The Pandora Project
Advanced Training Environment for Crisis Scenarios

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ABSTRACT
This paper describes a technical framework for the development of near real-life training environments for collaborative learning activities suitable for various training scenarios in different domains. The context in focus here is workplace learning that requires the training of collaborative as well as independent decision making among crisis managers in potential crisis situations. The training takes into consideration both the pragmatic nature of responding to crisis and 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.

Keywords
Technical Framework for Collaborative Learning Environments, Crisis Management Training, Human Factors in CM Training.

1. INTRODUCTION
There is increasing recognition for the need to train non-technical skills like control and decision making for crisis management in national emergencies, high-reliability industries, as well as in industrial workplaces [2,3,6]. Crisis management is a major issue in preventing emergency situations from turning into disasters. In last years, mismanagement of emergencies often created critical situations. In the happening of a catastrophic event, it is human behaviour and often human behaviour alone that determines the speed and efficacy of the crisis management effects. Frequently, untimely and ineffective response is not due a lack of knowledge of procedures, but to the inability to operate in contexts where consistent, potentially catastrophic events are occurring [1,4].

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 are prevailing in real-life situations and are crucial to the training of timely and effective decision making. On the other hand, crisis managers trained through simulation exercises on the field can be very effective, but 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 environment by emulating a complete crisis room: realistic 3D visuals and audio to engender a truly immersive, chaotic and stressful environment.

2. Human Factors in Crisis Management
The focus on the Affective state of the crises manager is given by Pandora, because the knowledge of human behaviour, in all phases of emergency management, is critical in the development of effective emergency policies, plans and training programs. For many years, business continuity planners worked under a simple assumption: 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 people during emergencies [3,4].

Traditional business continuity plans do not adequately take into account the forces of human behaviour, especially when scenarios include extreme fear, harmful behaviour and survival responses. 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 [1].

For these reasons the Pandora system mechanisms to maintain Affective profiles and 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 practicing 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

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architectural sub-systems, implementing the corresponding high-level functionalities, whereas the last represents the type of environment where those functionalities are applied.

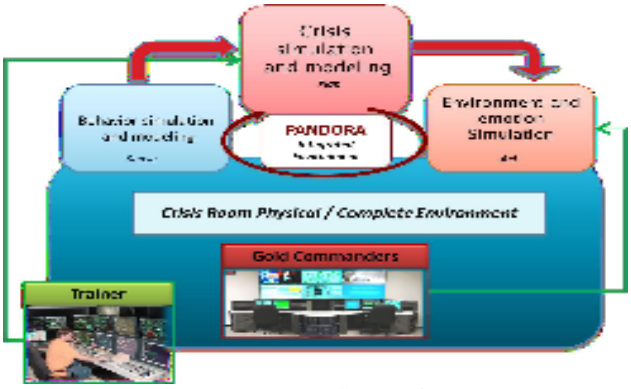

Figure 1. Pandora System Overview

The interaction assumes two types of actors: the Gold commanders, which are a group of individuals from different agencies undertaking the 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.

3.1 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 the 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 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 in account both psycho-physiological parameters, (e.g., heart beat rate, personality traits, self-efficacy, etc.), and pedagogical parameters, like 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 setting up a pre-evaluation protocol for each crisis manager that enters a training session.

3.2 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 side it must offer a knowledge base (static information) that shall be able to contain all the information relevant for the system, like 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 Gaming Room.

3.3 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 are undertaken with the objective of engaging and involving trainees in the simulated scenario. This functionality detailed in the following two sub-functionalities:

Emotion simulation has two objectives: on the one side it provides information regarding Non Playable Characters (NPC) that need to be simulated inside the system, and it is able to customise their behaviour according to trainer input and the evolving scenario; on the other hand it provides a tool that can select and customise the content in the form of video, image or text that must be provided to the trainees to represent a range of emotional states.

Environment simulation aims to create a realistic and emotional engaging environment for the trainee. A number of elements should be used to realise the environment: a graphical rendering of the scenario and of the NPC, as well as the appropriate devices in order to display information in form of video, maps, images, emails, phone calls, radio play out and so on, to the trainee.

3.4 Crisis Simulation and Modelling

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

4. An Enabling Technology

The main functionality of the Pandora architecture is depicted in Figure 2, and the functionality of the comprising components is described in the subsections to follow.

4.1 Trainer Support Framework

This is the system module responsible for managing the interaction with the trainer. A trainer is able to interact with the system in three different situations: 1) at the beginning, as the trainer needs to broadly define the training scenario and training goals; 2) during the simulation at runtime, the trainer needs to be able to drive the training session dynamically depending on how the team is progressing, to speed it up or slow it down, to add extra information, to stop the team going down a dead-end; and 3) at the end of the simulation, the trainer needs support in giving feedback to the trainees, based on their performance.

It incorporates the following main components:

- A learning strategies expert system, which defines the best pedagogical methods that suit the particular training objectives. These objectives are defined by a trainer at the beginning of a training session, and are appropriate to the profile of the trainees. This component also offers an interface allowing a trainer to insert different available pedagogic methods.
- The trainer runtime manipulation manager, which allows a trainer to modify the course of events in a training session. This means, for example, being able to go forward and backward in terms of timing, to accelerate or decelerate the session according to the progress of each trainees. This component also allows trainers to alter the event flow of a training scenario in order to address specific learning needs that have not been achieved within the progress of a session as intended; and
- The trainer de-briefing support manager, which supports a trainer during or at the end of a training session in order to aid trainers in composing a report for debriefing. It receives information about trainee performance during the training session, in order to organise that information into a report to which the trainer can add his evaluation and comments.

4.2 Behavioural Framework

This framework offers five functionalities:

- Behavioural Profile Manager, which is related to the collection of the trainee profiles. This operation is performed upon first registration of the trainee into the system. The trainee is presented with some questionnaires aimed at setting some initial psychological data, which will be adjusted and updated throughout the training sessions;
- Behavioural Planner, which gets the information flow from the crisis simulation framework, as well as the trainee behaviour and the trainee profiles. It uses this information to generate a set of instructions on how to personalise the training environment to improving the training exercises according to the trainee status. It also maintains and updates the sensor trainee parameters, which are mentioned below (e.g., Psycho-physiological trainee data and their evolution over time), for de-briefing purposes;
- Behavioural Recording Manager, which continuously observes the trainees' actions and behaviour. According to their performance, the framework might decide to ask the Crisis Simulation Framework to generate more or less stressful events or to raise or lower the difficulty level
- Action Input Manager, which collects the trainees' decisions and actions;
- Sensor Input Manager, which collects the sensor measures.

4.3 Crisis Simulation Framework

The crisis simulation framework is responsible for maintaining the Pandora system consistency. The main data structure of the Pandora system is modelled by means of an "event network", which maintains a representation in terms of events and relations among them. The event network provides interfaces for adding/removing events and relations between events as well as offering query services for events happening at a given time.

4.4 The NPC Framework

In Games terminology, a Non-Playable Character (NPC) can be defined as a sprite or game element that acts as an agent of the game, to facilitate game-play, and is not subject to independent player control or independent autonomous actions. Within Pandora, there are four types of NPCs that can be rendered within the simulation environment:

- HICON (Higher Control Strategic Agents) representing the most senior authority figures within the scenario taking place, i.e. Government Ministers, International Agency CEOs, etc. Such

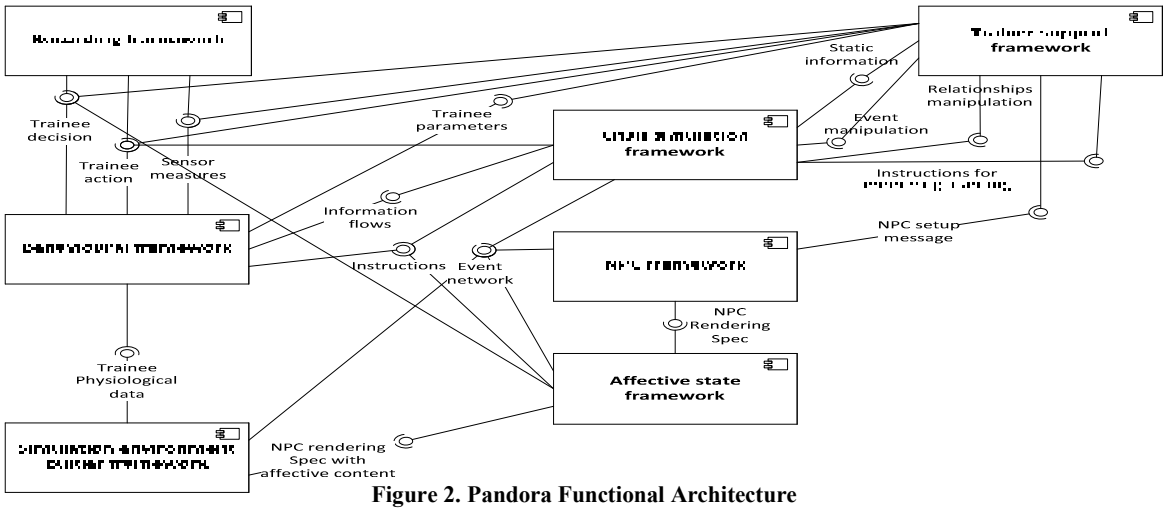

Figure 2. Pandora Functional Architecture

individuals would be above the level of Gold Commanders, have the authority to demand actions or constrain resources, and can impose their decisions on the crisis team and the scenario.

- LOCON (Lower Control Tactical Agents) representing the lower levels of command within the crisis team who can provide valuable feedback on tactical level realisation of a strategy being developed by the Gold Commanders, as well as on-site reports of the situation, available resources, local constraints, etc.
- External Experts, representing specialists in particular areas of importance in given scenarios who can provide inputs through media interviews or information sites, or can be directly consulted by the trainees.
- Missing trainees, for each scenario a set of key players will be identified, and these must be represented so that all the elements of the scenario can be realised. Each of these players will also be modelled as an NPC, where their actions will be pre-determined in relation to the narrative of the scenario. In the event that a training event takes place in which one or more of the trainees are missing, the relevant NPC(s) can be configured to take their place and enable the event to take place.

4.5 Affective State Framework

A key aspect of the development of the Pandora system is in the provision of tools to both determine the emotional and behavioural condition of the trainees during the training event. The emotional and behavioural condition of the trainees are monitored in the Behavioural Framework, which provides input to the Affective State Framework, primarily associated with determining the level of affective input to provide to the trainees, individually or as a group. This information can be pre-determined within the event network, dynamically created by the behavioural framework on an individual or group basis, or input directly by the trainer through that framework.

Within the Affective State Framework a local Multimedia Asset Store provides a repository for a wide variety of multimedia assets developed to support the scenarios. Each of these assets will be meta-tagged with an XML emotion mark-up language specification, developed specifically for Pandora, which will provide standard information on the type and nature of the asset, the media channels for which it is appropriate, the potential for combination with other multimedia assets, duration, etc. It will also indicate an affective level that the asset individually can be expected to engender in the trainees, based on an affective scale defined and categorised for the Pandora project. These assets can also be specifically tagged for use in specified events in training scenarios, to support rapid selection of assets.

4.6 Simulation Environment Builder

The Simulation Environment Builder Framework create a realistic and engaging interaction 3D environment around the trainees and is focused on the best way to render the simulation scenario to the trainees. It uses the event network data coming from the Crisis Simulation Framework to decide what information should be displayed to the trainee, in terms of maps and the information on them and in terms of video/audio that must be played to trainees.

When a video/audio involves an NPC, an NPC Rendering Manager component is considered. It starts from the NPC rendering specification with affective content that comes from the Affective State Framework, and tries to animate the NPC and to recreate the required emotional affect.

Since the GUI towards the trainees not only will be composed of different windows, but also will be displayed using different tools (video-wall, laptop PC) and can be different for each trainee, it is necessary to have an Information Rendering Manager to cover this required functionality. Finally, the Simulation Environment Builder Framework also collects information to generate the trainee profile to be sent to the Behavioural Framework for the subsequent elaboration.

4.7 Recording framework

This Recording Manager is responsible for the recording functionalities, which are concerned, firstly, with the collection of trainee actions, decisions, and any available information that is related to these actions and decisions with trainee behaviour. This framework also collects the output coming from sensors. This data is stored in digital format and subsequently accessed and used by other frameworks within the Pandora system.

5. Summary

The paper describes a technical framework for the development of near real-life training environments for collaborative learning activities. The architecture 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 expected near-real time in real-life situations; a simulation that reproduces the realistic emotional status; and simulation allows the collaboration of different crises managers belonging to different sectors.

6. ACKNOWLEDGMENTS

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