Engineering Advanced Training Environment for Crisis Management: The Pandora Project

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Abstract: The paper describes the technical framework of a near real-life training environment for learning activities suitable for training in crisis scenarios. The underlying architecture features a design that makes provision for a learning environment capable of training collaborative, as well as independent, decision making skills among crisis managers in potential crisis situations. Modelling the training scenarios takes into consideration both the pragmatic nature of responding to crisis, as well as the human behavioural factors involved in dealing with situations of chaos and uncertainty. This work is part of ongoing research on the Pandora[1] project, which aims to provide a near-real training environment at affordable cost.

1. Introduction:

There is increasing recognition for the need to train managers in non-technical skills such as control and decision making for crisis management needed in national emergencies, high-reliability industries, as well as in industrial workplaces (Caird 2007, Lehto 2006, Sniezek 2002, Stern 2002). Crisis management is a major issue in preventing emergency situations from turning into disasters. In recent years, mismanagement of emergencies has often created critical situations. Often when a catastrophic event occurs, it is human behaviour and often human behaviour alone that determines the speed and efficacy of the crisis management interventions. Frequently, untimely and ineffective responses are not due to a lack of knowledge of procedures, but to the inability to operate in contexts where frequent, potentially catastrophic events are occurring (Buck 2003, Pauchant 1993).

Training plays an important function in the preparation of the crisis manager. Currently, there are two main modalities for such training: table-top and real-world simulation exercises. Table-top exercises are low cost and can be easily and frequently organised. However, they cannot create a believable atmosphere of, for example, stress and confusion that is prevailing in real-life situations and is crucial to the training of timely and effective decision making. On the other hand, crisis managers trained through simulation exercises in the field can be very effective, but these are considerably more expensive, require specialist equipment and are difficult to organise on site.

Pandora aims to provide a framework to bridge the gap between table-top exercises and real-world simulation exercises, providing a near-real training environment at affordable cost. Pandora is developing an enabling technology to simulate believable dynamic elements of an entire disaster

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environment by emulating a complete crisis room using realistic 3D visuals and audio to engender a truly immersive, chaotic and stressful environment.

2. Human Factors in Crisis Management:

Pandora focuses on the Affective state of the crises manager, because the knowledge of human behaviour, in all phases of emergency management, is crucial to the development of effective emergency policies, plans and training programs. For many years, business continuity planners worked under a simple assumption that when a disaster strikes, people will follow plans and procedures. Psychologists and other behavioural scientists have found that this idea fails to consider the often surprising behaviour of individuals during emergencies (Lehto 2006, Pauchant 1993).
Traditional business continuity plans do not adequately take into account the forces of human behaviour, especially when scenarios include extreme fear, harmful behaviour and require survival responses. Strategy planners often wrongly assumed that an organisation's emergency plans will be automatically accepted, understood and acted upon by all. The principles of human psychology suggest that the behaviour of individuals and groups is shaped more by numerous intangible factors than by official or executive demand (Buck 2003).
For these reasons the Pandora system is including mechanisms to maintain Affective profiles of trainee crisis managers and to create believable immersive environments that aim to engender affective reactions as crisis scenarios unfold. Such Affective interaction should help improve the decision making agility of novice decision makers in terms of their ability to identify and assess cues, handle negative information, and make decisions from a number of decision action options. In addition, since the scenarios and the feedback given to trainees are underpinned by Rules of Engagement, Pandora should help in training and facilitate practice in interpreting Rules of Engagement.

3. A Collaborative learning environment:

The underpinning Pandora system, as depicted in Figure 1, is composed of four components: the first three are intended as architectural sub-systems, implementing the corresponding high-level functionalities, whereas the last represents the type of environment where those functionalities are applied.

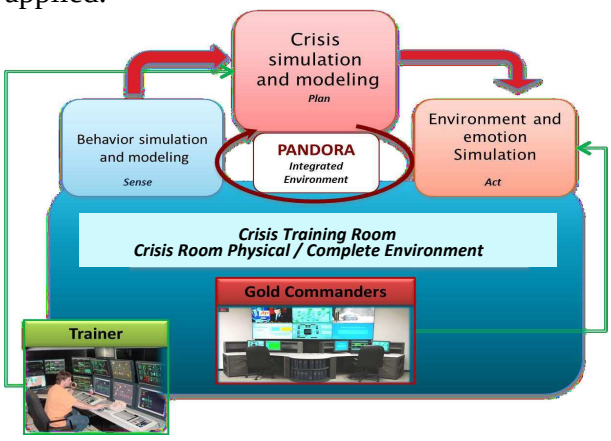

Figure 1. Pandora System Overview

Interaction assumes two types of actors: the Gold commanders, which are a group of individuals from different agencies undertaking training; and the Trainer, who activates the exercise and monitors the progress of actions and environment during a training session. One of the main achievements of the Pandora system is the provision of retroaction, which allows the trainer and trainees (through their decisions) to modify the scenario at runtime.

4. Behaviour Simulation and Modelling:

In order to enhance the believability and realism of training sessions and to simulate real aspects of a crisis situation, it is necessary to take into account the trainees' behaviour and how their emotional/psychological profile can influence the decision making process during a simulated crisis.

The Pandora environment maintains an account of the behavioural status of crises managers and reacts accordingly. It also models different levels of abstraction so to make possible its use in diverse crisis situations. The environment is, however, not totally automated but is populated by several actors, among which a simulation director and some extras (Non Playable Characters - NPCs) participating to de-structured simulations with third parties.

The Behavioural Simulation and Modelling functionality has three main goals: 1) to select, model and monitor the relevant human factors or psychological variables that can have an influence on the decision making; 2) to develop a model able to represent trainee's actual behaviour/profile; and 3) to propose (plan) high level personalised training goals and user interactions to the crisis planner.

In particular the trainee model takes into account both psycho-physiological parameters, (e.g., heart beat rate, personality traits, self-efficacy, etc.), and pedagogical parameters, such as training methods. According to the particular trainee's status, this component decides personalised training paths with customised difficulty levels and challenges.

Training sessions are personalised by maintaining an Affective profile of trainees and activating useful training activities according to the reconstructed mental context of trainees; a model of training strategies; and a set of user classifications. Classes of users are represented defining a set of so-called user "stereotypes" elicited from an analysis of domain knowledge. They are aimed at creating a structure that allows personalisation of the user model for the training phase. Information on individuals is obtained by setting up a pre-evaluation protocol for each crisis manager that enters a training session.

5. Crisis Simulation and Modelling:

Crisis Planning and Modelling is the key functionality of the overall Pandora system, as it creates the simulated network of events driving the entire training session. The objective of this functionality is twofold: on the one hand it must offer a knowledge base (static information) that shall be able to contain all the information relevant for the system, for example, the crisis procedure for managing crisis situations, information about the available resources, information about crisis events and their relations in terms of cause-effect and so forth; on the other hand it shall be able to elaborate a model that describes the joint effect of the static information, the action of the trainees, the adjustments of the trainer and the behavioural model and information.

An intelligent Crisis Planner is defined such that it receives as input a symbolic model of how a crisis can be simulated (what can happen during a crisis, how and when, according to which cause-effect relationships) and the high level characteristic of the training session from the Behavioural Planner and instantiates the contents of the crisis scenario that will be enacted by the Simulator in the Crisis Training Room.

6. Environment and Emotion Simulation:

The Environment and emotion simulation functionality aims to render the sequence of events that comes from Crisis Planning and Modelling. Rendering these events is undertaken with the objective of engaging and involving trainees in the simulated scenario, for example, it is important to simulate situations of information overload and related stress, together with the pressure in making decisions. Therefore, the Pandora system aims to play out events in a way such that certain emotions will be transferred to the trainees. Accordingly, the functionality of this component includes the following:

Emotion simulation, which has two objectives: the first is to provide a tool that can select and customise environment content in the form of video, image or text that must be provided to the trainees to represent a range of emotional states; and the other is to provide information regarding NPCs that need to be simulated inside the system and customise behaviour according to trainer input and the evolving scenario.

Environment simulation, which aims to create a realistic and emotional engaging environment for the trainee. The following elements are used to realise this environment: graphical rendering of scenarios and of NPCs, as well as the appropriate devices necessary to display information in the form of video, maps, images, emails, phone calls, radio play out and so on, to the trainee.

7. The Crisis Training Room:

The Crisis room is the "place" where a training exercise is conducted. Typically, it is comprised of a selection of audio-visual components and appropriate displays, communication and data delivery channels that are relevant to a training scenario.

Pandora has identified three use cases for the potential deployment of the room in order to maximise trainee benefit within the boundaries of physical setup and requirement considerations where training is to be conducted:

Single Site Training: Training is delivered to group of trainees at the same time and at the same location. The group is called together by the trainer and trainee members are working around a table in a dedicated room where the system is installed, at a national or international training facility. This dedicated room has been set up with sensors, devices, tools and monitors that are fixed and not portable.

Within the room each scenario instantiation is initiated by the trainer, who turns on the biometric sensors and sets the objectives of the exercise by defining the mission, the initial scenario, rescue resources available, and so on. In addition, the trainer prepares the system to be used by the group.

In addition to sensors, the room is setup with Multi-Screen Display - MSD consoles enabling trainees to receive multi-channelled information on a number of consoles reporting a range of happenings and events through multimedia representations (texts, sound, pictures, graphs, animations, videos). Such events include: actors' intervention, specific requests, third party impacts, and much more. Typically, the crisis room consoles look as follows:

Deployed Training: This use case differs from the previous in that it does not use a dedicated room and is located, for example, at an institutional building of a Gold Commander taking part in a training session (Civil Protection Centre, MIC, etc.). Once again, the system can be used by one or more trainees at the same time, which meet in a standard meeting room that has been

properly equipped for the training session. For this use case the necessary equipment are portable and are transported on site for the purpose of training.

Figure 2. Typical Setup for Multi-Screen Display Consoles

Distributed Training: Here, training is delivered via the web, which means a dedicated room is not present and replaced by a virtual room in which the trainees can log in remotely and engage in training exercise scenarios. Again, the system can be used by one or more trainees at the same time.

A 3D Distributed Virtual Environment - DVE is being developed in order to set up this use case. The DVE provides a flexible training environment where trainees can participate in the training from anywhere. The DVE simulates a 3D virtual crisis room similar to that of the physical room described above and is capable of incorporating the same communication and data delivery channels that are relevant to a training scenario as shown in Figure3.

In this use case, participating trainees will each control a 3D avatar, represented within the DVE, using their keyboard, mouse and/or microphone. Trainees collaborate with each other by in-world typing, speaking or emailing as needed and appropriate for the scenario at hand within the overall exercise.

Figure 3. In-world Slide Show, Streaming Video and Map Application

The DVE itself does not generate events or storylines unless users make responses to world events. It is a frontend to the Pandora system, which controls its storylines. Specific crisis events within an overall crisis scenario are generated over time by the Pandora components and passed to the DVE for rendering through avatar actions, in-world text popups, streaming videos, maps, PowerPoint slides, etc. Trainees can respond to these events inside of the virtual world by typing or choosing one of the other options the system provides.

The prototype DVE is being developed using OpenSim (OpenSimulator), an open-source server platform for hosting virtual worlds. Upon receiving event requests from components, the DVE server generates a timeline XML file using native manipulating scripts, which are based on LSL (Linden Scripting Langue) (Heaton 2007) and OSSL (OpenSim Script Language) (OSSL).

8. Conclusion

The paper has described a technical framework for the development of near real-life training environments for collaborative learning activities. The key components and architecture of the system detailed here will help create an environment useful in the training of crisis management by facilitating a realistic and complete simulation that is time coherent to that of expected near real time in real-life situations; that reproduces the realistic emotional status; and that supports and facilitates the collaboration of crisis managers from different agencies in training scenarios.

9. Acknowledgments

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