INDIVIDUAL SKILL MEASUREMENT BY MEANS OF A SIMULATED TEAMMATE IN THE CHEETAH TANK SIMULATOR

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ABSTRACT

In our research project, a simulated teammate was used to determine the effectiveness of tank simulator training for individual task aspects. This tank simulator was built to teach a crew how to use an Armoured Air Defence tank called "Cheetah". In this tank, a team of two crewmembers carries out the necessary actions. Besides teamskills, they both need a basic amount of individual skills to work effectively as a team. To obtain those skills, students are trained in different team combinations each lesson. During the normal training program, students' individual skills are evaluated by looking at the team results. Our project aimed at measuring the individual skills of a crewmember separate from the team results. We considered two options to measure the skills individually; the first option used speech recognition and the second a computer-simulated teammate to work together with a student during the test in the simulator. After testing, we selected the second option in order to obtain objective individual results on skill acquisition. A number of trials with the selected option showed that the students reacted positively to the new test and that the objectivity of the test was considerably improved. Individual differences became clear and the need for extra training could be determined more precisely. Further research issues are discussed in the paper.

AUTHORS BIOGRAPHY

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Geert Slegtenhorst is a scientific researcher at TNO Physics and Electronics Laboratory, and is involved in research and development projects in the field of Training and Instruction. Most of the time is spent in Project Management for training simulators. The TNO-FEL CAI System was developed under his supervision.

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INTRODUCTION

In 2000, the School for Air Defence Artillery of the Educational Center Ede introduced an advanced training simulator, the Cheetah-simulator (previously known as the Armored Airdefence Artillery Trainer-Improved; PLT-V). In the Cheetah simulator, tank commanders and gunners are trained to accomplish their individual tasks and to work as a team.
To develop a training program for the Cheetah simulator the instructors used their experience with the previous simulator PLT. To optimize this training program TNO-TM and TNO-FEL were asked to study the retention of skills in the Cheetah simulator. Aim of the study would be to determine how long the acquired skills remain intact and to provide recommendations for the optimal training frequency and composition of training.
However, before this retention study could start, a problem concerning the performance measurement had to be tackled. The simulator lacked an easy accessible individual performance measure that monitors the reaction time of an individual student. In this paper, the two individual measurement options that we tested are described.

We will start by explaining why we think that individual skills should be measured and what performance measures should be used. After that we will describe the Cheetah simulator, the training and the standard used performance measurement. Finally, we will address the tested individual measurement options and discuss the results.

Why do we want to measure individual skills?
In a battle situation, all tasks should be performed as a team. However, during training, individual measurement is important for a number of reasons:

1. Without sufficient mastery of the individual task aspects, good team performance is hard to obtain (Boot, Timmer, Slegtenhorst, Van Schaik, & Bots, 2001.). Individual skill measurement ensures the mastery of individual skills before students move on to team skill training.
2. Due to the diminishing numbers of military personnel, it is increasingly hard to keep a tankcrew together over a longer period of time. Therefor, more changes in crew composition will occur and individual task mastery and task allocation will become increasingly important.
3. Individual skill measurement makes it possible to study skill retention over a longer period of time, even if a team has been split up.
4. Individual performance measurement enables individual feedback. This can save learning time and it helps to keep a student motivated.

What performance measures should be used?
Based on an extensive task analysis, special test scenarios had to be constructed to obtain a thorough indication of the skills of the student. A literature study revealed that for this highly procedural task, error and speed measures were the best performance measures to apply (Smidt, 1988). Based on these findings, we decided that we wanted the system to measure the number of seconds a student needs to execute an action. Further, we wanted the system to log which actions the student chooses out of a set of possible actions. For example, switching between two targets can be carried out in a number of ways. Dependent on the situation one way is faster than the other. A student should select the fastest way. Inexperienced students may choose a sub optimal way to switch and loose valuable time.

The Cheetah simulator
The Cheetah simulator consists of an Instructor Station, which runs the CAI and four (Dutch version), or seven (German version) simulators

resembling the tanks turret. The stimuli for the students are presented on the visual systems within the periscopes as well as on the simulated radar display. The instructor is able to monitor the actions of the students via video and data presentations.
The Cheetah simulator is equipped with state-of-the-art automated lesson monitoring and control tools. A Computer Assisted Instruction (CAI) System, developed by TNO-FEL, assists the instructors in using the simulator System (see Kuiper, 1995). This CAI System contains powerful tools for preparing and using training material, which consists of scenarios and judgement criteria. The scenarios contain the stimuli for the crew; the criteria are used to judge their performance.
The training part of the CAI System supports one instructor in training up to eight separate crews in their simulated turrets simultaneously. The CAI System handles the lesson progress by selecting the scenarios, based on the automated judgement of the crews' performance. This performance is judged by comparing the behavior of the crew with the judgement criteria prepared for the specific scenario. On the basis of this, the crew is provided with feedback on how to enhance their performance by texts presented on a LCD display in the simulated turret.

Students and training
In the Cheetah-simulator, tank commanders and gunners are trained. The students are new recruits who have no former experience with the tank. However, also more experienced crews train on the Cheetah simulator to get used to operating the Cheetah instead of its predecessor (the PRTL).

All students start with a basic training of 12 simulator lessons, spread out over three months. In this training, individual skills and team communication skills are trained. The students practice individual motor skills, e.g. directing the radar manually to a chosen target or using the firing pedal. They further train procedural skills, for example how to check the important panels with respect to weather information, to identify hostile objects correctly, to decide when to fire on a target, to use the fastest way to switch to another target and to communicate in a clear and prescribed way.

Standard measurement of performance
In a battle situation, a tankcommander and a gunner work together closely to detect identify and destroy targets. Working together as a team, they can help each other and compensate for certain skill deficiencies. During the normal training program, the students are trained in teams in the Cheetah simulator. Some assignments are worked through individually, but most of them have to be fulfilled as a team. To ensure that all students are trained equally, the teams are compiled of different student combinations each lesson during the initial training. The evaluation of their work is based on the team results. The Cheetah simulator monitors the performance automatically and compares it with predefined criteria. Insufficient performance of the crew will be noted by the CAI system and it will offer the crew a comparable scenario to practice the same training objective. In some cases, it will alert an instructor. Good team performance is followed by a new trainingscenario.

Providing feedback on team performance is insufficient to ensure an objective evaluation of individual skill retention over a longer period of time. A team may function well in standard situations in a fixed team combination. This does not necessarily mean that the individual teammembers are able to perform all tasks as well under different circumstances (for example, with a new teammate). To evaluate a persons individual capabilities, an individual test excluding the influence of a teammate is needed.
Moreover, the system determines the correctness of an action by measuring whether an expected response is given during a certain time frame. For example, a student has to fire within three seconds after the system indicates that it is ready to fire. If the student reacts within these three seconds, the action is logged as correct. No easy accessible record is kept of the real reaction times; it is only noted that the student was reacting within the time frame. This is especially troublesome because the reaction time frame is given initial values that are regularly adjusted by the teachers to match the real performance of the students. A retention measurement needs an unambiguous and clear performance measure, like the number of seconds that a student needs to react.

No easy accessible method was available to measure the reaction times of one single member of the team in the simulator. We tested two ways

to measure the individual skills of a crewmember separate from the team results. Both will be discussed next.

MEASUREMENT OPTIONS

The new individual reaction time measurement method had to meet certain constraints. One of the most important was that the functionality and hardware configuration of the Cheetah simulator and the CAI System were not changed in any way. Further, the extra workload for the instructors should be kept as minimal as possible. Finally, the test should not create a substantial interruption on the regular lessons.

Two options were developed and tested. The first option involved speech recognition to measure the reaction time of a student separately from the other student. The second option involved a simulated teammate to replace one of the students.

The first option implied that the commands given by one team member to the other had to be recognised by the system. After recognising the given command, the system could start monitoring the reaction of the second crewmember. How many seconds did he need to react to the given command and did he choose the correct action? A number of problems emerged during the test of this method.
First, the Cheetah simulator produces a lot of tank related sounds. These sounds are very loud and make it hard for a speech detection system to separate the human voice-sounds from the environmental noise. Further, the speech recognition program would have to recognise many different voices. It proved to be impossible to recognise the spoken words amongst a variety of speakers with the current speech recognition technology. This left us with the option to register only the presence of human voice sounds without recognising the meaning. This possibility was rejected because it would lead to an undesirable situation: the difference, for example, between a cough and a command would not be detected by the system.

The second option tested used a simulated teammember. Normally two students man the simulated turret simultaneously. During a test, one of the teammates was replaced by a simulated teammate who gave audio-responses and commands. For example, after aiming at a particular target, the audio-response could be: 'Fire!' The system would measure the reaction time of the human teammate; the time between 'Fire!' and the actual firing.
The retention lessons are specially prepared to be handled by a single crewmember (the gunner). The commands, normally given by the commander, are simulated by the simulated teammate. The audio-responses are predefined and time-driven. This means that the audio-responses start a fixed number of seconds after a scenario-event. As these events are standard procedures, the required moment for a command is known. At lesson preparation, the timestamps for these audio-responses are set. The gunner's reaction to the command is then measured, by the CAI System.
By making intelligent use of the data that the CAI System already produces during the training, and adapting the scenarios with available means, the Cheetah simulator and the CAI System could be left unchanged for the retention measurements. The data required by a Retention Toolkit is extracted from the Cheetah simulator, to be processed separately.

TEST WITH SIMULATED TEAMMATE

A first test with 12 students showed that the students were able to work through the scenario's with the simulated teammate. They reacted positively to the unusual situation of working alone in the simulated turret. They experienced no problems in working with the simulated teammate. Important to our research project was that individual differences became visible. Some students appeared to choose sub optimal actions or needed extra time to execute an action. Their improvements can now be monitored independent from the performance of their training partner. Later this year the 12 students are tested again to determine the retention of skills. A larger group of students will be followed during and after their training in a follow-up study.
One potential problem was observed. For technical reasons the audio-responses are time-driven in stead of event driven. This means that a very good student may have to wait a number of seconds for a voice-command of his simulated teammate and a low performing student may be too slow to perform the actions. This did, however, not cause problems during the test.

CONCLUSIONS

The test with the simulated teammate showed that it is possible to assess individual skills in the Cheetah simulator with a simulated teammate. The method is now being used in a retention study. The method is also interesting from a training's point of view. It enables an early discovery of individual skill deficiencies without the potential performance masking effect of the skills of the other teammember. Weak students can easily be identified and provided with extra training.

Currently the follow-up retention study has started, using the new method. A group of military students is being followed during their training. They receive the basic training and are tested with the simulated teammate at the end of the training period. As soon as they return to the school to start the next training period, they are first tested to determine the amount of skill retention. Next year the results of the retention study will be available.

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