ISSN: 1231-4005
e-ISSN: 2354-0133
DOI: 10.5604/12314005.1161791

DESIGNING ADVANCED VEHICLE TRAINERS USING VIRTUAL SIMULATION TECHNOLOGY

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Abstract

The material presents issues related to using virtual simulator technology to design and implement various types of vehicle training stimulator-simulators. The needs were discussed for computer-assisted training using virtual simulation. Benefits of using virtual simulation technology were pointed out. The properties of a selected virtual simulation environment, as VBS3 [8] [13] is, were presented.

Examples of three different vehicle-training simulators were presented: a medium-sized State Fire Service combat vehicle, and a railed as well as a wheeled LAV Rosomak armoured vehicle. Each of the trainers was built in order to carry out the training. The State Fire Service vehicle is used to study decision-making by the driver while driving to the place of action. The LAV Rosomak is used to train the use of weapons systems fitted in the vehicle by the commander as well as actions taken. The rail vehicle simulator is designed to train operators of these types of vehicles and to train for proper response to signals and situations within the area of the track. Examples of dedicated virtual objects were presented. At the end, exemplary training stimulator-simulators are presented using the technology of virtual simulators.

Keywords: *virtual simulation, simulators, trainers, crew training*

1. The needs for using virtual simulators for training

One of the fastest growing trends in the field of simulation is the market development of virtual simulators and trainers [1]. The emergence of specialized virtual simulators on the market, enabling the replicating of objects with high accuracy, significantly developed their suitability for training [2], [3].

The use of virtual simulators for training is aimed at replacing the real world with the virtual world. This ability provides new opportunities for training, allowing carrying out exercises in the virtual world using the current procedures and the use of real or close to real equipment.

Possible applications of virtual simulators for training result from the following properties of these simulators: course of action, the ability to build and model their own objects (combat vehicle, people, buildings), the ability to build their own maps, the ability to build their own scenarios, the ability to program weather conditions as well as the behaviour of the simulated natural environment, the possibility of the instructor to interfere during the simulation, the ability to program the behaviour of objects, the ability to record and playback the course of the simulation.

The application of advanced virtual simulation environments allows building a variety of exercise scenarios. It is one of the most important advantages of these environments. The scenario consists of the following elements: map, fixed objects (e.g.: buildings, warehouses, towers), elements of the natural environment (e.g.: trees, animals), vehicles, people.

Application of advanced simulation environments as an important element of the trainer offers the following benefits:

- lower training costs,

- training situations that are very difficult to reproduce in reality,
- training situations that are impossible to reproduce in the real world due to high costs or high risks for trainees
- possibility to practice the efficiency of procedures and validating new procedures,
- possibility to practice using new equipment.

2. Characteristics of virtual simulators allowing their use for building advanced training simulators

Programmable virtual simulation environment is a set of software tools that enable comprehensive and integrated simulation of various types of actions including individuals and groups of individuals with the use of modern information technology [8]. The system presented in the study has advanced simulation algorithms of various actions with a high degree of detail in graphic imaging. This technology allows conducting *Serious Game*-type exercises and enables achieving a high level of immersion of exercisers into virtual reality – a high level of immersion.

The simulation performed using the VBS3 system takes into account the impact on simulated objects of the natural environmental and the processes occurring in it. The simulation takes into account the following aspects of the environment: weather conditions (cloudiness, rain, snow, insolation), the transition cycle of the sun during the day, the cycle of the moon and stars in the night, wind strength and direction, sound propagation depending on the terrain and fixed facilities, sea conditions depending on the weather, the distribution of light, fire and smoke imaging depending on the source as well as weather conditions and imaging associated with sound and visual effects of an explosion of explosives.

The simulator provides a set of specialized tools to: build own objects, such as vehicles, buildings, weapons, plants, people; prepare own terrain using data obtained from standard map resources; preparing advanced scenarios on various aspects of the simulation at the level of individual objects. An important element is the database of prepared elements that can easily be used in own solutions. This includes military and civilian equipment database (wheeled and tracked vehicles of various armies in the world), a diverse database of weapons and ammunition, soldiers and civilians with various equipment, terrain objects database (buildings, objects and vegetation).

There is a possibility to use the prepared maps with different characteristics: open terrain, urban setting, European buildings, American buildings, small or large forested land, the different categories of roads and various types of buildings. The simulator also provides tools to build virtual maps reflecting real areas. Building and launching scenarios is one of the most important ways to use the VBS3 simulation environment. Building of the mission is done using a special editor in 2D and 3D views. The mission during simulation can be modified. This is possible by using an additional editor that is available for the administrator.

An important component of the virtual simulation environment is the ability to create your own dedicated software. The primary method of programming the VBS3 environment is by using scripting language and using the ASI interface.

3. Examples of completed trainers of selected vehicles

In the following section, examples of implementing trainers of various types of vehicles are presented using virtual simulator technologies. Presented examples include:

- National Fire Service vehicle (medium sized Renault MIDLUM vehicle) made in the form of a mobile container,
- Fire Control System Simulator for the KTO Rosomak combat vehicle with accurate imaging of components of the mechanical structure of the turret,

- Rail vehicle for a simulator designed for training drivers of rail vehicles.

National Fire Service vehicle simulator

The Renault MIDLUM National Fire Service vehicle trainer station was created using the VBS environment [3]. The virtual simulator software was used to build virtual maps and scenarios, in which the training driver has modelled exercising decision-making situations. Because of the view of the three large monitors, the driver should properly evaluate his/her surrounding situation and make the right decisions.

The simulator consists of the following positions:

- training driver,
- instructor,
- administrator.

Fig. 1. Components of the National Fire Service vehicle driver simulator [3]

The driver's station in the Renault MIDLUM was made using original elements of the vehicle: the dashboard with the indicators and buttons, steering wheel, gearshift, handbrake, brake pedal, clutch pedal, gas pedal, seat with safety belt, upper panel.

Suitable object models (buildings, elements of urban infrastructure, vehicles and personnel from different services) have been developed for the virtual simulator to give the environment more of a "Polish" appearance for the trainee in the vehicle.

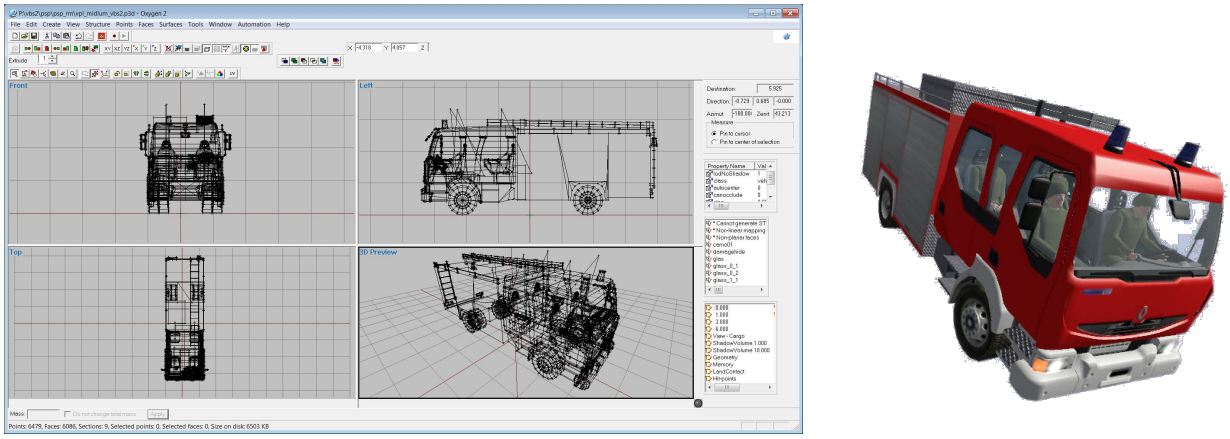

Fig. 2. Virtual 3D model of the National Fire Service vehicle [3]

Since the training vehicle in the simulator is a Renault MIDLUM vehicle, its model has been implemented at a large level of detail that allows the mapping of its behaviour in the virtual world and its interaction with the physical elements of the driver's station (steering wheel, buttons, joystick, etc.).

Fig. 3. Replicating the National Fire Service vehicle driver's station with the view generated by the virtual simulator [3]

Fire Control System Simulator for the SK1-Pluton

Fire Control System Simulator [6] of the Hitfist-30P turret for the SK-1 Pluton KTO Rosomak Simulator is one of the most advanced solutions on the market of trainers. The software was made using the VBS programmable virtual simulation environment. The software works with instrumentation imitators of the Hitfist-30P turret and generates an image on the monitor of the gunner and commander (daytime, night time and thermal camera view), on nine periscopes and on direct observation devices.

Fig. 4. SK1 Pluton Simulator and software elements of the SKO simulator [6]

The software reproduces the full algorithmics of the fire control system operation including: switching the turret on and off, turret rotation and lifting using manual and automatic mechanisms, the choice of weapons and the type of ammunition, switching the turret and weapon locks on and off, aiming, firing and acting in case of an emergency. The developed SKO software interacts with the driver's software as well as supervisor's and instructor's software. The simulator allows you to conduct advanced training in the use of the turret as well as commander and gunner tactics.

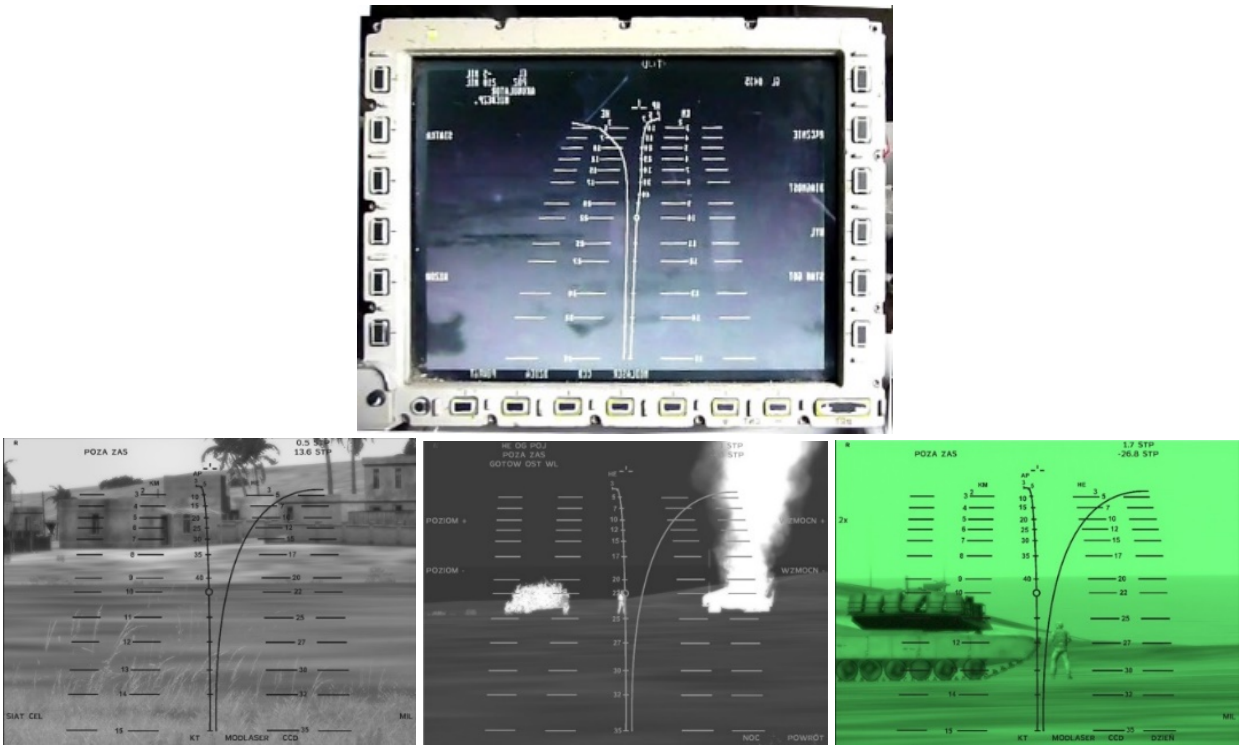

Fig. 5. Examples of simulated imaging on the monitors of the Fire Control System in the SK1-Pluton simulator (real monitor and virtual imaging [6]

Rail vehicle simulator

Simulator project [5] is based on the use of advanced technology of virtual simulation in the form of a cab of a selected locomotive. The use of the virtual simulation environment will allow imaging the virtual world as seen by the trainee, taking into account the need for imaging objects with a high level of detail. Along with the trainee's station, other stations are developed, such as the administrator's and the instructor's station running in one simulation environment. Simulation engine software as well as the graphics engine allows users to reproduce the movement of the training object (locomotives) in a virtual world using a dedicated map.

Fig. 6 shows the possibility of replicating the logic of directing rail traffic was also considered. The station will be equipped with a set of joysticks suitable for the given locomotive model to replicate truly the locomotive station of the person controlling the locomotive. Imaging the virtual world will give the trainee spatial orientation to the extent that is possible in a real vehicle.

Fig. 6. A fragment of the real map [google/maps] and the digital map of the rail vehicle simulator for the railway section Mostówka-Wyszków (2D view) [5]

An important element of the map for the rail vehicle simulator is to replicate elements of the railway line and its immediate environment to recreate the environment to the maximum extent where the training is taken place. Fig. 7 shows examples of projects dedicated to the objects that have been designed and implemented in the virtual simulator.

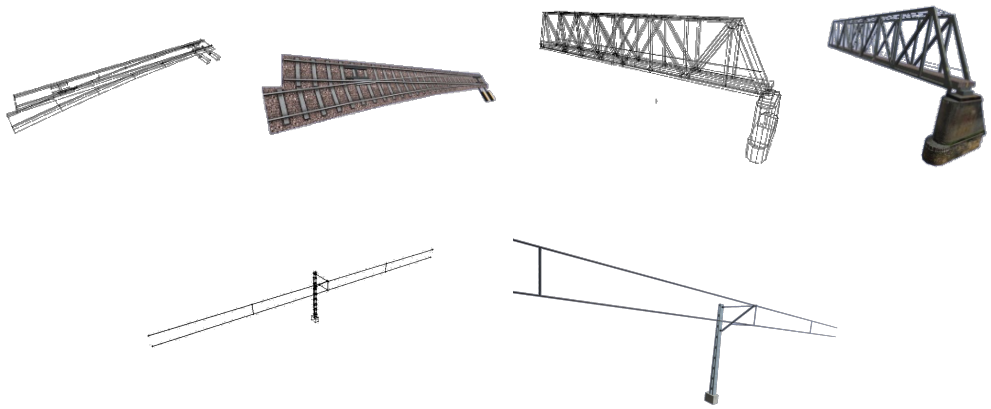

Fig. 7. Project examples of objects for the virtual simulator (railway junction, the span of the bridge, electric traction) [5]

The main object of the simulation is a locomotive, which operation is reproduced in the virtual simulator as a training station in Fig. 8.

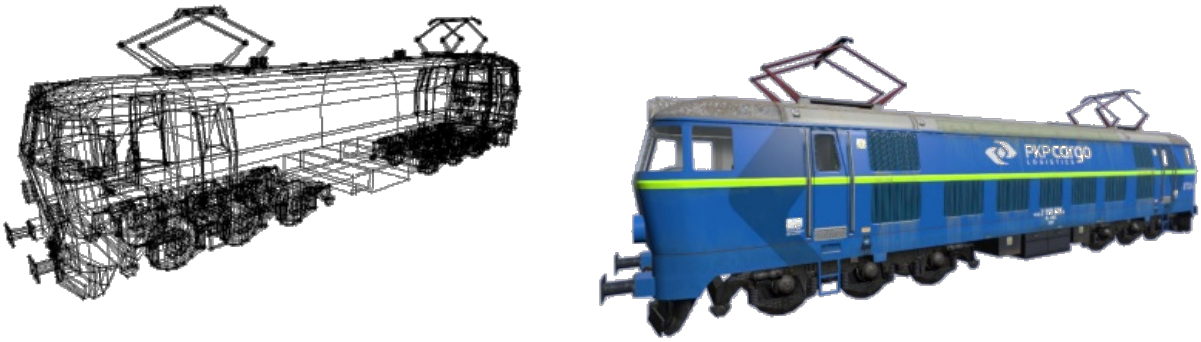

Fig. 8. ET22 virtual locomotive model [5]

Another issue is the construction of the physical station for the trainee. An integral part of this station is the imaging, which can be made in the form of a large-format display.

Fig. 9. The construction of the large-format display and exemplary imaging [5]

4. Conclusion

Presented in this paper are examples of using virtual simulators to build trainers demonstrate their great possibilities in this regard. The main issue pursued by the engines of virtual simulators is to simulate the phenomena occurring in the virtual world with regard to the conditions existing in the real world.

VBS3 simulation environment along with a set of additional tools provides a comprehensive solution for supporting *Serious Game*-type exercises [13].

The trainers are focused on the training of individuals, groups, task forces, holders of positions and equipment operators. Such properties of virtual simulation environments allow reproducing a high level of immersion of conducted computer-assisted exercises, which is an important element of exercises carried out using them.

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