A Virtual Environment for Learning Aiport Emergency Management Protocols

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Abstract. This paper presents a virtual environment designed to enhance the learning of airport emergency management protocols. The learning is performed in an informal manner, with each learner playing a different role in a particular emergency simulation. Learners interact within the virtual environment, managing the available information and following the steps prescribed for each type of emergency in the Airport Emergency Plan of the Spanish Civil Defence Organization. The simulation can be run in different modes of difficulty, and can be used as a learning tool as well as an evaluation tool to measure the accuracy of the learner's actuation within the protocol. It can also support standalone training having some of the emergency roles played out by the computer. The virtual environment has been built using DimensioneX, an open source multi-player online game engine.

Keywords: Virtual environment, emergency, game engine, simulation.

1 Introduction

Airports should always guarantee a fast and effective response to any kind of emergency. All the efforts and decisions should be perfectly coordinated to minimize the consequences whenever an airplane accident, natural disaster or any other emergency interferes in the normal progress of the aeronautical operations. Following this objective, airport emergency plans are specified in order to compile all the norms, measures and procedures that should rule all the actions taken by each of the actors involved in the emergency management, before, during and after the emergency. Learning such protocols and plans is then crucial.

The use of games and simulation in the field of training has been widely explored [1, 2] due to the facilities they provide to recreate virtual environments that could support situated learning. Situated learning happens when knowledge and skills are applied in a realistic context [3], in our case a real emergency. Situation games or simulations bring a great level of realistic immersion and promote situated learning, which, according to the literature presents the following advantages:

- Apprentices are aware or the actual conditions in which they should apply their knowledge and abilities. If the situation is a simulation of real incident children can dive into the real problems that are going to have to face.

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- Real situations create an atmosphere that produces a greater motivation and engagement of users.
- Apprentices understand better the implications of their knowledge or ignorance.
- There is a better understanding of the knowledge structure that facilitates its application in real situations.

For instance, in the military area an adapted version of the commercial game DOOM has been used to train US Marine fire teams [4], while the first person shooter game Unreal Tournament serves to implement a simulation of a first-responder to a mass casualty airline accident scene [5]. Simulation and virtual environments are also common tools for training and education in the aeronautical area, and they have also been applied to the area of emergency response training. [6, 7].

This paper presents a virtual environment designed to enhance the learning of airport emergency management protocols. An open source multiplayer game engine has been used to implement a virtual world where different types of airport emergencies can be simulated. Simulation participants play the role associated to their position, interact within each others and manage the emergency information as it becomes available. The virtual environment can be used as a learning tool as well as an evaluation tool to measure the accuracy of the learner's actuation according to the protocol. From the wide range of aspects of an airport emergency, our application will focus in the management of the emergency information and the communication between the different roles involved.

The rest of the paper is organized as follows: first, the objectives and scope of the airport emergency plans is outlined. Second, the Airport Emergency Management simulator (AEM-Simulator) is presented, its interface is described and a example of use is provided. Next, the use of the simulator with different interaction devices is analyzed, and the characteristics of the game engine used for implementing the virtual environment are also detailed. Finally, some conclusions and future work lines are exposed.

2 Airports Emergency Plans

The Spanish Directorate of Civil Defense and Emergencies (DGPCE - Dirección General de Protección Civil y Emergencias) of the Ministry of Interior defines an Airport Emergency Plan as "*a set of pre-defined norms, measures and coordinated procedures which aim to minimize the impact of an emergency situation that could take place in the airport or in the response areas defined in the emergency plan*" [8].

The emergency plan predetermines the degree of participation of all of the dependencies and services involved in an emergency by clearly stating their functions and the procedures to follow before, during and after the emergency. The operability of the plan is guaranteed by defining each of their responsibilities, the chain of command, the communication procedures, the coordination system and the specific actuation procedures.

An emergency plan defines the set of methods and procedures to follow for a particular number of emergency types that are classified depending on whether they involve aeroplanes or not, if the aeroplane is flying or not, or by using the airport zone where the emergency takes place. Any other type of emergency which differs from

the ones considered in the plan will be treated using the procedures of the closest typified emergency.

The plan defines the actuations directives before (phase 1), during (phase 2) and after (phase 3) an emergency takes place. Phase 2 is the very essence of the plan and for each of the emergency types and each of the services involved in it a directive record is defined. The directive record defines the hierarchy, the person in charge, the pseudonym to be used in radio communications, the means of communication and an ordered explanation of the task to be performed until the emergency situation is under control.

In order to guarantee the efficacy of the plan the staff involved are regularly trained in their specific functions, and the reliability and effectiveness of the plan is evaluated through periodic emergency exercises and practices. As a result of those experiences the plan is constantly reviewed and new norms and improvements are introduced whenever it is consider necessary. The aim of our work is the development of a tool to facilitate the training and learning of the different plans of actuations of an airport emergency plan, reducing the number of real simulations in order to decrease costs. Moreover, the simulation can also be used to test the own plan efficacy and detect flaws or inconsistencies since the behaviour during the emergency can be recorder and analysed in the aftermath to learn from errors and help to build and institutional memory [9].

3 AEM Simulator

Currently, the training on the actuations plans is performed through tabletop exercises and full-scale practices. During the first ones, each of the participants play the role associated with their position, following the procedures established in the plan of actuation of a particular emergency. Participants use phones to communicate to each other the decisions adopted, ask for information, confirm data, etc.

This scenario can be improved by making use of a graphic and interactive multimedia environment. The virtual environment can be used to support the communication between the different participants/players while keeping track of all the action adopted during the emergency procedure. The actions performed by one actor at a particular stage in the emergency can be compared to the one established by the specific plan of actuations. This can serve both as a training tool, providing the participants with suggestions or feedback on the appropriateness of her actions, and as an evaluation tool, providing a measure of how well each of the participants has followed the procedure. Moreover, the whole procedure can be recorded to be studied afterwards and learn from errors, something that can't be done using full-scale exercises and phone-based communication.

Following this idea a virtual environment for training in the emergency management protocols has been implemented. Trainers connect to the virtual environment and play the emergency role associated with his/her position. Currently the protocols implemented are the ones for "Control Tower Unit", "Advance Command Post", "Principal Command Post", "Airport Fire and Rescue Service" (AFRS), "Airport Health Service" (AHS) and "Airport Coordination Centre" (ACC) for an emergency type of "Incident in a flying aeroplane". It is expected that in the future all the roles

could be played by either real user or the computer, allowing individual and whole team training on the protocols. At present users can only play the roles of "Control Tower Unit", "Advance Command Post" and "Principal Command Post".

The emergency simulation can be played in different modes providing a different range of feedback and tips to the user. This way using the easiest mode, "*Step by step training*", users will be provided with feedback for each of the actions taken, indicating the compliance with the actual action specified in the actuation plan. On the other hand, in the "*Evaluation*" mode, no feedback will be provided until the end of the simulation. Once the simulation is finished the participant will be presented with a score based in the deviation between her actuation and the one specified in the actuation protocol. To produce this score, the relevance of the information gathered, accuracy of the communications with the other participants, unnecessary contacts, time spent, etc, will also be considered. When more than one participant plays the simulation a team-score is also computed to evaluate the actuation of the whole group.

This simulator has been designed following a participatory design process in which experts on civil protection take part. Experts provide descriptions of the functionalities and characteristics of an ideal application for airport emergency management. Taking as a start point their opinions and the traditional table-top exercises used for training, an initial design of the simulator was produced. The same experts collaborate on its refinement during subsequent meetings until the version here described was produced. Keeping the use of simulator simple was a major goal of the process.

3.1 Interface Description

Fig 1 shows a screenshot of the virtual environment. The numbers depicts the different sections in which the simulator screen is divided: *information section* (1), *role section* (2), *communication section* (3), *action section* (4), *auxiliary screen section* (5), *message section* (6), *event section* (7) and *feedback section* (8).

The participants use the *information section* to store relevant information about the emergency as it becomes available. Whenever they consider a piece of information is relevant, they can assign one of the slots of this section to save it. This is achieved by selecting the keyword corresponding to that information from the drop-down menu on the left side of the slot. Once a slot has been assigned, he/she can type the value of the data directly in the right hand side box, or obtain the information from other participants. The status colour can be used to indicate whether the data has been computed by the user, received from another role or confirmed.

The *role section* provides a list of the roles involved in the emergency management. Different colours are used to specify if a particular role is played by the computer or by a real player.

The *communication section* provides five options to support the communication between the emergency roles: send, request, confirm, not available and error. Buttons in this section are used in combination with the *information* and *role section* to compose and send messages. For instance, whenever a user needs to send data he/she will select the data slot in the *information section*, select the role or roles he/she wants to receive the data, and finally push the "Send" button. The *messages section* will then display the composed message and the *information section* of the selected roles will be refreshed to show the data received. A similar process will be followed when a user requires information or confirmation from another role.

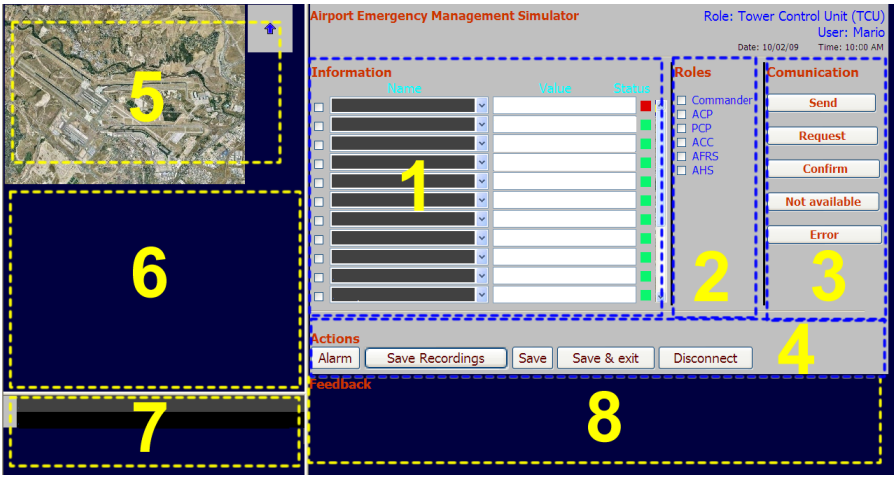

Fig. 1. Screen sections of the Airport Emergency Management Protocols Simulator

In the *action section* the user will find buttons specific for the actions of the role he/she plays. For instance, user who plays the "Tower Control Unit" role will find one button to fire the emergency alarm and other one to order the recording units custody. On the other hand, the one who plays the "Principal Command Post" role will find buttons to establish the grade of emergency and the coordinates of the command position. The *auxiliary screen section* will be used to support these role-specific actions, being populated with role-specific maps, templates for generating reports, etc. Depending on the action performed, the *event section* may display a message to inform of the action taken to some or the rest of the users.

Finally, the feedback section provides participants with appropriate hits and advice about the actions they should undertake at each step of the emergency. Hints will be more frequent and precise depending on the game mode selected.

3.2 Example

Figure 2 shows a screenshot of a particular moment of the simulation, which can be used to track the users' actions. The screenshot corresponds to the view of the "Tower Control Unit" during the first stages of the "Incident in a flying aeroplane" emergency management and playing the simulation in a "Step by step" mode.

The emergency procedure starts when the air traffic control unit receives a "fire in cabin" notification message from an aeroplane commander (1). The AEM simulator automatically assigns a slot of the information section to store the data received (2). Following the plan of actuation, the user asks the commander for confirmation of the incidence (3), and next the corresponding confirmation message is received (4). The red colour next to the incidence data in the information section reflects this confirmation.

Next, as can be seen in the events section, the person responsible of the Tower Control Unit user have fired the alarm to alert of the incidence to the Airport Fire and Rescue Service (AFRS), the Airport Health Service (AHS) and the Airport Coordination Centre (ACC) (5). The three services should send confirmation of the alarm

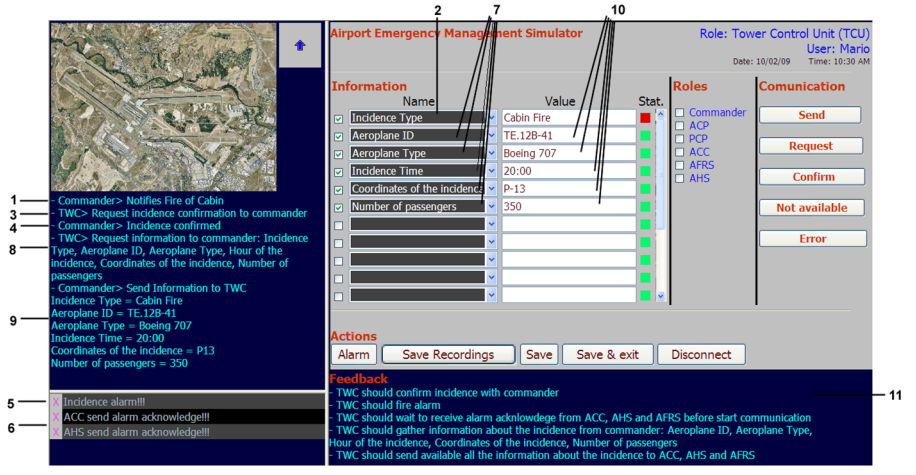

Fig. 2. Screenshot of the Airport Emergency Management Protocols Simulator

notification before to trigger communication with the Tower Control Unit. At this moment only the ACC and AHS sent acknowledgments (6).

As he waited for those confirmations the traffic control started to gather information about the incidence from the commander. He assigned slots for data about the identification and type of aeroplane, coordinates and time of the incident and number of passengers (7), and composed a "Request" message (8). The commander sent the requested information (9) which was populated by the simulator to the information section (10).

As the game mode selected was "Step by step" the feedback section of the screen reflects the different tips provided at each step of the emergency (11).

3.3 AEM-Simulator Interaction Devices

Work has been carried out to explore different possibilities of interaction with the AEM-Simulator. On the one hand, given that the only requirement to run the AEM-Simulator is a common web browser, and that the actions are carried out by simply clicking on the screen, the use of mobile devices or PDAs to follow the training becomes an obvious option to be investigated. In practical terms, this means that the application can be used in a wide range of environments.

On the other hand, to identify drawbacks and inconsistencies in the emergency plans it would be useful to offer a turn-based game mode, in which all the main players work together using the same device, thus facilitating the free exchange of views and opinions. Interactive whiteboards lend themselves to this type of use of the AEM-Simulator, as an ideal medium for collaborative activities such as these (Figure 3).

3.4 The DimensioneX Game Engine

The AEM-simulator has been implemented using DimensioneX [10], a free-open source multiplayer game engine provided under the GNU General Public License.

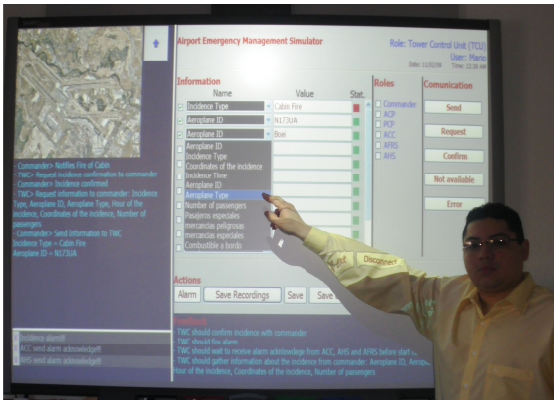

Fig. 3. Use of a AEM-Simulator with an interactive whiteboard

DimensioneX provides a software kit for developing and running adventure games, multiplayer games, multi-user real-time virtual worlds and turn-based games. Among many other features, DimensioneX provides online multiplayer capability, multimedia support, game maps and player tracking, game saving and events handling.

The game engine is actually a Java servlet. The games developed for this engine can therefore be run in any servlet container, typically Tomcat. Players connect to the game via a conventional web browser without any additional software required.

DimensioneX provides a script language for specifying virtual worlds; this is, to describe the rooms, links, themes, characters and events that can take place during the game. Worlds' descriptions are stored in plain text files with ".dxw" extension, and processed by the game engine to produce an HTML document. Players interact via browser within each others as well as with the rest of the game elements. As a result of these interaction the world state becomes modified, which in turn triggers the creation of new HTML documents which reflect these changes. The world state is stored in the server and continually updated.

We have chosen this engine due to the facilities it provides for implementing the communication between the different players which is a most important requirement in our domain. Modifying the source code of the engine would be relatively straightforward if that were ever necessary, and it is also worth noting that the programming language is simple.

4 Conclusions and Future Work

This paper presents a virtual environment to facilitate the training and learning of protocols for the management of emergency in airports. The virtual environment has been implemented making use of an open source game engine named DimensioneX. Users can connect to the simulator via browser, without installing additional software on the machine for players.

The project is on its first stages. Currently, the "Incident in a flying aeroplane" emergency plan has been implemented to be play in the "Step by step" mode; this is, providing participants total guidance about each of the actions they should performed

at every moment. The next step will be to complete the implementation of the "Evaluation" mode. This will allow starting to test the application with real users and validate its usefulness as a training tool. At the same time work is carried out to implement the rest of the airport emergency plans defined by the Spanish Civil Defense Department. Moreover, the system has to be tested with real users. Even though it has been designed with domain experts the efficacy of any interaction device can only be assessed when end users try to perform their tasks with it.

Future work lines consider integrating within the AEM-simulator role specific simulators as, for instance, an Airport Fire and Rescue Services Team Management Simulator. The participant who plays the role of person in charge of these units could then be trainned in emergency protocols and, at the same time, in actions specific of his/her role as emergency analisis, strategy selection and unit personal leading. The output information from one simulator could serve as input and the other provinding a more realistic experience.

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