Evaluation of a Virtual Scenario Training for Leading Firefighters

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ABSTRACT

Artesis Virtual and VSTEP BV developed a virtual scenario training for leading firefighters. We evaluated the usability of the training application and measured the satisfaction of 53 trainees. The trainees were positive about the training application, the training itself, and the interaction with the interface. We observed that trainees experienced navigation difficulties and sometimes misjudged visual information. Evaluations of new versions of this application, should address the influence of interface problems on performance.

Keywords

Virtual training, usability, evaluation, firefighting.

INTRODUCTION

The first version of a virtual scenario training, developed by Artesis Virtual and VSTEP BV, was presented to 53 leading firefighters of the Gooi and Vechtstreek fire brigade, as part of a full day training of several traditional methods. Our goals were to assess the quality of the interface and environment, and the satisfaction of the trainees. Since only limited time was available for preparation, we used well-known methods like questionnaires, interviews and observations.

The training of leading firefighters in the Netherlands is traditionally performed with various instruments, such as photographs, maquettes, displays with toys, and mock buildings equipped with smoke machines (Figure 1). The virtual training program tested here is one of the few used in the Netherlands. It aims to provide (1) a cost-effective tool for scenario training of leading firefighters, offering realistic scenarios that can be adjusted during the training session, and (2) support for the instructor in evaluating the trainee. The scenarios adhere to the so-called "Leidraad Oefenen" guidelines for training the Dutch fire brigade.

The variety of factors determining the system, the training procedure and the context, makes a scientific assessment of the effectiveness of virtual versus conventional training difficult to achieve. Also, the need for real users makes an evaluation costly and difficult to organize. Hence, more effort is spent on development than on evaluation, and empirical studies of virtual training and learning outcomes are scarce (Hall, Wilfred, Hilgers, Leu, Walker and Hortenstine, 2004).

Figure 1. Outdoor scenario training and training with toy models

THE VIRTUAL TRAINING SYSTEM

The training scenario we used represents a fire in a suburban house. The trainee plays the role of the fire commander. An instructor reacts verbally and impersonates all other persons that occur in the scenario (dispatch center, crew members, local residents, police, etc.). Another person, the operator, responds to changes in the situation or requests of the trainee, by performing appropriate actions in the virtual environment, such as transporting and adding vehicles and avatars, and manipulating the fire. The operator controls the events, and logs the main events and actions of the trainee, with a special module. The recorded data are used for evaluation of the trainee's performance. The operator module was not evaluated in this study.

The Scenario

At the beginning of the session, the trainee is located in a fully equipped fire engine at the fire station, when a dispatch call is made about a fire reported in a house. On the way to the given address, the trainee should request all relevant information, instruct the members of the team, and decide on actions for the moment of arrival. The operator makes the vehicle arrive at the location of the fire and places the trainee outside. From that moment on, the trainee is free to navigate in all directions.

The trainee should perform the required procedure, by gathering information about possible victims, locating the fire visually from outside, saving victims, determining sources of danger in the direct vicinity, inspecting the house, assessing the extent of the fire, and taking actions such as instructing the crew and ordering a 2nd alarm.

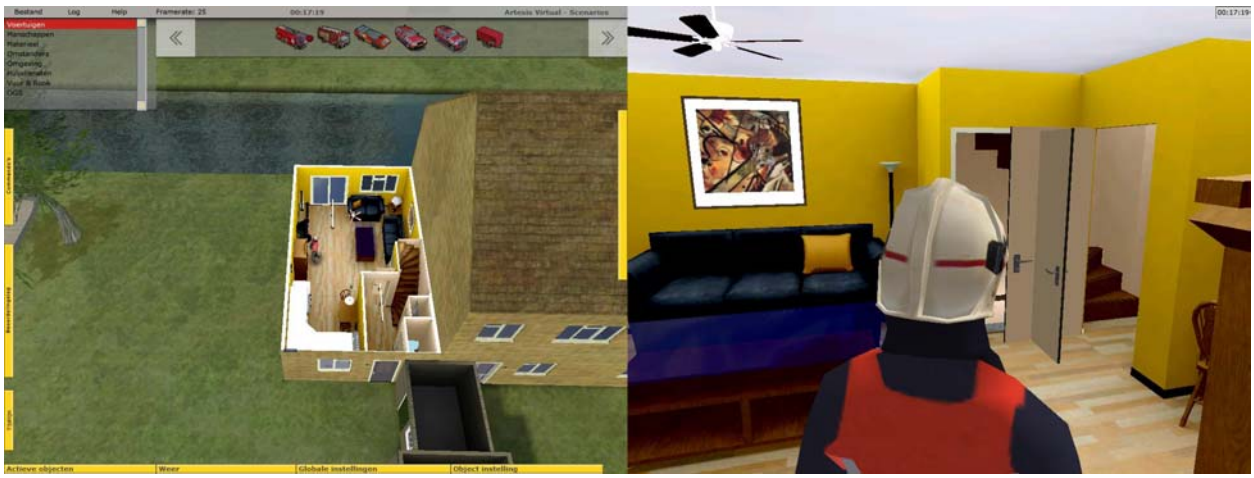

Figure 2. The virtual scenario. On the left the operator's module, on the right the trainee's view.

The Virtual Environment

The trainee may be located inside the fire engine, in the vicinity of the house, or inside the house (Figure 2). The model of the suburb provides all relevant elements, such as water sources. The elements are geometrically accurate and possess textures to create a realistic impression. The affective quality of the environment is neutral: it is not designed to increase arousal or tension. The firemen, police and local residents are represented somewhat schematically, but are easily recognized. The trainee toggles between a 1st person view and a tethered view. Collision blocks are placed around smaller elements and groups of people.

THE TRAINING SESSION

Evaluation instruments

During the training session, an observer recorded problems that hindered the trainees, that elicited remarks on the system or environment, or that were considered serious flaws by the observer. Categories considered were the virtual world, the functioning of the system, navigation, and communication with the instructor.

After completing the training session and after discussing the performance with the instructor, the trainee was given a questionnaire. It comprised 6 questions on the trainee's experience, 20 statements about the virtual training with a 7 point Likert scale, and room for remarks. The purpose of the questionnaire was to record any perceived problems with the system or communication with the instructor, to assess the perceived quality and convincingness of the environment and the scenario, and to record the opinion of the trainees about the effectiveness of the training.

Finally, interviews were conducted with the trainees and, at a later date, with the instructors.

Participants

The trainees were 53 volunteer and professional leading firefighters, 50 male and 3 female. Ages varied from 25 to 55, mean 40 years; their experience as a leading firefighter M=5.9 years (SD=5.3), and as a crew member M=10.2 (SD=5.4). They mentioned having little experience with computer games and using a joystick (M=2.74 on a scale of 1 to 7, SD=2.0, and M=2.75, SD=1.9).

Equipment

The configuration used consisted of a pc with 3ghz Intel CPU, 2GB internal memory and a GeForce 7950 GT graphical card containing 512MB memory; a beamer, and a projection screen. The image displayed was 1 by 2m. The trainee used a Logitech wireless controller Rumblepad 2 for navigation. The operator used a 19" Philips TFT monitor for the operator module.

Location

The operator and the instructor were seated behind a desk, with full view on the projection screen. The trainee chose a position either sitting or standing, to the right side of the instructor (Figure 3). The distance between the trainee and the projection screen was 2 to 3 m. The lights were dimmed to a level that still enabled the instructor to take notes. This of course diminished the contrast and brightness of the projected environment.

Procedure

First, the trainee was allowed to navigate a simple environment. Then, the objectives of the training were explained. Directly after concluding the training, the instructor discussed the performance with the trainee. The trainee was then presented the questionnaire.

Figure 3. The virtual scenario training, October 2006.

RESULTS

Results of the Observations

The instructor assessed the performance of the trainees on qualities such as analyzing the situation, taking action, leadership etc. The performance of 75% of the trainees was judged sufficient, of 25% insufficient. Trainees that scored low were often relatively inexperienced as leading firefighters. We did not analyze the reasons for bad performance in the scenario, only in using the system. The most frequent and important problems trainees encountered with the system were related to use of the controller, navigation and orientation in the virtual environment, and visibility and comprehension of some elements in the environment. Of the trainees that performed less than satisfactory, 65% experienced problems with the use of the controller and navigation. Of the trainees that performed well, this percentage was 42.5%.

Maneuvering through a small, geometrically accurate staircase, created major problems, was time consuming, demanded attention and required help of the operator. A similar problem occurred in corridors and small rooms of the house, where trainees walked into walls, doors, or crew members. The effect of looking at a door or wall from a very short distance, confused the trainee even more. The over-the-shoulder view, or tethered viewpoint, that is known to enhance human navigation performance by integrating information from different frames of reference (Wang and Milgram, 2003), was used by 30% of the trainees, often on instigation of the operator. With this viewpoint however the shoulders and head of the avatar partially block the view of the trainee on the environment (Figure 2). Many trainees had difficulties visually locating the fire from outside, which required looking at the house from a distance, and tilting the view upward.
Trainees got confused by the representation of the roof, fire and smoke behind the window, and a bug in the representation of the attic floor. Also distracting was the appearance of the avatars, which was considered amusing. Outside, collision boxes around bystanders and vehicles confused the trainees, because they did not understand why they could not pass for instance between two avatars.

The flow of actions was often disrupted when the trainee turned away to communicate with the instructor or to check the buttons on the controller, instead of looking at the display. Miscommunication between the trainee and instructor, about commands and reactions, also disrupted the flow.

Results of the Questionnaire

16 statements for assessing the satisfaction of the trainees, all measured on a 7 point scale, were grouped in 3 categories: navigation and orientation, virtual environment, and communication and response to actions. 4 extra statements concerned the scenario, and performance in training, as perceived by the trainee. The categories were

internally consistent, and a mean for each category is shown in Table 1. The results show a high satisfaction on all categories.

	N	Mean	SD
Navigation and Orientation	53	4.61	0.90
Virtual environment	53	5.11	0.77
Communication and response to actions	53	5.68	0.90

Table 1. Results of the questionnaire.

The statement "ascending and descending the stairs was easy" was judged mildly, M=3.34 (SD=1.39). The representation of the environment (M=5.28, SD=0.91), persons (M=4.98, SD=0.94) and apparatus (M=5.16, SD=0.86) were considered convincing. The trainees felt easily engaged in the virtual world (M=5.15, SD=0.95), and the scenario was considered realistic (M=5.46, SD=0.76). Nevertheless, tension or stress experienced by the trainees was relatively low (M=2.94, SD=1.43).

The trainees were in general satisfied with their performance (M=5.30, SD=0.87), and felt they would be able to apply what they learned in a real life situation (M=5.06, SD=1.2). There was a positive correlation between their appraisal of navigation and orientation, and their own perception of their performance (Spearman's rho, r=. 29; $p<.05$). This may indicate that the trainees found it difficult to distinguish between their skills in handling the system, and acting in the scenario. No significant correlation was found between the performance of the trainee (according to the instructor) and age, or experience with computer games.

Results of the Interviews

The interviews revealed the same interface problems as the observations. Many trainees mentioned that it took effort to get used to the controller, and to navigate. Some remarked that using the controller and navigating distracted them from the scenario and deteriorated their performance. About 1 in 7 remarked that they did not feel immersed or convinced by the virtual environment, that they missed sound, or that the display and the graphics might be improved. The trainees were confident that these problems would be solved by future developments in gaming and simulation, and by practice. Some missed interaction with crew members. Trainees also remarked they enjoyed the experience. They thought that virtual training will replace other types of training, because it offers more, and realistic, information.

Comparison of the Results

The trainees were in general satisfied with the scenario, the system, and the training. They felt engaged in the virtual world, which probably contributes to the effectiveness of the training (Mantovani and Castelnuovo, 2003). Interestingly, the problems we observed in the interaction with the interface, that evidently distracted the attention from the scenario, do not seem to have a negative influence on the satisfaction of the trainees. Possible explanations are that firstly, the trainees felt awkward about their lack of experience with the controller and computer games. They ascribed navigational problems to their inadequate handling of the controller, and not to shortcomings in the system. Secondly, the trainees are very tolerant of the representation of a scenario, as far as convincingness and verisimilitude are concerned. They are used to training with toys and photographs. In comparison, virtual training offers more information and interactivity. Lastly, the evaluation was not performed anonymously, and trainees may have hesitated to criticize the system.

CONCLUSIONS AND FURTHER RESEARCH

User testing of new versions will help to optimize navigation and the representation of important elements. Observation, questionnaires and interviews are useful techniques to evaluate the training. They should however be designed to detect whether navigation and orientation induce a cognitive overload which degrades the performance

of the trainees. Focus groups, inviting the participants to express their opinions about the system, as well as ideas for improvement, may provide valuable information but are time consuming.

Attention must also be paid to the desired level of affective intensity of the training environment, which may improve effectiveness of the training (Wilfred, Hall, Hilgers, Leu, Hortenstine, Walker and Reddy, 2004). Although the environment and scenario now provide affectively intense effects, the stress experienced by trainees is low.

Methods should be developed to measure the effect of the training over time. This may prove difficult since firefighters are trained on a regular basis with several methods, so that the effect of a particular virtual training over a longer period of time cannot easily be isolated.

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