

Training for Crisis Response with Serious Games Based on Early Warning Systems

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ABSTRACT

This paper discusses serious games developed as part of a training program developed for a Dutch crisis response group, which acts during a (potential) flooding crisis. Training in general contributes to a wide range of learning objectives and can address different target audiences. For each combination of learning objective and target audience, the proper form of education has to be selected, ranging from self-tuition to large scale multi-party training and exercises. Serious games can be a useful and educational addition to the set of existing training tools. For operational crisis response groups a high match with real-time warning systems is essential. Our approach shows how to integrate both serious games and early warning systems for effective training and exercises. We end with our lessons learned in designing serious games based on early warning systems, in the context of a training program for a crisis response group.

Keywords

Training, serious gaming, early warning systems, flooding, crisis organizations.

INTRODUCTION

In case of a crisis like a (potential) flooding, organizations have to work together to be able to act quickly and appropriate in a complex situation under (time) pressure. Complete, correct, and timely information is essential. In order to improve the preparedness, the involved parties should train their specific tasks, but also the communication between each other. Since actual flooding occurs very infrequent, professionals cannot operate in a real situation as often as actual needed to train their skills. Serious games provide an alternative method of training to gain and maintain skills. Serious games can be entertaining, but their main purpose in a training context is to help the students to reach their learning objectives.

This paper focuses on the training program in development for a Dutch crisis response group, the Storm Surge Warning Department of the Netherlands (SVSD). This crisis response group is part of the early warning system of the Netherlands, and becomes active when there is a threat of a storm surge on the North Sea. They generate predictions of water levels based on weather forecasts and water level measurements using water level prediction models and expert judgement. Based on the predicted storm surge levels, they have to inform and warn the appropriate parties involved in keeping the Netherlands safe from flooding.

LEARNING OBJECTIVES AND TEACHING METHODS

In general, a training program can be divided in three different parts: education, training and exercise. Each part has its own set of learning objectives and therefore its own set of preferred teaching methods (see also Table 1).

- Education on theoretical topics, such as meteorology and hydrodynamics.
 - Learning objective is to understand the theory and to be able to apply to new (theoretical) problems, preferable methods for this are lectures and self-tuition with books or a game for a specific task.

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- Education on the (software) tools to use.
 - Learning objective is to be able to use a tool in a correct and effective way, by self-tuition and workshops, in which the student can work with case studies and tutorials.
- Training of skills.
 - Learning objective is to apply the theory using the proper tools to realistic situations you can encounter, mainly done by repeatedly performing the required tasks. In a serious game, the difficulty can be increased. Useful methods are workshops with case studies and serious games.
- Exercise of a complete scenario.
 - Learning objective is to operate effectively and to adequately respond to unexpected situations, by applying the acquired skills on a complete scenario from beginning to end, without help or intermittent feedback. In case of a multi-party exercise, communication between students is very important to reach this objective. The exercise is often carried out in a multi-party setting.

Table 1 gives an overview of the different parts of a training program and the available preferred teaching methods. The games discussed in this paper have been positioned in this table. You may notice that as we move from theoretical to practical learning objectives, the preferred teaching method becomes more interactive.

	Education - theory -	Education - tools -	Training	Exercise
Lectures	Yes			
Self-tuition (books, tutorials, etc)	Yes	Yes		
Workshop (case studies)		Yes	Yes	
Game for specific tasks			FEWS game Procedure game	
Game for complete scenario				SVSD game
Large scale multi-party training				Yes

Table 1: Overview of learning objectives vs. teaching methods, including some games which will be explained below

TRAINING PROGRAM FOR THE CRISIS RESPONSE GROUP SVSD

The training program that is being developed for the crisis response group SVSD needs to address education of theory and tools, but also training and exercising of skills. Based on an analysis of the learning objectives of the SVSD and research done within the Flood Control 2015 program (FloodControl2015, 2010), we conclude that serious games can be used to train the skills of the employees and to serve as an environment for a full scale exercise. A serious game allows water management professionals to train their specific tasks frequently, but also to go through a crisis situation from beginning to end in a realistic exercise within a safe gaming environment. Such a facility to train and exercise is necessary for the SVSD, since actual flooding occur very infrequent.

This paper discusses the design of serious games in general, and the serious games for the crisis response group SVSD in particular. Because these games are designed to train specific skills of the SVSD, we first give a brief description of their activities, i.e. making storm surge level predictions and giving out warnings according to the procedures.

- Predict storm surge levels using a Delft-FEWS system
A SVSD professional makes use of an operational forecasting system to predict the storm surge levels. This system is based on Deltares' Flood Early Warning System (Delft-FEWS) provides a state of the art flood forecasting and warning system (Delft-FEWS WIKI, 2010). The system is a sophisticated collection of modules designed for building a flood forecasting system customized to the specific requirements of an individual flood forecasting agency. The philosophy of the system is to provide an open shell system for managing the forecasting process. This shell incorporates a wide range of general data handling utilities, while providing an open interface to a wide range of forecasting models (Gijsbers, 2008).
- Giving out warnings and information according to the procedures

Based on the water level predictions, the crisis response group SVSD will have to follow the appropriate procedures, in which for example the involved parties within the crisis management structure are informed.

DESIGNING A SERIOUS GAME

In the design of a serious game, one should focus on the learning objectives of the game and the target audience. Choices for the game design should be based foremost on these two aspects (and as always the available time and budget). Choices for game design involve the game concept, scenarios, required information, actions the student can take and the look and feel of the game. The following questions, connected to the most important aspects can help during the game development phase to keep the right focus:

- Game concept
 - What are the learning objectives, e.g. what skills need to be trained?
 - What (game) model should be used to reach the learning objectives?
 - What kind of additional gaming tools are necessary, such as logging, scoring, interaction with a game master, etc?
- Scenarios
 - What scenarios are required to reach the learning objectives?
 - Does the student need to be able to deal with unexpected situations?
 - What actions should the student be able to take?
 - How much should the student be able to influence the course of the scenario?
 - How realistic should a it be (completeness, available information, etc)
- Information
 - What kind of information is required for the scenarios of the game?
 - When should which information be made available to the student in what form?
- Interaction
 - What actions should the student be able to take?
 - What kind of software / tools are necessary for this?
- Appearance
 - What should the game GUI look like and how realistic should the GUI be?

A game development is often a question of keeping the right balance between the three main elements of a serious game (Harteveld, 2010): reality, play and meaning of the game (see Figure 1).

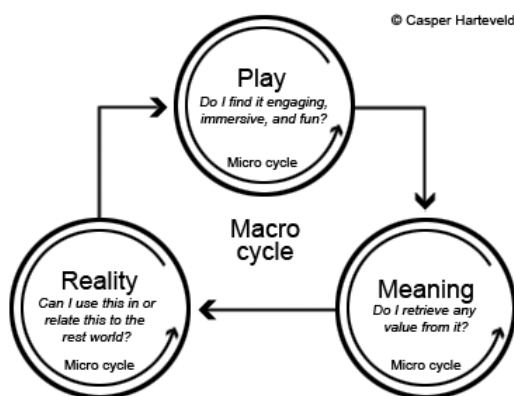


Figure 1. Triadic game design (Harteveld, 2010)

DESIGNING A SERIOUS GAME FOR THE CRISIS RESPONSE GROUP SVSD

The same general approach of game design can be used for serious games that fit in the training program of the SVSD. The target audience are water management professionals, and the learning objective is to operate effectively and efficiently during a risk of flooding, using the available forecasting system. To cater to these needs, it is necessary to reach a high level of reality in the training. Therefore, it is logical to incorporate the actual early warning systems in the serious game.

Training: FEWS Game

The purpose of the FEWS game is to submit a correct and timely storm surge level forecast, by using all available information correctly and combine information with knowledge and experience. The game exists of two parts: the game engine and the forecast system. The gaming engine holds the scenarios, controls the game time, distributes additional information such as weather forecasts, logs the actions of the student and allows the game to be paused. The forecasting system is a copy of the actual operational Delft-FEWS system for the North Sea as used by the SVSD. It contains the regional information, including hydrodynamic models and measurement stations, and offers all possibilities to assess the situation that the student has at his disposal in the real environment. The use of the operational forecasting system for this game makes the training very realistic.

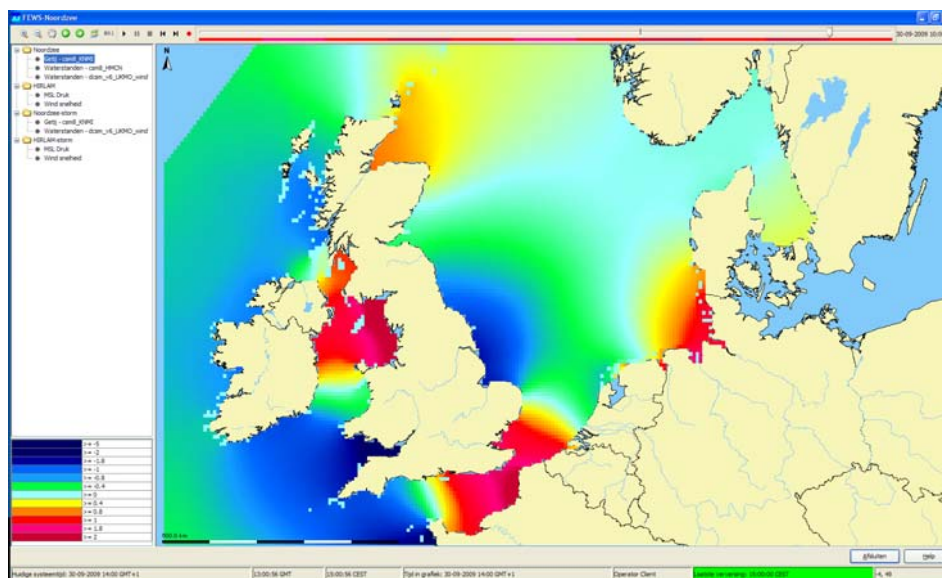


Figure 2 Delft-FEWS system for the North Sea, showing the tides in the North Sea

At the start of the game, the student can select a game scenario and select a speed-up factor for the in-game time. The forecasting system contains all model results and measurement data that would be available at the current in-game time. No calculation is necessary during the game, which allows for in-game time speed-up and makes the game portable in terms of installation and system requirements. These measurement and simulation data can be used for analysis in the same system interface as used in the actual operational forecasting system of the SVSD. At the end of the game, the student can archive the results for evaluation.

The game engine can be used for any existing or new Delft-FEWS system, for any location, without sacrificing realism. The scenarios for a game can be based on historical events, for which measurement data-feed and model runs from the specific Delft-FEWS system have been archived. Based on such a data-set, several scenarios can be generated, tailoring to specific learning objectives. In 2011, further research will be performed to automate parts of this process, and assist the generation of effective scenarios.

Training: Procedure Game

The Procedure game is a training tool to learn, practice and test the procedural knowledge of the student. The game is designed to follow the normal workflow as much as possible.

In the game, the student is confronted with a situation. Based on his or her judgment of the available information about the situation, the student selects the proper procedures in the procedure guidance book. The student has to perform all steps within the selected procedures, such as make phone calls, send text messages and faxes, and give out the official warning messages (see Figure 3). Instead of simply checking a box on a list of procedures, these actions are actually simulated in the game, including the occasional busy line, unanswered phone calls, malfunctioning of hardware, etc.

The performance of the student is scored in all phases of the game: judgment of the situation; selection of the procedures; and complete and correct following of the procedures. The game can be played alone or as a multi-player game, so it can be used for maintaining and test individual skills as well as the capacity of the whole team to meet the correct response in a crisis.



Figure 3 Actions that can be performed in the procedure game

Exercise: SVSD Game

The SVSD game is a facility or tool, in which the total operation from storm surge level prediction to following all the procedural steps as a whole can be exercised. Therefore, both the FEWS game and the Procedure game are combined in the overall SVSD game (Figure 4). The exercise tool approaches a real life experience for the crisis response group during a flooding risk as much as possible within a game. All activities during a flooding risk are incorporated and all tools from the operational system are integrated.

During the entire exercise, a game leader has an overview of all actions performed by the students in a continually updated logging system. Based on this overview, the game master can decide to help or thwart a specific student or group of students by sending helpful or misleading messages as could occur in a real life situation. In this, the game master can impersonate different actors of the scenario, such as the weather forecast agency or the local government. All actions of the game master are logged as well, so a complete registration of the game is available for an after action review.

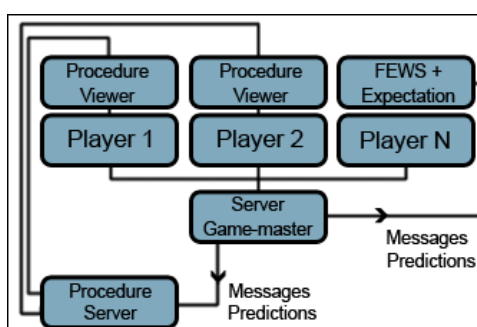


Figure 4 Overview of the components of the SVSD game

All three serious games will be incorporated in the training program of the SVSD starting May 2011. An evaluation of the games and their abilities to reach the learning objectives, is scheduled for the end of 2011.

LESSONS LEARNED

By developing the serious game in the same environment as the operational forecasting system, the student can concentrate on the task of information analysis and decision making, without being distracted by unknown interfaces. The gaming and learning experience becomes more realistic and the trained skills can be applied directly in the operational early warning systems. Furthermore, the FEWS game is set-up generic and flexible such that every forecasting system based on Delft-FEWS software can make use of the same game functionality.

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