Aspects of Visualization in Vehicle Simulators

G. Gudzbeler, Andrzej Urban, and Krzysztof Łojek

***Abstract*—Authors decided to conduct a comparative study aimed to assess the occurrence of changes in the organ of vision in people who train in a truck simulator and the evaluation of differences in type and frequency during training on simulators with "on screen" and cylindrical displays. The same they decided to make an attempt to give the preliminary answer to a question which from studied projection systems causes lesser degree of symptoms of simulator sickness during training. This paper presents the results of comparative tests carried in consortium by Police Academy in Szczytno, Poland as a part of scientific project "Building simulator of driving privileged vehicles in typical and extreme situations". For the purposes of examinations two test platforms were prepared. One equipped with a screen with a cylindrical projection system, the second with "on screen" projection system.**

***Index Terms*—Simulation, visualization, projection systems, simulation sickness, cylindrical view, on screen.**

I. Introduction

Simulator's sickness is a term used to describe a variety of adverse reactions of persons under training on simulators of moving targets - aircrafts, marine and ground vehicles[1]. Due to the increasingly widespread use of simulators for training operators of various moving objects, literature is very rich, but focused mainly on pilot training aircraft. In the analyzed literature, there is no conclusive resolution of the causes and prevention of simulator sickness. This illustrates the complexity of the reasons causing it, which is the subject of intensive research. For purposes of this study term simulator sickness is used, regardless of platform simulator. The most general statement is that "simulator sickness has many symptoms and largely depends on the characteristics between individuals" . The authors decided to conduct a comparative study aimed to assess the occurrence of changes in the organ of vision in people who train in a truck simulator and the evaluation of differences in type and frequency during training on simulators with "on screen" and cylindrical displays. The same they decided to make an attempt to give the preliminary answer to a question which from studied projection systems causes lesser degree of symptoms of simulator sickness during training.

Manuscript received July 27, 2012; revised September 3, 2012. This work was supported by the Ministry of Science and Higher Education under Grant form National Center of Research and Development No. O ROB 0011 01/ID/11/1.

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II. Research Results

This paper presents the results of comparative tests carried in consortium by Police Academy in Szczytno, Poland as a part of scientific project "Building simulator of driving privileged vehicles in typical and extreme situations".

For the purposes of examinations two test platforms were prepared. One equipped with a screen with a cylindrical projection system, the second with "on screen" projection system.

Fig. 1. Simulator with a cylindrical screen - a view of the cabin and the screen with displayed image, from outside and from inside the cabin.

Fig. 2. Simulator with a cylindrical screen - visible cabin, cylindrical screen and projection system.

Simulator with cylindrical projection system.

1) Cabin - of intercity bus Autosan A1012T Leader
2) Screen (cylindrical: with radius R = 4.1 m and a height h = 3.75 m, angles of sight from a point of view of the driver: angle width: vfov = 180 deg, angle height hfov = 50 deg)
3) Projection system (four projectors Projectiondesign F22 SX +, 1400 x 1050 resolution, brightness - 2100 ANSI lumens, contrast ratio: 2500:1, type of matrix: DLP)

That made the projection system provided an angular resolution in front of the driver's sight - 2.9 arc minute / pixel.

Photos 1-3 show the simulator with a cylindrical projection system.

Simulator with on screen projection system.

1) Cabin – Mercedes Acros truck.
2) Screen - “on screen” - stuck projection foil to all front and side windows allowing view using the rear projection type, rear windows were completely blacked out.
3) Projection system:
   - 3 ultra-short throw projector Mitsubishi WD380U-EST serving front and left window (brightness: 2800 ANSI lumens, resolution: 1280 x 800, contrast ratio: 3000:1, type of matrix: DLP),
   - 1 projector Panasonic PT-LB1E displays the image on the right window (brightness: 2200 ANSI lumens, contrast ratio: 500: 1, resolution: 1024 x 768, type of matrix: LCD).

That made the projection system provided an angular resolution in front of the driver's sight - 2.1 arc minute / pixel. Photos 4-8 show the test stand with "on screen" rear projection system.

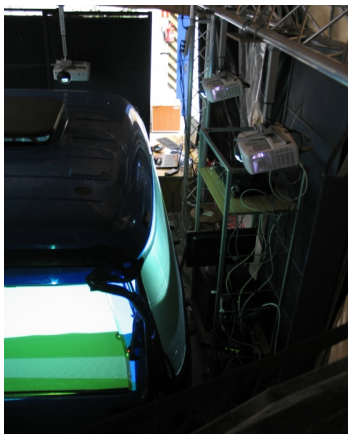

Fig. 3. The test simulator with "on screen" projection - visible cabin with "on screen" screens and projectors that support front and left side windows

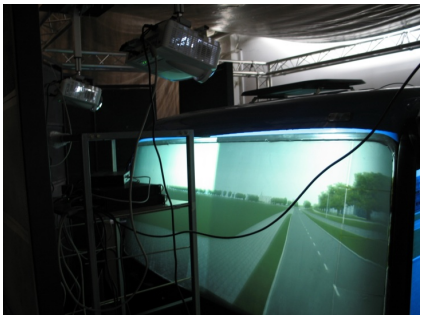

Fig. 4. The test simulator with "on screen" projection - visible cabin with "on screen" screens on the windscreen and windscreen supports projectors.

The following methodology of the examination consisting of three stages was accepted:

- Preliminary examinations (statement being aimed whether at the examined person illnesses of the sight organ aren't appearing).
- Examining before the training on simulators (subjective and objective examination).
- Examining after the training on simulators.

The study of the eyes in 15 individuals before and after training on simulators of the imagery on the screens "on screen" and the cylinder showed that did not cause significant changes in the organ of vision in patients. Surveys carried out after training on the simulator with a cylindrical screen simulator showed the disease by 1 degree (Chiłow) in 3 patients.

After training on the simulator with "on screen" projection system symptoms of the disease was found in 5 patients, in 4 of them they had grade 1, one person had 2nd degree (Chiłow). It can be concluded on this basis that training on the simulator with a cylindrical screen was slightly better tolerated by the subjects than training on the simulator with "on screen" projection.

Tests of visual acuity, tear film status, state of binocular vision, stereoscopic eyes and the settings did not show differences. Differences in visual acuity, tear film and stereoscopic view after training on the cylindrical and "on screen" simulator were very small (0.1 or 1 degree) and within the limits of error of the method .

Based on the survey can therefore be concluded that the simulator sickness in these patients is not due to anatomical changes in the parameters and functions of the eye. These results argue for the theory that disease is caused by a lack of correlation between the signals received from different senses to the brain. The person feels the training on the simulator because the sense of sight ("sees"), a strong visual stimuli apparently indicating the existing (virtual) movement, which is not accompanied by irritation of the receptor kinetic vertigo. This leads to confusion (conflict) signals within the central nervous system between small kinetic stimuli coming from the labyrinth and proprioceptors informing about the movements of the head and strong visual stimuli informing the rapid movement of our body. This causes stimulation of the parasympathetic and autonomic symptoms characteristic of simulator sickness.

III. Conclusion

Why simulator sickness was more common in the simulator with the screen "on screen" than a cylinder? It seems that this is due to the proximity of the screen. There is an analogy to the occurrence of symptoms when watching movies in 3D. Watching the three-dimensional films at the cinema rarely causes disease simulator because the screen is far from the spectators. The introduction of 3D technology for television meant that her symptoms began to be felt much more often. It is estimated that it may occur in 10-20% of people watching 3D TV. Because they sit closer to the screen, the greater is probability of feeling symptoms of simulator sickness.

REFERENCES

[1] R. Ilyas, "Simulator Sickness: A Threat to Simulator Training. MIROS," *SCI – COSH*, 2011.

[2] R. S. Kennedy and J. R. E. Fowlkes, "Simulator Sickness Is Polygenic and olysymptomatic: Implications for Research. Essex Corporation, Orlando," *Florida the International Journal of Aviation Psychology*, vol. 2, no. 1, pp. 23-38, 1992, Lawrence Erlbaum Associates, Inc.

[3] P. Bogdalski, "Survey on the teaching staff of European police colleges," *Internal Security Journal*, 2009, vol. 1, no. 1, pp. 145-162.

[4] G. Gudzbeler, A. Urban, and M. Nepelski, "Simulation of Police actions and operations," *Journal of Physical Science and Applications*, 2012, April 2012, pp. 103-110.

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