

SIMULATION SYSTEM FOR CRISIS MANAGEMENT

Author: Boris Glogovac¹; Co-authors: Denis Rožaj², Gregor Krnec¹

¹Logon d.o.o., Dunajska 129, 1000 Ljubljana Slovenia

²ZootFly d.o.o., Knezov Štridon 94, 1000 Ljubljana, Slovenia

boris@logon.si (Boris Glogovac)

Abstract

Natural or man-induced hazards may have severe consequences. The response to such disasters may require massive resources from large number of responding entities, therefore a holistic approach and efficient crisis management is needed. Recent crises have shown that systems for crisis management are in need of significant improvements. It is critical to provide new tools for improving training and decision making capability to a large number of responding entities. Since it is difficult to recreate exact situation of the catastrophic disaster in real environment, training based on field experience is usually not possible. Correct procedure training and the preparedness of the crisis responders, is possible through virtual simulation where incident scenarios can be created and actors' roles can be trained in a synthetic environment where disaster events can be adequately presented. The realistic qualities of computer games today make them a perfect tool for training in virtual environments and they appear to be ideal solution for merging traditional Modeling & Simulation environments with crisis management training needs. All above mentioned guidelines were regarded in our research projects where operational prototype training tool for crisis management named CROM was constructed which is a cost-effective simulation system for planning, training, interactive education, testing and validating for all decision levels, from government to single company level. The purpose of this paper is to present new ideas for simulation modeling in crisis management based on military concepts and serious games initiative for interactive training in virtual environments. This paper seeks to explore answers to the following questions:

- Is there a future for virtual reality based simulation systems for crisis management?
- How can we implement military concepts with the help of games solutions into crisis management simulation systems for civilian purposes?
- Can computer assisted exercises improve crisis preparedness and coordination for different response entities?

Keywords: crisis management, incident, simulation modeling, virtual reality, training.

Author's biography

Boris Glogovac holds a bachelor degree in mechanical engineering. He has over 15 years of experience in visual simulation area. In the year of 2001 he started visual software solutions firm named Logon where he is working on various management positions. He supervised the production of several visual simulation projects for Nuclear Power Plant Krsko, Slovenian Electricity Holding, Ministry of the Economy, Ministry of Defense, etc. Currently he is involved in two research projects in the area of military simulations. He is finishing postgraduate Master of Science program at a Faculty of economics, University of Ljubljana.



1 Introduction

Media daily reports about new natural or man induced catastrophic disasters which are becoming the integral part of our lives and endemic for our society [1]. Recent crises have shown that systems for crisis management are in need of significant improvements. It is often pointed out that crisis responders were not adequately prepared to deal with such disastrous events.

National-security system in Slovenia developed successful crisis management procedures in all of its subsystems, responding organizations and also some large companies, but there is a lack of inter-agency coordination [2].

Therefore it is critical to provide new tools that will improve training and decision making capability to a large number of responding entities. A holistic approach for efficient crisis management is needed, which is highly dependent on the timely and adequate participation, coordinated interactions and collaborative work of the numerous responders that can only be obtained through interactive training.

Since it is difficult to recreate exact situation of the catastrophic disaster in real environment, training based on field experience is usually not possible. Drills and field exercises are good training tools but have certain limitations. Correct procedure training and the preparedness of the crisis responders, is possible through virtual simulations where incident scenarios can be created and actors' roles can be trained in a synthetic environment where disaster events can be adequately presented. Such training in the virtual environment seeks to develop habit and instinct so that trained participants can act quickly and intuitively.

The realistic qualities of computer games today make them a perfect tool for training in virtual environments and they appear to be ideal solution for merging traditional Modeling & Simulation environments with crisis management training needs.

All above mentioned guidelines were regarded in our research projects where operational prototype training tool for crisis management named CROM was constructed. The main purpose of this paper is to present new ideas for simulation modeling in crisis management based on interactive training in virtual environments. The emphasis is put on usability for Slovenian companies and their coordination with other entities from national-security system.

2 Simulation systems for crisis management training

Learning is the bridge from information to understanding and is most effective when coupled to experience. It is agreed that a well-balanced mix of testing, training and simulation will produce a superior

trainee. Simulation training systems can provide a dynamic productive and engaging learning environment.

Training teams of people to work together has always been a challenge to any organization. This is usually done with either large live exercises, elaborate mockups of all assets and facilities, or networked groups of computer terminals. Simulations are most widely recognized for their ability to teach specific skills to individual. 3D virtual worlds are usually created to provide an environment in which individuals and teams can play autonomously and learn to do their jobs better.

Virtual reality techniques are rapidly reaching a level of effectiveness where they can simulate realistic coordination on the ground for large numbers of crisis response entities in real time for the sake of training. Furthermore, it seems inevitable that future disaster response systems will utilize such technology [3].

Simulations are the best tools for exploring the dynamic relationships between objects and activities. As training support tools, models and simulations are like databases that change automatically in response to relationships between new and old information. Where a database is generally a tool for organizing, storing, and searching for data, a simulation is a dynamic tool for rearranging, combining, changing, and exploring new configurations of data from one second to the next [4].

Through the increasing complexity of modern crisis management it is very important that training procedures are adapted to modern concepts, such as computer assisted exercises. The use of simulation model on computer assisted exercises is a learning method, which dynamically represent operational conditions of the real world in a synthetic environment. Computer assisted exercises enable quality training on individual and collective level [5].

Crisis management simulations are often conducted as human role playing exercises. When these are assisted by computers that track decisions and provide information about the crisis scenario, they can also be integrated into the computer assisted exercises for crisis management, which are periodically organized by EU, NATO and national response centers for crisis management.

3 Implementing military concepts into civil crisis management

There are several compelling reasons why military systems and civil systems for crisis management should be compared with one another. Despite different terminologies and operating philosophies many of the under-laying concepts, processes, architectures, and technologies have much in common [6].

Several civil organizations and multinational companies are experimenting with conversion of military leadership training systems like Joint Combat Analysis and Tactical Simulations (JCATS) which may be able to present command situations for emergency managers as effectively as they have for military commanders.

The simulations necessary to address the complexity of the crisis management for civilian purposes should implement concepts from the current military simulations, as shown in Fig. 1.

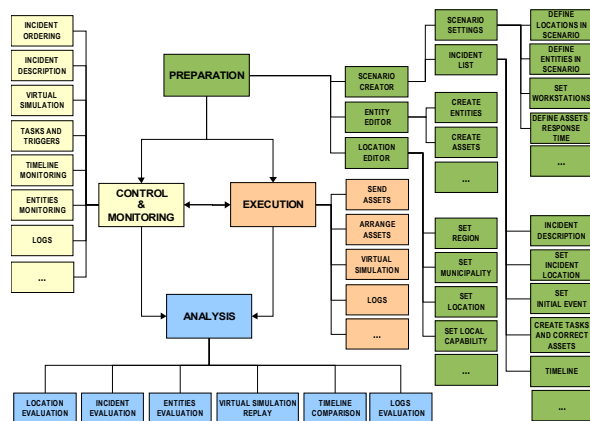


Fig. 1: Military concept for computer assisted exercise in crisis management

4 Gaming technology for simulation and training

The gaming technology of today can provide training anytime and anywhere. Increased processing speeds and graphics processors can provide a realistic 3D environment that may be manipulated in different ways from a variety of perspectives. Computer gaming has become a major influence behind the latest developments in PC technology from input devices, graphic cards and sound cards to voice over IP and wireless connectivity. The engine core of most commercial gaming engines is modular enough that modifications may be made as needed to meet the specialized requirements of almost any application.

Most existing Modeling & Simulation applications use runtime engines that perform identical functions as a commercial game engine. Some applications are built from the scratch while others are built upon commercial APIs. These APIs generally perform a similar task to a commercial gaming engine. The features that most commercial gaming engines include often exceed the features included with most traditional Modeling & Simulation applications. A commercial gaming engine may provide proven platform which allow these applications to utilize the latest advances in PC technology [7].

Long before the term serious game came into wide use with the Serious Games Initiative, games were being developed for non-entertainment purposes. Serious games may be simulations which has the look and feel

of a game, but corresponds to non-game events or processes like business operations, crisis response, military training, etc.

The Serious Games Initiative is focused on uses for games in exploring management and leadership challenges facing the public sector. Part of its overall charter is to help forge productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy [8].

5 CROM simulation system overview

CROM can be described as a cost-effective simulation system that integrates state-of-the-art 3D graphic engine into a unique high fidelity system for personnel training. It allows creating scenarios of destruction, triggering incidents and simulating a dynamic coordination and collaboration of the multi-disciplinary entities, saving lives and protecting property. It is useful tool for all decision levels, from government to company level. This way, leaders from all levels are able to enhance crisis decision making and teamwork for their organizations before they are hit by disasters.

It is an interactive virtual reality based simulation system that provides trainees an opportunity to develop skills in crisis response procedures, because it is capable of creating an infinite number of various crisis scenarios. Scenario generator allows users to create any type of disaster scenario, but they present the initial incident and conditions, because there are no pre-scripted outcomes. Only actions from trainees are determining outcomes and because it operates in a truly authentic virtual world, no two training sessions can be the same. Only threats like fire and smoke spreading, gas and chemical leaks, floods, bomb explosions, etc., have pre-scripted outcomes if left unattended.

Simulation system CROM allows response teams from different entities to improve their coordination and communication in a process of crisis response for different emergency incidents such as fires, explosions, floods, earthquakes, road accidents, riots, kidnapping, hazmat incidents, technical failures and terrorist attacks, as shown in Fig. 2.



Fig. 2: Terrorist attack in front of the shopping mall

It provides positive training experience through the help of authentic virtual environments and high-fidelity 3D database of entity assets. All models are based on true-to-life physics-based dynamic interactions.

CROM is based on the commercial gaming graphic engine XUBL™ created by co-authors' company ZootFly. XUBL™ graphic engine can generate high resolution 3D situational details such as people, vehicles, equipment, buildings, threats, weather effects and vegetation, as shown in Fig. 3.



Fig.3: Hazmat spill and fire in industrial facility

Designed to train a crisis team, CROM has inherent multi-user capability and can be easily deployed on laptops or desktops over a LAN or through the Internet, delivering cost-effective solutions for distributed interactive training on computer assisted exercises, as shown in Fig 4.

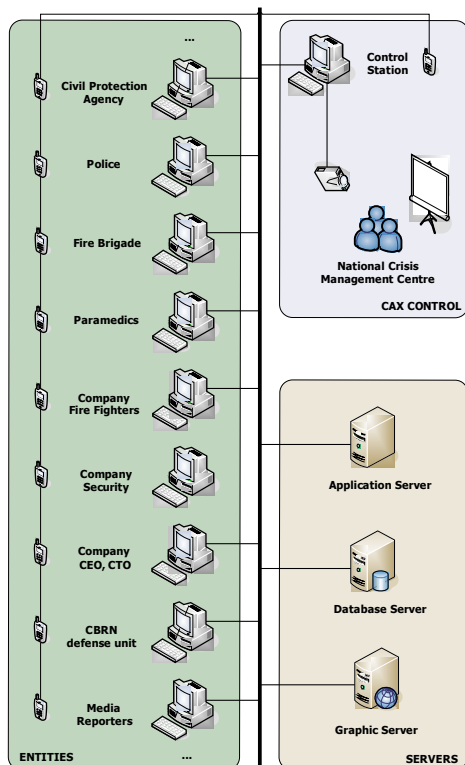


Fig.4: CAX scheme for crisis management training (hazmat incident)

Depicted training concepts were implemented from military training systems.

CROM can facilitate the following types of training:

- Crisis management training
- Emergency responders training
- Multi-agency coordination training
- Threats evaluation and response planning

CROM supports rapid terrain development and offers large, realistic terrain areas with very high levels of visual fidelity, as shown in Fig. 5. Environments are created to be geo-referenced with accurate definitions of all GIS data.

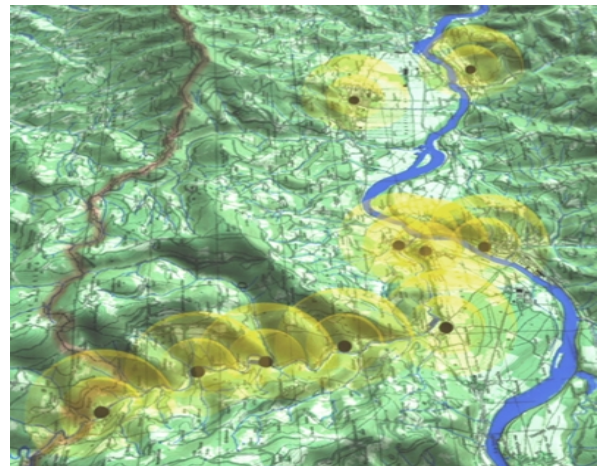


Fig. 5: Terrain simulation of Slovenia

Terrain generation is based on a new geometry clipmaps optimization technique for real-time dynamic level of detail terrain rendering. It caches geometry in a set of nested grids, which are incrementally shifted as the viewer moves. Rendering algorithm renders layers of clipped quantized rings of terrain clipmaps centered around the viewer, as shown in Fig. 6. Quantized ring clipping provides unlimited terrain extends, visual continuity, constant triangle output and very low memory requirements.

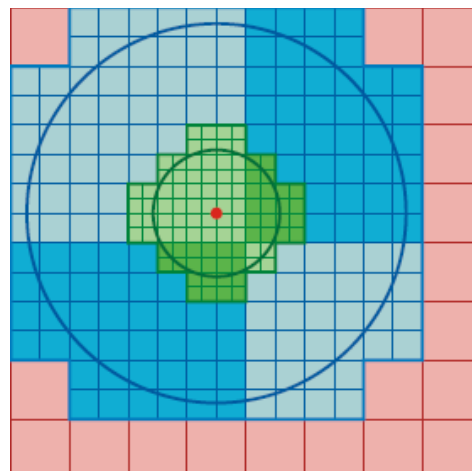


Fig. 6: Quantized ring clipping optimization method for real-time terrain rendering

Above mentioned optimization method provides a number of benefits such as: simplicity of data structures, smooth visual transitions, steady rendering rate, graceful degradation, efficient compression, and runtime detail synthesis.

CROM simulation system is also shipped with data logging and after action review functionality, as shown in Fig. 7. Different multivariate analysis tools from Department for Operational Researches, Simulations and Analysis at Ministry of Defense are used for outcome assessment and scoring analysis.

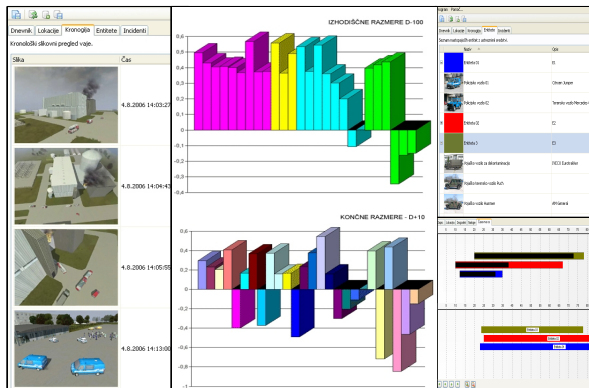


Fig.7: After action review with CROM analysis tools

6 Summary

It seems inevitable that future crisis management training systems will utilize virtual reality technology which is rapidly reaching a level of effectiveness where it can simulate exact situations on crisis incidents.

Increasing complexity of modern crisis requires that training procedures are adapted to new concepts which derived from the military systems, such as computer assisted exercises.

The use of simulations on computer assisted exercise is a learning method, which enable quality interactive training on individual and collective level with coordinated interactions and collaborative work of the numerous responders thus improving crisis preparedness and inter-agency coordination.

The realistic qualities of computer games today make them a perfect tool for training in virtual environments and they appear to be ideal solution for merging traditional Modeling & Simulation environments with crisis management training needs.

All above mentioned guidelines were regarded in our research projects where operational prototype training tool for crisis management named CROM was constructed which utilizes gaming technology and provides efficient crisis training to crisis responders. It develops and presents a realistic, customized virtual simulation of crisis incidents, guiding participants through their crisis management, and providing them tool for analysis of their response strategy, tactics,

decision making and communication for all decision levels from government to single company level.

Through the CROM presentation we achieved the main purpose of this paper which is the presentation of new ideas for simulation modeling in crisis management based on training in virtual environments.

7 Acknowledgment

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