TRUCK AND BUS SIMULATOR AS AN ELEMENT OF THE PROFESSIONAL DRIVER TRAINING SYSTEM – EXPERIENCE FROM THE EUROPEAN PROJECT “TOT TO FCO”

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Abstract: Driving simulators are increasingly used for training of the drivers almost all over the world. They are practical and effective educational tools to encourage safe driving techniques among the drivers.

The paper includes the assumptions of EU Leonardo da Vinci project - Transfer of innovation (TOI) entitled - Training of Trainers for the obligatory periodic training (« TOT to FCO ») of truck drivers (transfer of EU directive 2003/59/EC as of September 10, 2009) which was created to improve the quality of driver training and to increase road safety. It was designed to help adapt existing innovative practices for use in new settings, through working with transnational partners (Poland, Spain, France, Belgium).

1. INTRODUCTION

the use of driving simulator in training.

During initial qualification “…each driver may drive for a maximum of eight hours of the 20 hours of individual driving on special terrain or on a top-of-the-range simulator so as to assess training in rational driving based on safety regulations, in particular with regard to vehicle handling in different road conditions and the way they change with different atmospheric conditions and the time of day or night.”

As part of the compulsory periodic training whose duration must be of 35 hours every five years, given in periods of at least seven hours, such periodic training may be provided, in part, on top-of-the-range simulators.”

2. DRIVING SIMULATOR – THE ELEMENT OF TRAINING

Simulator is an equipment, which imitates drivers’ working environment. It is very useful in training and advancement of the drivers’ skills, in the research connected with drivers’ behaviours and various kinds of dysfunctional influences on the safe driving. The impacts of fatigue, medications and drugs are also take into account. Because of the possibilities to take measurements, it is also useful in designing road infrastructure.

The important factors of accidents in transport system can be divided into three: human, technical and environmental. Human mistakes can be the result of improperly performed task and/or equipment design and ineffective training [2]. So, the special significance of the driving simulator is in the driver training.

The first simulators were used in training of pilots at the beginning of the XXth Century. Sometime at the end of the 1960’s and at the beginning of the 1970’s they made their way to motorism.

Driving simulators are increasingly used for training of the drivers almost all over the world. They are practical and effective educational tools to improve driving training techniques for all drivers.

Compared with training in vehicles in the real traffic, truck driving simulation training has many advantages and benefits:

- It increases quality and efficiency of training.
- It improves driving skills in risky situations.
- It is environmentally friendly and can be useful in teaching eco-driving (the effect is lower fuel consumption in real vehicle operation and air pollution reduction - 1000 of training trucks in Europe produce 40 000 tons of CO₂ a year, 50% use of simulator for training may reduce pollution by 20 000 tons).
- Lower staff costs.
- Optimization of training costs.
- Compliance with EU directives on drivers qualification training.
- Long lifetime of the simulator (as compared with the real vehicle).

Training on the simulator offers:
Exposition to a wide variety of traffic situations - specific training scenarios can be arranged in such a way that they offer many educational moments in a short period of time.

Repetition of the scenarios (or only difficult moments) - the trainee-driver can practice dangerous and unexpected situations in the safe conditions many times.

Different weather conditions (fog, rain, snow), road environment (city, village, motorway, country roads, mountain roads), day or night time and risk level (for example; intrusion of the pedestrian into the road) – all conditions can be selected from the list and adjusted according to the required scenario.

Computerized and objective assessment – the evaluation is done by the program or/and by the instructor, the trainee-driver’ behaviour can be measured very precisely and objectively.

Feedback from different perspective - driving simulators have the possibility to provide audio and visual feedback after training, while a learner is driving – from the trainer and a bird’s eye (helicopter) view or another road user's viewing point.

A driving simulator allows drivers to practice dangerous situations in a safe environment. It’s very important, since about 3 thousands people die in road accidents everyday world wide. This brings it to a number of 1,3 million people every year. The total costs (mental, social and financial) of the accident, which people have to pay are so high that the European Union is deeply concerned in the phenomena.

The form of regulation of driver training on a simulator is the aforementioned Directive. This Directive obligates the Member States to change the system of drivers training (buses and trucks). The emphasis is on the road safety, reducing emissions and fuel consumption.

The trainee-driver after training on a simulator should be able to demonstrate practical knowledge in the following areas:
- respecting traffic regulations,
- use the power-assisted braking and steering systems,
- use on-board monitoring devices,
- recognition of traffic dangers and evaluation of their seriousness,
- understanding attitudes of other road users,
- avoiding causing dangerous situations and to react appropriately when dangerous situations happen,
- performing necessary manoeuvres accurately and safely,
- driving efficiently and with minimum fuel consumption in the city and when driving for a long time with the set speed,
- identifying specific risk factors related to the lack of experience of other road users and to various road conditions,
- proper use of the vehicle in respect to the environment.

Although simulation can eliminate a crash risk, the use of simulation introduces another risk – simulator sickness, which has similar symptoms to the motion sickness. This sickness was initially documented by Havron and Butler in 1957 in a helicopter training [1]. There are quite large individual differences in susceptibility to simulator sickness. Not everyone who experiences the same simulation gets sick [3]. There's is no universal solution to avoid simulator sickness.
3. THE EUROPEAN LEONARDO DA VINCI PROJECT – TRAINING OF TRainers

Transfer of innovation project (TOI) entitled - Training of Trainers for the obligatory periodic training (« TOT to FCO ») of truck drivers carrying of goods (transfer of EU directive 2003/59/EC as of September 10, 2009) was created to improve the quality of driver training and to increase road safety.

The project started in September 2009 and has finished in September 2011 (duration - 24 months).
The three main objectives of the project are as follows:
- adopt innovative content of the driver training,
- produce tangible products,
- transfer the results to new setting to the third parties.

This project assumes that through the cooperation of the international partners from Poland, Spain, France and Belgium, the new standards of training for drivers will arise, and they will be then possible to be used in various European countries.

It will happen by:
1. Implementing an e-learning and face-to-face training programme for trainers based on the observation and needs analysis during mobility weeks in Poland and Spain.
2. Training Spanish and Polish trainers thus contributing to their professional development through international co-operation.
3. Accompanying trainers via e-learning with a view to facilitating transfer of innovation in Spain and in Poland.
4. Developing and delivering “TOT to FCO” on a European level through dissemination and taking advantage of the results.

There are 5 partners in the project:

1. ITS (Motor Transport Institute) - Poland
2. ZMPD (Association of International Road Transport Operators) - Poland,
3. ASTIC (Association del Transporte Internacional por Carretera) - Spain
4. IRU (International Road Transport Union) - Belgium
5. The Promotrans Groupe - France
Each partner has own role and contribution to the project. 
Three modules are being prepared: 
1. technical (include driving simulator module), 
2. pedagogy, 
3. methodology. 

France (PROMOTRANS) role is to design the e-learning technical and pedagogy modules. Spain (ASTIC) is designing methodology module. The role of Poland - Motor Transport Institute (ITS) - in the project is to design a driving training module for use on the simulator. Belgium (IRU) is a core partner, whose role is taking advantage of the results and disseminate them at the international level. 

The project consists of 9 phases. Each of them includes key activities, deadline, duration, partners engaged in the phase, output and deliverables. 

One of the most important stage in the project was training 4 Polish and 3 Spanish trainers to conduct the training of trainers to FCO. Their role after this training would be teaching FCO in their own countries. This training took place in Paris in October 2010. 

TOT to FCO training content: 

1. **Technical module** 
The objective of the module was as following: Trainers should be familiar with the technical content of the obligatory periodic training programme in order to train truck drivers carrying of goods. 
The module comprised three groups of issues:  
- Advanced Training in Rational Driving based on Safety Regulations  
- Application of Regulations  
- Health, Road and Environmental Safety, Service, Logistics  
The part of technical module was training on simulator. Driving simulator module was conducted in the third week of instructor training. The Polish and Spanish trainers got familiarized with using simulators in drivers training. The objective of the module was for the trainers to have full command of the pedagogy applied to driving simulators in both normal and difficult situations. 
The emphasis was on fuel-efficient driving practices, design of learning programmes in driving based on various parameters, analysis of trainee’s learning outcomes and assessment of driving performances. 

Each partners of the projects (PROMOTRANS, ASTIC, ITS) possesses driving simulators. Each of them comply with Directive 2003/59. The most important difference is that one of them - THALES TRUST3000 (France) – is the mobile simulator.
Fig. 1. The photo of LANDER simulator - Spain [7]

Fig. 2. The photo of THALES simulator – France [6]
2. **Methodological module** shows the possibility of using Internet, e-learning platform in training trainers and drivers. The objective of the module was: “Identify the e-learning environment and training characteristic as well as acquire knowledge of the distance-learning platform”.

3. **Pedagogical module** will provide trainers with basic principles of andragogy – designing, teaching and evaluating the Obligatory Periodic Training course meant for LGV drivers under EU directive 2003/59/EC.

This module anticipates, besides the theoretical part, a lot of problem exercises, and case studies. At the end of the module, each participant had the task to prepare and show the presentation connected with the theme of the directive.
The role of ITS in the project was to create training module of the simulator for drivers’ trainers and adapting a training module content to current national highway codes and road freight transport rules. However, driving simulators in Poland are not compulsory during the periodic training but they can be used during the initial qualification. The objectives are:
- to gain knowledge of driving pedagogy for the simulator to utilised in both normal and difficult situations,
- to help trainee drivers optimise fuel consumption,
- to carry out various learning situations and implement different driving scenarios,
- to measure driving behaviour and assess driving performance.

ITS simulator - AS 1300 [5] which were used in designing the module, is a full-scale, top-of-the-range, truck and bus simulator training system, designed to fulfil the future European heavy vehicle driver trainings need. Driver cabin interface, which is the replica of the real truck driver workstation (SCANIA) is fixed to a motion platform with three degrees of freedom (DOF). The motion system simulates the vibrations and collisions that occur in real operating conditions. The Audio system reproduces the sound effects generated by vibration (cabin moving during travel), another noises. An important element of the simulator is a visualization system, which recreates on a projection screen the same environment that the operator would actually experience. Outside the cabin, there is an operator workstation interface, equipped with a special monitors for following the exercise in real time. The simulator’s software enables the projection of up to 100 objects simultaneously and to imitate over 200 km virtual roads.

The simulator takes advantage of delusion experienced by human senses. A driver sitting in the vehicle feels that he/she participates in the real traffic (there are realistic visualisation and replication of traffic with vehicles, cars, motorbikes, cyclist and pedestrians). The vehicles interact with each other to give a natural flow of traffic. The traffic has been programmed to follow the normal traffic rules, which can also be overridden by the exercise system to cause the driver to perform unexpected manoeuvres.

The Road Transport Act - called the Anti-crisis Act - written that the simulators which have been certified by the Polish System of Accreditation (PCA), are admitted to training. Article 6 of the Act of 12 February 2010 amending the Act of The Road Transport and amending some other acts (Dz. U. Nr. 43, poz. 246) said that “The technical device to simulate driving in special conditions, with an appropriate certificate issued by an accredited in the Polish System of Accreditation before the entry into force of this Act, shall be considered as meeting the requirements specified in regulations issued art 39g ust.12 of the Act amended in Article 1.”

Motor Transport Institute prepared proposal of training strategy. The basic goal is to practice driving safety (according to road safety rules) and in eco- (economy, ecology) way. Thanks to such training, drivers will become aware of the risky situations that can occur in traffic and may develop a cautious attitude.

Trainers play very significant role in providing high level and effectiveness of training. They share the basic knowledge and practice gained on a simulator with trainee-drivers. Desired skills include a high standard of driving ability, a sound knowledge of the subjects related to instructing others, how people learn, interpersonal and communication skills. Because simulator is a unique equipment, besides features required in street training, the trainers who provide training with the use of the simulator should have a special
competences: pedagogic qualifications (the best candidate is a person who has been a trainer in real situations for some time), general and specific knowledge of all the areas of training and practical experience. Personal skills are also important.
The strategy has been prepared for driver training and divided into eight units:

**Unit 1: Practical skills inside the simulator—adaptive training**
The **aim**: The trainee-driver practices the basic skills inside the simulator

**Unit 2: Basic manoeuvres in a work area**
The **aim**: The trainee-driver practice the basic manoeuvres

**Unit 3: Driving on a motorway**
The **aim**: The trainee-driver practices driving in a specific area - motorway in different weather conditions.

**Unit 4: Driving in a village**
The **aim**: The trainee-driver practices driving in a village area with average traffic congestion, both during the day and at night.

**Unit 5: Driving in urban area – town**
The **aim**: The trainee-driver practices driving in a urban area with traffic congestion in different weather conditions and various speeds.

**Unit 6: Driving in the hills**
The **aim**: The trainee-driver practices driving on a road in the mountains (hills) in different weather conditions. The driver also learns how to brake downhill and start uphill on an icy road.

**Unit 7: Manoeuvres**
The **aim**: The trainee-driver practices to manoeuvre a large vehicle.

**Unit 8: Eco-driving**
The **aim**: The trainee-driver will learn and practice eco driving and will become aware of how driving style and the co-ordination of accelerator and gear-shifting affects fuel consumption and other costs by analyzing the variation in fuel consumption and other simulated costs, while driving in different ways.

The strategy of training:
- All Units are described in the same way and have their own aims, duration, exercises (scenarios), skill acquired after training, and methodological recommendations for trainers.
- Almost every unit offers several scenarios. The trainer has the possibility of selecting scenarios and adjusting them guided by the time of their duration, knowledge and experience of trainee-drivers.
- The level of difficulty will increase with time and other units.
- Each scenario has its own map – the route.
- The scenario from the first Unit is obligatory for each driver-trainee. It is meant as a preparation for the task to be performed in subsequent ones.
- Taking part in these kinds of trainings the drivers become aware of the risky situations which can occur on the road.
- In each Unit, there are some hard or risky situations, which can occur on the road (tyre puncture, deer/bicyclist crossing the road, drunken pedestrian crossing on red light, road works, brake failure, accident etc.). Trainee-drivers have the possibility of driving in fog, snow, rain on slippery road, during a day and at night. Each scenario is evaluated
by the trainer or computer program. The trainer checks if all tasks are performed according to the instructions. He/she also makes pedagogical observations on a driver’s behaviour in the simulator, and a trainee’s engagement in performing exercises.

Fig. 5. The example of the map

Below is the example of the first unit.

<table>
<thead>
<tr>
<th>Title:</th>
<th>Practical skills inside the simulator–adaptive training</th>
</tr>
</thead>
<tbody>
<tr>
<td>The aim:</td>
<td>The trainee-driver practices basic skills inside the simulator</td>
</tr>
<tr>
<td>Duration:</td>
<td>8 minutes</td>
</tr>
<tr>
<td>Difficulty level:</td>
<td>Very easy</td>
</tr>
<tr>
<td>Scenario:</td>
<td>Parking/manoeuvring place + rural road</td>
</tr>
<tr>
<td>Traffic:</td>
<td>None or very small</td>
</tr>
<tr>
<td>Weather conditions:</td>
<td>Excellent</td>
</tr>
<tr>
<td>Time:</td>
<td>Day</td>
</tr>
<tr>
<td>Description:</td>
<td>A trainee-driver gets familiarized with the truck. The scenario is divided into two parts. The first one is an interactive training (instruction) for handling car equipment inside the cabin. During trainer’s cabin presentation, the trainee-driver is asked to use named devices. The second part is practicing some basic maneuvers: moving off, stopping and reversing the vehicle.</td>
</tr>
</tbody>
</table>

Tab. 1. Unit 1
Scenario:
The exercise starts at the lay-by on the road. The task is to move the vehicle, drive straight, stop the vehicle and reverse. The next step is to drive straight on a suburban road without other road users, where trainee-driver practices starting the engine and moving the vehicle smoothly as well as stopping the car, accelerating using higher and lower gears and using split gears and then stopping the car. It is important to locate the vehicle in one lane. These manoeuvres are repeated for the second time. The exercise ends at the car park (for example in front of the store). The trainee-driver has to park the car between the vehicles, using mirrors.

After the exercise the trainee-driver is able to:
- Adjust the seat as necessary, use the seat belts, use the vehicle controls (steering wheel, accelerator, clutch, gears, handbrake and footbrake, split gear, crawl gear).
- Start the engine and move the vehicle smoothly.
- Use the mirrors during driving as well as parking.
- Brake and reverse.

The trainer sits by the control station, using only an intercom and screen view from camera inside the cabin. He/she supervises training process and pays a special attention to trainee-driver behaviour (simulator sickness symptoms). The important, from the trainee-driver point of view, is to get feedback about the results of the exercises.

The instructor can create simulation scenarios (in all weather conditions and all times of day), make drivers repeat a test in the same conditions, in the event he has not performed well in a particular scenario, and can analyze any errors, which he/she made, move to the...
higher training level, gradually introducing more demanding scenarios as the drivers gradually enhance their skills.

Simulator module prepared by ITS, was tested in July/August 2011 by several driving instructors with long practical experience as well as by others trainer and drivers with C driving licence category. Trainers and drivers were satisfied with the high level of the pilot training. Now the driving guidebook for use on a simulator is being prepared.

4. CONCLUSION

Growth number of vehicles in Polish market Institute approximated about 3,2%. In this case more than 20 000 new drivers per year must graduated initial qualification. A lot of them will be training using driving simulator.

The driving simulator complies with EU directive 2003/59/CE with regard to driving based on safety regulations. The goals are to increase training quality, or increase cost-efficiency of training. Driving simulator allows to check trainee-drivers qualifications and driving progress. It also optimizes safety driving and eco-driving practices.

A lot of research proves that the simulator is a good tool to support drivers training. It doesn’t have to replace practice in real road traffic but it is useful in combined training. There were some Research European Project concerning simulators which were run under the auspices of General Direction of Transport and Energy European Commission.

- EU Project "CLARESCO" - Car & Truck Lighting Analyses
- EU Project "SHE" - Simulated Hydraulic Excavator
- EUREKA Project "CARDS" - Comprehensive Research and Development Simulator
- EUREKA Project "TRaCS" - Truck and Coach Simulator

There is a necessity to be in keeping with a rapidly-evolving road freight transport industry and to comply with European safety requirements as well as facilitate professional integration through exercises based on real-life driving situations.

The next step of the project is the implementation of the results – training of trainers who will in turn train drivers in each country (Poland, Spain). Project has finished in September 2011 and now is being disseminated by the project Partners.

References

5. http://www.autosim.no/
SYMULATOR AUTOBUSU I SAMOCHODU CIĘŻAROWEGO, JAKO ELEMENT SZKOLENIA KIEROWCÓW – WYKORZYSTANIE W PROJEKCIE EUROPEJSKIM – LEONARDO DA VINCI – TRANSFER OF INNOVATION (TOI)

Streszczenie: Symulatory jazdy są coraz powszechniejszym wykorzystywane na całym świecie w procesie szkolenia kierowców. Są praktycznym i efektywnym narzędziem do wzmacniania bezpiecznych zachowań kierowców na drodze.