded and serves mainly for the evaluation phase. The take-home package is the source of all relevant data from the exercise. It can be given to the exercising subject via video, audio, screenshots and statistical data. Specialised software tools are used to create the individual components of this package. The Logger device uses visualisation and 3D visualisation of the synthetic environment, continuously recording all kinds of actions and activities during the solution of a simulated emergency.[5] The device does not allow the recording to be exported to video formats, but it can be converted to the required video output through a unique converter.

Application software collects statistical data, enabling detailed data registration on the simulation's progress. These statistical data are exported in various formats, such as tables, texts, graphs, or images. This statistical tool records:

- the number of entities in the synthetic environment
- damage to entities or their destruction
- number of fuels consumed
- paths of entities, along which routes any entity moved, etc.

5 Nečas et al. 2011.

The statistical application ensures the central recording of data of interest from the simulation during its course. It brings the possibility of obtaining detailed relevant data for the overall evaluation and analysis of the implementation of the solved situation or after its parts or phases. Part of the "take-home package" is the creation of the so-called bookmarks with a description of the activity. Bookmarking is a simpler alternative to the video format. It involves creating simple images from the simulation, which serve as relevant background or evidence of the performed (not performed) activity. Such a "take-home package" containing video sequences, communication records, images and appropriate statistical data is given to all participants in the exercise as an optical medium (DVD) or flash drive, respectively uploaded to a cloud service. It can be used for subsequent analysis or as teaching material. However, its creation requires a longer interval (at least a month).

Conclusion

The presented RVS components and the image generator can create a virtual reality environment. Several studies have confirmed that such an environment has elements almost similar to a natural environment for individuals, eliciting a complex reaction involving correlated changes in the emotional state, autonomic activity and postural balance.[6] For the needs of simulating hybrid threats, this system allows simulation of the environment for performing tasks at the operational level (firefighters, police, medical service, etc.) which, for example, can be the elimination of the consequences of accidents and natural disasters. These can result from hybrid threats, such as dam sabotage, a terrorist attack, or civil unrest. All the mentioned aspects are reflected in the virtual environment, and the trainee at the operational level has to deal not only with the technical solution of his task but also with his psychological resistance to stress. The simulation built in this way gives the trainees a realistic picture of the temporal context during the crisis (virtual reality does not allow jumps either in time or from place to place), develops the ability to autonomously solve operational problems with a high risk of intervention from third parties, and builds the individual's psychological resilience in fulfilling time-consuming tasks under mental load. On the other hand, constructive simulation tools like WASP fully

[6] Bzdúšková et al. 2022.

support the simulation environment. The entire time sequence of the simulation is solved by individual events defined in the space of the constructive simulation program. In addition, its elements can react in real-time (or leave a passive flow of events) to individual measures taken by the trainees. This game makes the constructive simulation software an ideal partner for the decision-making body component (for example, the city hall and its crisis staff). Thus, the constructive simulation tool provides a map basis for the simulation process and a sequence of events directly related to the hybrid activity. For example, civil disobedience can result in the blockage of essential transport channels; it can also lead to flooding from a burst dam. The tool of constructive simulation determines the time pace of the entire exercise. It serves to practice the decision-making process using risk management when performing time-consuming and critical tasks. Another vital part of the simulation environment is the communication system. In addition to modelling events stemming from a hybrid threat in the constructive WASP environment, communication systems (phones, ASTRA, PC network) were added another dimension where hybrid threats could be modelled. This is mainly about electronic communication channels. These are implemented in an artificial environment through websites, e-mail accounts, public radio and telephone connections. In every section of this layer, it is possible to apply a hybrid threat by spreading disinformation, interrupting the communication line, or overloading it. If the trainees do not respond to these stimuli in time, the consequences will be reflected, e.g. in the form of civil disobedience. This will be implemented through a constructive simulation tool (a complication for the crisis team) and, thanks to the distributed simulation, will immediately transfer to the virtual space (unexpected obstacles for operatives in the field). This method of simulating hybrid threats greatly helps trainees acquire basic resistance to attacks in the electronic space.

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