Developing Realistic Crisis Management Training

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Abstract

Current crisis management training, at the strategic level, is predominantly focused on two approaches, table-top exercises and large-scale physical simulations. Unfortunately, neither of these approaches provides the necessary realism to accurately prepare trainees for the stress, volume and speed of decision-making required in an actual crisis situation. The development of virtual environments, rich multimedia, and games technologies has resulted in considerable work in developing new training support tools. Some of this work has introduced more realistic stress into the training environment, but to date there has been no systematic approach to the creation and management of stress in crisis management training. The Pandora project has built from existing models taken from crisis management Gold Commander training, timeline-based event network modelling, augmented and virtual reality serious games environments, affective computing research, and emotional ambience models from film and TV, to develop a rich multimedia training environment offering just such an approach.

Keywords

Rich multimedia training environment; Gold Commander training; affective computing; decision-making under stress; emotive ambience; realistic crisis scenarios.

1   INTRODUCTION

Research shows that learning under stress, for example meeting deadlines for submission of coursework or studying for exams, focuses the mind and results in faster processing, storage and recall of information. While there is often debate about the retention of that information and the knowledge thereby gained, there can be no doubt that this model is frequently self-imposed by students. Additionally, decision-making in stressful situations can be impacted by the affect of elements of the situation on the emotional and behavioural makeup of the decision-maker, causing some to perform better under stress and others to perform worse. In developing training environments for crisis management training it is important to ensure that these elements of stress impacting decision-making are included, under control, to render the training more realistic and to provide appropriate feedback to trainees on their performance in such situations.

At the ISCM symposium in Athens (ISCM, 2011) a Greek ship-owner passionately demanded that those developing training environments for crisis management ensure that the trainees are made to experience the stress of the real situation, giving the example of one of his ships that was lost, and caused considerable ecological damage, through failures in the crisis management of the situation. He reported that, following the incident, it became clear that those responsible for the situation had abrogated responsibility for decision-making, despite the urgency of the emergency, deferring to insurers and politicians to take responsibility for the decisions that needed to be made. Under the stress of the actual situation, they had not felt capable of making the decisions that were their responsibility, and as a result a disaster that could have been averted took place, which the ship-owner felt could have been avoided with better and more realistic training.

For those involved in operational and tactical crisis management responses, physical simulation exercises for clearly constrained physical events work extremely effectively, providing real-time experience and feedback for the trainees. However, such simulations, although large in scale, are necessarily limited in the scope and range of what they can represent, so while a train crash is feasible, the wide-ranging effects of a severe weather scenario are not. For those involved in the strategic, and some levels of the tactical, planning and response for crisis management, the use of table-top exercises has been the norm. These enable consideration of very complex, involved and wide-ranging scenarios, involving large numbers of services and personnel, but, although time-constrained, the realistic stresses of the scenario are absent. In recent years, the availability of computer-based multimedia systems, and computer games technologies, has led to a growth in the development of more interactive and media inclusive training environments for crisis management. Some of these have begun to address the issue of realistic levels of stress for trainees, but to date there has been no systematic approach to the creation and management of stress within individual trainees engaged in crisis management training at a strategic level. In this paper we describe the Pandora project, which is seeking to develop just such an approach.

2   OVERVIEW OF THE PANDORA PROJECT

The EU FP7 Project, Pandora (Bacon et al, 2011), has developed a rich multimedia training environment, and associated toolbox, which aims to use emotional affect to impact decision-making and enhance learning. The application under development is designed to enhance and expand training exercises for Gold Commanders in crisis management. Gold Commanders develop strategic plans, whose objectives are to: save and protect life; protect the health and safety of staff; relieve suffering; contain the emergency; provide the public with information; safeguard the environment; protect property; maintain / restore critical services; promote and facilitate self-help; maintain normal services appropriately; facilitate the investigation / inquiry; facilitate community recovery and to evaluate and identify lessons learned.

The training of Gold Commanders to prepare them to manage a crisis is very important and is typically delivered, as described above, in two ways: either table-top exercises or real-world simulations. These training events are intended to analyse and develop the skills of Gold Commanders. Specifically they are designed to:

- Determine the strategic planning ability, decision-making capability, flexibility and capability under pressure of the trainees
- Develop the strategic thinking of the trainees in considering the implications of their decisions and the effects on other services
- Develop the responsive skills of trainees in formulating alternative strategies and remediating actions in the event of the failure of a strategic response
- Develop the collaborative skills of the trainees in formulating strategic responses across a number of organisations and events
- Develop skills to deal with the media, which are inevitably required in the event of a crisis.

However, as outlined above, the typical table-top training model that is used has serious limitations in achieving these goals, and is almost entirely dependent on the ability of the trainer to engage and motivate the trainees, and to assess their performance subjectively in the training event.

When a crisis occurs, human behaviour and preparedness is critical to the delivery of an effective solution and therefore training needs to be as realistic as possible. It is important to be able to simulate the information overload and related stress, together with the pressure in making decisions. Pandora therefore aims to bridge the gap between the low cost, table-top exercises and the expensive real world simulations by providing an eLearning environment in which the group and the trainer can participate. This environment will provide realistic, dynamically changing, time sensitive, immersive crisis simulation exercises that allow trainees to practice their decision making and negotiation skills within realistic, stress-controlled scenarios. One of the key features of the training system developed for Pandora is that it must provide an environment that engages the trainees on an emotional level. The aim is that the trainees should experience emotions of a similar nature and intensity to those that they might experience when dealing with a real emergency. To this end their emotional state is be monitored and manipulated during the training in a variety of ways. This aspect of Pandora is based on research into models of emotion, decision-making and learning which are discussed in the next section.

3   SERIOUS GAMES AND RICH MULTIMEDIA TECHNOLOGIES

In recent years there has been an explosion of interest in the use of games technologies and gaming approaches for subjects other than entertainment, now using the rather unfortunate soubriquet of " Serious Games" . There has been a proliferation of games in eLearning, eHealth, eGovernance, Industrial Animation, Process Visualisation, Complexity Modelling, and almost any kind of professional training that can be imagined, including crisis management. The rationale for this rapid growth is in the perceived benefits of the addictive and immersive nature of games engagement, in that players will spend hours attempting to solve problems and unravel complex puzzles, frequently failing and restarting, to achieve progress in the game. If such energy, enthusiasm, and determination were to be applied to " real" problems, so the argument goes, then considerable benefits and progress could ensue. Indeed the Federation of American Scientists released a report in 2006 saying that students could learn some skills better from playing games than from conventional training. This included the ability to make fast decisions in critical, high-stress situations, and this view was reported from a number of other industries (Chan 2007).

Two particular approaches are of relevance here, in considering what might be used to create realistic training scenarios for crisis management and, in particular, Gold Commanders:
- Creating a training game where the tasks are crisis management activities, including the planning and realisation phases, and the dynamic feedback and decision modelling (VR - Virtual Reality)

- Create a rich multimedia training environment, where games and multimedia technologies can be used to enhance existing physical training media and processes (AR - Augmented Reality)

In considering the VR approach, three key issues currently have impact on design:

- Graven & MacKinnon (Graven & MacKinnon, 2010) report that great care has to be taken in embedding learning content in existing pre-authored games, as this tends to compromise the game-play, while developing games specifically for purpose is more effective, assuming good game-play can be achieved. The rationale being that without effective game-play the benefits of immersion, in particular in the suspension of disbelief and full engagement, are lost.

- Flynn et al (Flynn et al, 2011) report on the value of a training scenario specifically authored for social workers, as part of a package of training techniques. Their paper highlights the costs associated with developing the number of scenarios necessary to fully address a complex topic, and a requirement to use VR immersion as one of the approaches in a blended learning environment.

- The age demographic of Gold Commanders is such that we can reasonably argue the majority of them will have had limited exposure to VR environments and games technologies, except potentially as parents. This may well have a negative effect on their perceptions of the technology, and may also result in a reluctance to engage and immerse fully, a so-called technophobic effect.

The advantages of the AR approach are in the inherent flexibility to use variations of physical media, digital media, and VR/gaming techniques in combinations that best fit the profile and makeup of the trainee group, assuming that the required assets are available in both physical and digital form, which lends itself to an adaptive blended learning approach. It is very likely that over the next 10-20 years we will see a far greater acceptance of virtual technologies to train and prepare for actual physical situations, as the current " digital native" population move into more senior positions, and the technologies prove their worth, but for the current situation the use of VR will have to be tempered for the specific audience. So, the conclusion for Pandora is that it has to develop an AR approach, but build VR capability in an expectation of greater take-up in the future.

4   AFFECTIVE COMPUTING & EMOTIONAL MODELLING

For the purposes of the Pandora project, the relationship between affective state and learning is key, and in order to optimise that the project has to have techniques to determine the affective state of the trainee and make appropriate changes to the environment and scenario to address that state. Pandora has provided inputs to the standards process on emotional modelling, and contributed to a research workshop defining aspects of the W3C EmotionML standard (Anonymised), to develop the Pandora affective model. The model provides a standard cybernetic feedback loop, with the crisis scenario represented as a stateful event network with each event being individually handled relative to the emotional state of the trainees. Some inputs will be able to influence the event network to achieve a general affect on all participants, while others will target individual trainees relative to individual events. In order to achieve this, the system has to capture the emotional and behavioural state of each trainee, at an appropriate level of dimensionality and within a defined scale, at the event threshold. This information has to be passed to an internal rule-based mash-up engine, which can construct multimedia content representations in a multi-channel, polyphonic, time-constrained model driven by a trajectory definition to move from an existing trainee state towards a desired state. The calculation of the desired state may be pre-defined within the training scenario, dynamically generated by the system, or as a result of direct trainer input.

The key argument for the use of affect in the Pandora scenario is in the creation of affective ambience, by which we mean the use of multimedia assets and information management and manipulation to engender requisite levels of emotional impact on the trainees at the decision making points. Although there is some consideration of the use of avatar representations of emotion in the distributed mode of the Pandora Box, the key affective representation is associated with the creation of ambience or atmosphere. We have taken a number of techniques from film and TV production, combined with a number of known issues in information distribution and management, to create a set of rules by which multimedia mashups can be created and made available to the trainees across a set of configured media channels. This provides the potential to induce stress in the trainees through the use of vocative inflections, video and image representations of crisis situations, and textual updates from those situations. However, the system can also induce stress through the corruption of media channels, incomplete information, missing information, noisy channels, and a variety of other techniques to diminish the certainty of information available to trainees at those points in the scenario where they are required to make decisions. Using this kind of induced stress the system can impact on trainees in terms of their self-efficacy, leadership capability, and existing personality traits, to determine their capability to make effective and appropriate decisions under stress. Existing crisis management training using human media personnel as actors to achieve these effects has had considerable success (Kent Leadership Centre, 2012), and existing research in affective computing has shown this can be successfully achieved systemically (Marsella et al, 2010). Initial

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evaluations of the Pandora system have shown encouraging results, and a full-scale training event evaluation will be reported at the conference and in future papers.

5   DESIGN OF PANDORA

The Pandora crisis training room, which is where training is conducted, is designed to work in three different delivery modes. These are - single site training (AR), deployed (networked AR), distributed (full VR with avatar representation for trainees). All of these offer the same functionality, realised slightly differently dependent on mode. The trainees sit around a table in the same way as they would have done for the paper-based table top exercise however, with Pandora, a range of consoles are used to provide multimedia information using sound, pictures, maps, animations, videos, to simulate receiving information about the crisis, such as a news broadcast. Biometric sensors are also used to gather physiological information about the trainees to assist in an analysis of their stress levels. The trainer is able to configure the scenario to set up non-playing characters (NPC) to role play an emergency service not represented within the group of trainees; subject matter experts; higher control (HICON), such as Government ministers; and lower control (LOCON) - representing the lower levels of command within the crisis team.

Figure 1. VR representation of crisis room, with Slide Show, Streaming Video and Map Applications

The underpinning architecture of the system is the same for all three deployment modes and is made up of several key components which are described below:

- The Crisis Module Framework – This provides an event network to model a crisis scenario against a timeline, supporting the management of the training process including the introduction of decision points for trainees incorporated into events within the crisis scenario. Event network planning and mapping to timelines is managed through a knowledge-based approach, utilising rules stored in the Crisis Knowledge Base.

- The Behavioural Framework – This considers the behaviour of trainees, based on a pre-determined user model (variables taken into account are personality traits, leadership style, background experience, self-efficacy, stress and anxiety), and feedback from a variety of biometric sensors and the trainer during the training session. This component shows how a complete loop crisis-stimuli/trainee-reaction/PANDORA-behaviour-analysis can be implemented and shown to work in a training environment.

- The Trainer Support Framework – This allows the trainer to carry out three key functions:

1. The setup of a scenario for use with a particular group of trainees, e.g. configuring an avatar to represent a missing trainee from one of the emergency services

2. Customise a training session and dynamically update a scenario whilst it is being executed e.g. by compressing the timeline in which events occur and / or to interject additional events, in order to increase the stress levels of one of more of the trainees

3. Record each run of the scenario so the trainer can review the training session after it has been completed with one or more trainees to reflect on the rationale for the decisions made and the alternative choices that could have been chosen during the simulation.

- The Emotion Engine – This is a middleware component within the PANDORA system, providing facilities for the development, configuration and introduction of non-playing characters (NPC) into the crisis scenario to

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interact with the trainees, and multimedia information assets, tagged for emotional affect. The NPC framework also permits the trainer to take control of an NPC to provide direct inputs, in specific events, to the trainees. The Affective Framework, which is a sub-component of the emotion engine, manages a repository of affectively tagged multimedia assets, and uses inputs from the behavioural framework and local mashup rules to produce combinations of those assets to provide emotionally and behaviourally affective information to the trainees. The output of the Emotion Engine, generated through the Environment Framework Builder, is a rendering specification describing the environmental conditions, multimedia information assets and NPCs to be generated in the training environment.

6   CONCLUSIONS AND FUTURE WORK

The growth in the use of digital technologies, and in particular visualisation and simulation technologies, has already had an impact on the training of crisis personnel at operational and tactical levels. However, the provision of training for those involved in the development of high level tactical and strategy plans and responses has yet to take advantage, in any real sense, of these technologies. There are good reasons for this, both in the engagement of high level personnel with modern VR and games technology and, more pertinently, in the need to develop an appropriate, dedicated training environment that addresses their needs. The Pandora project has taken the best of the existing models, in terms of the use of AR approaches, the benefits of table-top and physical simulation, and the impact of real world factors, representing by public media and emotional artefacts, to create just such a dedicated training environment.

Unlike existing systems, the Pandora system has been developed both as an AR and a VR system with a view to offering both blended learning and a fully virtual experience, where this is appropriate and desired. In keeping with the needs of an expanding requirement to train more personnel in crisis management and to deal with ever more complex scenarios, the system has the potential to encompass crisis situations of all types and perspectives and to support strategic level training in all of them. The Pandora box, being the set of tools and the methodological approach to configure the system and environment, have intentionally been developed to be generic, rather than specific. The next stage of development for the Pandora system, which is currently in prototype and will be available under open source license in 2012, is the development of a robust general purpose scenario authoring tool and the redeployment of the environment as a command & control centre.

7   ACKNOWLEDGEMENT

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