Usage of Multi User Online Computer Games as a Simulation Platform in the Disaster and Emergency Management Arena

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"We will now discuss in a little more detail the struggle for existence"

(Charles Darwin, *The Origin of Species*, p.49)

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Acknowledgments

This thesis is dedicated to my mother (1924-2007) may she rest in peace, and to all victims and survivors of disasters, natural or man-made. Who may give you will suffer no more.

I can describe the last three years as a journey. A journey with a lot of participants, each holding in his hand a piece of a jigsaw puzzle. Some held big pieces, some held smaller ones, and some even had a few of them. Some just handed in the pieces and went on, some stayed for a while, and some were there through the whole journey. However, all were important to the success of this journey and completion of the puzzle.

I wish to thank all the people that shared this journey with me:

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Abstract

Keywords: MMORPG, computer game, simulation, human behaviour, disasters, emergencies, training, emergency management.

Emergency response agencies that need to care for large crowds in real-life events, report a constant lack in human volunteers in large numbers for training purposes. Moreover, existing computerized training aides either totally omit affected crowds in their scenarios, or represent them as computer generated models. A potential solution that can provide real human input in large numbers for training purposes can be found in the form of **M**assive **M**ulti-user **O**nline **R**ole-**P**laying computer **G**ames (MMORPGs) that attract millions of users on a daily basis.

In order to evaluate the use of MMORPGs as an emergency simulation platform I had to examine the in-game behaviour of participants, usability issues, data collection methods, and data reliability. I did so by constructing a multi-user computer game that included food shortage and a pandemic spread scenarios. Data collected included every possible item that could be technically logged, both qualitative (questionnaires, user's self tagging of events) and quantitative (all in-game actions and their coordinates, players and virtual environment in-game status).

The abundance of data enabled easy triangulation and verification. The main findings were: participants attention span was about 90 minutes, they demonstrated only a narrow range of behaviours necessary for their in-game survival, and this behaviour followed loosely real life behaviour patterns. Usability wise participants ignored interface components and in-game tasks that interfered with their game flow. Data reliability: unlike other methods that rely solely on participants accounts, the game had the ability to compare between actions to questionnaire answers, and was able to detect inconsistencies between people's actions within the game and their accounts of their actions. The ability to create spatial maps of event types enabled a fast way to visually analyze data.

The research concludes that MMORPGs can be used as an emergency simulation platform if: 1) its duration fits the participants' attention span (as a result aspects of human behaviour that happen over a prolonged period of time will not be demonstrated); 2) the demographic composition of participants fits that of the population examined by the simulation; 3) participants should be properly reimbursed for their time; 4) it is known that participants' in-game behaviour might be negatively influenced by lack of real-life experience of similar events; 5) in-game rules and mechanisms are set to filter out game abuse; 6) preliminary sessions are run to determine ideal attention span and data skewing factor.

Glossary

This is a general terminology glossary. A technical glossary appears at the beginning of the Methodology chapter.

AI	Artificial Intelligence. A computer program capable of autonomous decision taking upon input data. In the context of this research: a computerized individual.
CD	Civil Defence
CDEM	Civil Defence Emergency Management
CIMS	(In New Zealand) Coordinated Incident Management System. A system developed to control and handle emergency events. Can expand or shrink according to the event size and participating entities. also known as Incident Control System (ICS) in the U.S
Community	a group of people living in a particular local area
Computer game	Also known as Video Game. An event-driven simulation that interacts with a human user, regularly used for entertainment purposes. Can be played by a single player on a stand-alone machine, or as a network game where multiple users interact simultaneously.
Computerized simulation	A computer program based on an algorithm that represents a model and includes dependent and independent variables, and the relations between them in the form of equations or formulas.
Crowdsourcing	Outsourcing of repetitive or challenging work to a large group of semi-organized individuals (a crowd) via the internet
DSM	Diagnostic and Statistical Manual of Mental Disorders. A book published by the American Psychiatric Association providing diagnostic criteria for mental disorders.
EMTC	Emergency Management Training Centre. A New Zealand agency that provides emergency management training courses.
EOC	Emergency Operation Center
GIS	Geographical Information Systems
GUI	Graphic User Interface. Information a computerized application displays on a computer screen.
LAN	Local Area Network, a network of computers connected between themselves but not to an external network or the Internet. Can host from a few to a few hundred machines.
MMORPG	Massive Multi-user Online Role Playing Game. A type of computer game that enables more than one user to play and interact simultaneously. Derives from pen and paper Role Playing Games like Dungeons and Dragons (D&D), which were

	created in the mid-1970s and in which people used to assume roles of imaginary characters.
Model	A representation of the essential aspects of an existing system which presents knowledge of that system. Often referred to a mathematical equation
Multi-agent models	Models intended to simulate a crowd of human individuals that can interact with each other.
NGO	Non Governmental Organization
NPC	Non Player Character. An artificially generated character that can take a human or another form. It interacts with PCs via Dialogs and Scripts.
NWN	Neverwinter Nights. The first graphical interface MMORPG. The game used to create this experiments' virtual environment. Produced by BioWare and released by Infogrames in 2002, it is a third-person perspective computer role-playing game that bears a medieval look. The core release includes: the game engine, a campaign (module) that can be played as single player or multiplayer, a server utility for multiplayer option either via a Local Area Network (LAN), or through the Internet, and a game editor utility (see Aurora Toolset)
PC	Player Character, also known as an Avatar. A virtual representation of a human player inside a virtual world that is manipulated by a human player.
Platform	Software used for development of content. In the research context it refers to NWN.
PTSD	Post Traumatic Stress Disorder. A collection of symptoms defined by the DSM to describe the mental status of people that experienced a physical or mental negative event such as a disaster.
Sector Post	(In New Zealand) a state-operated primary school that, when an emergency has been declared, serves as a gathering point for population that is given information and very basic support.
Triangulation	Data triangulation. Use of multiple data sources with similar foci to obtain diverse views about a topic for the purpose of validation.
USAR	Urban Search and Rescue.
User	A human participant in a computer game (also: player, gamer). Represented in the game by an Avatar.
Virtual Community	A group of people sharing the same virtual space.
Virtual World	A persistent imaginary visual three dimensional (3D) space that exists inside one or more computers. It can be accessed only through computers that are part of the same network. Refers to a world in which a computer game takes place.
Welfare Centre	(In New Zealand) a state-operated high school that, when an emergency has been declared, serves as a gathering point for population that is given information and support such as shelter, food, clothing and first aid.

Prologue: scope, context, initiative and outline of this research

Scope and context of the research: this research examines the use of multi-user online computer games (MMORPGs hereafter) as a disaster and emergency simulation platform, in particular in areas where interaction with large crowds of human participants is needed.

This research consisted of: 1) creation and analysis of a multi-user computer game that incorporates two different post disaster scenarios and in which human participants act as individuals that belong to the affected population; 2) creation and analysis of a data logging system in order to monitor, collect and analyze participants actions within the game; 3) assessment of the usability issues and in-game behaviour of human participants and their implications for creation of future applications.

What was **not** examined in this research? Although emergency training and education are the natural fields for implementation of this type of computer games and they are overviewed in the background chapter, the deployment of computer games in these fields was out of the research scope. This was done in order to concentrate and isolate problems associated with MMORPGs use as a platform, and a combined experiment might have not singled out these problems. The scenarios devised for the experiment also reflect this decision, as participants played the role of affected public members, and not as responding agencies personnel (which would be done if this was a training oriented environment).

Initiative for this research: the initiative for this research was a combination of a three factors that indicate an acute problem, and its possible solution:

- Lack of volunteers in large numbers for training purposes. This was concluded after preliminary research of the emergency and disaster literature, interviews with Civil Defence and City Council personnel in Christchurch, New Zealand at the end of 2006 and beginning of 2007, and observation and participation in Civil Defence exercises and training courses. Possible shortage was attributed to the following factors: 1) people were reluctant to volunteer; 2) there exists no method to recruit large numbers of volunteers, and; 3) there exists no compensation scheme for volunteers.

- Absence of crowds in computerized training simulations in the emergency training arena. This was concluded after a survey of the literature that showed that affected population was either not represented, or represented as a single mass by mathematical models rather than individuals. The trivial way in which computer games are used for emergency simulations nowadays is such that a human participant playing as the main virtual character of the game, interacts with random computer generated individuals that represent the population (this can be observed mainly in military simulators in which the main character played a soldier that had to interact with the local population).

- Voluntary distributed computing projects, Crowdsourcing, and multi-user computer games. All of these phenomena indicate the existence of virtual social networking and therefore the ability to find online volunteers in large numbers. Examples for the above are: 1) voluntary distributed computing projects: Rosetta@home (http://boinc.bakerlab.org/rosetta) in which users contribute their computers over the Internet in order to process vast amounts of data; 2) Crowdsourcing, a term that stands for commercial initiatives (Brabham, 2008) in which commercial companies seek public help in development, improvement, or unskilled processing tasks that cannot be done by computers (these can include: image tagging that pays a few cents per task by Google, product improvement by submitting feedback and comments to Dell and many more), and most significantly; 3) multi-user online communities of computer gamers that attract millions of people worldwide that spend a few hours on a daily basis playing them (Yee, 2006a).

A brief outline of this thesis:

- A background chapter that overviews the two major areas this research deals with: the realm of multi-user computer games, their advantages and drawbacks, and the arena of agencies responding to emergencies and their training methods. The chapter concludes with the research questions.

- A methodology chapter, that supplies a thorough description of the creation of a multi-user online computer game, and of the data collection mechanisms devised to examine my hypotheses. The game included two scenarios: 1) a food shortage in a virtual city following an earthquake, where participants play as affected population members, and; 2) a pandemic infection scenario in which participants roam around the virtual city and might get infected by the pandemic.

- The Results chapter presents the data collected and analysed from the computer game, which was run from early March 2009 until the beginning of July 2009. These data cover participants demographic data and statistics, players' answers to in-game questionnaires (of which part I deals with their character, and part II deals with their in-game behaviour and their own assessment of their immersion in the game, as well as with usability issues). In addition, the data presented also contain information about players' in-game behaviour patterns, and examples of spatial data collection methods.

- The discussion chapter discusses the issues that initiated this research, and possible solutions using the results from the experiment. The topics covered include the technical constraints involved in the creation of the simulation, usability issues, and participant-related issues such as their in-game behaviour and their motivations.

- The Thesis terminates with a short chapter that outlines operative conclusions regarding future implementation of multi-user computer games as emergency simulation tools, and possible areas of deployment.

1 Background: Disasters, training, and computer games

As can be seen in figure 1-1, this research mainly deals with the use of Massive Multi-user Online Role Playing Games (MMORPGs hereafter).

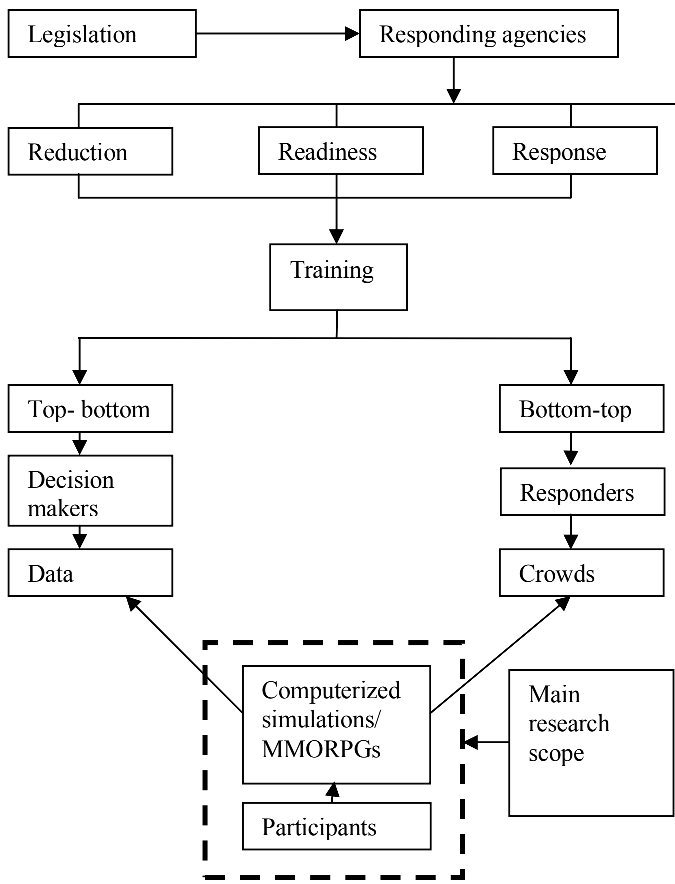


Figure 1-1 Where does the research area fit in the emergency preparedness arena?

However this cannot be discussed exclusively without mentioning its natural deployment areas, which are training of emergency response personnel and education of general population. The chapter starts with a definitions of real world emergency response arena (i.e. what are disasters, and who are the responding agencies), and virtual world definitions (i.e. modelling and simulation methods, MMORPGs, and the differences between them and real life).

The chapter continues with an overview of the training methods used by responding agencies, and where computer games fit into this field. Later on, the chapter focuses on MMORPGs: what are they, their advantages and drawbacks, usability and user related issues they pose. This is then followed by an overview of computer game obtained data accuracy and validity and its collection methods. The chapter terminates with the research questions.

1.1 The real world

1.1.1 What are disasters, emergencies and catastrophes?

In order to create a post-disaster virtual environment, I first had to define what a disaster is, and what components the definition included. Various definitions for disasters and emergencies exist in professional emergency management guides and in the literature (Alexander, 2003, McEntire, 2001, Quarantelli, 1985, Wilson and Oyola-Yemaiel, 2001); common to all is the fact that they describe situations or events that have in common the following conditions:

1) they disrupt the normal everyday life led by a community;

2) they cause damages (to environment, economy and human life);

3) they are beyond the capacity of the community to take care of;

4) resources outside of the community are needed in order to help in its recovery.

As can be deduced from the above definition, if the situation can be contained within a community (i.e. enough resources or aid agencies to deal with the situation), it is not considered a disaster. On the other hand, if an event impacts a few communities and causes a major disruption to everyday life, it can be considered as a catastrophe (Quarantelli, 2005).

The above definition suggests that there should exist at least the following elements in order for an event to be regarded as a disaster:

1) an initiating event (that can be natural or man-made, fast or slow, singular or continuous);

2) an affected physical area (including natural terrain, or man-made infrastructure);

3) an affected population (a community – a group of human beings that share the same habitat, but are not necessarily affiliated in any other way);

4) constraints that govern the participating entities (i.e. resources and time limitation), and (optionally);

5) responding agencies (can be community members volunteers, municipal services, NGOs, civil defence, military forces, international relief aid organizations).

For this research purposes, I used the above elements in order to create a virtual post -disaster environment to test the research hypotheses.

1.1.2 Legislation, responding agencies, their role in the different disaster's stages and their structure

Emergency management is an official organizational structure established by governments (can be on federal, state, county, and city levels) to manage the social repercussions of natural and/or technological emergencies (Wilson and Oyola-Yemaiel, 2001). In many developed countries (e.g., the United States of America, Great Britain, and Western European countries) population preparation for a disaster or an emergency is well defined in a state's legislation (e.g., the New Zealand Civil Defence Emergency Management Act (2002) the United Kingdom Civil Defence Act (1948), and the American Federal Civil Defense Act (1950)). These acts define the circumstances under which emergencies can be declared by governments, who are the agencies that can manage these situations, what are their responsibility areas and available resources through legislation. It should be noted however that these agencies will not perform the role of other agencies, but will rather collaborate with them (i.e. the New Zealand Civil Defence will use St. John's Ambulance services, and not attempt to operate a service of its own).

Emergency response organizations started as military divisions during World War II (e.g., Air Raid Wardens (Waugh, 2000)) that had to protect civilian population from the effects of a military attack. The term Civil Defence was coined in the 1950's era, at the height of the Cold War period (the period where the United States of America and Soviet Russia prepared for nuclear attacks upon each other) (Haddow et al., 2007, Wilson and Oyola-Yemaiel, 2001). The preparation of civil population included development of educational content related to the effects of nuclear attacks, school and workplace drills of evacuation into shelters, and preparation of the facilities needed like bomb shelters. The term has remained in use ever since, even though in some cases these military divisions turned into civil agencies that deal with general emergency management. The purpose of their existence changed as well, and broadened over the years to deal with up-to-date threats like terror attacks, pandemic, and response to natural disasters.

Emergency management agencies are constantly active, from pre-disaster stages where they are engaged in mitigation and preparedness activities, to post-disaster stages were they are engaged in response and recovery activities (these stages are known as the 4 R's in the New Zealand emergency management terminology: Reduction, Readiness, Response, and Recovery). Mitigation aims to prevent a potential hazard from turning into a disaster (i.e. proper legislation that will prevent people from building on coastal areas prone to tsunamis, or informing the public about hazards) (Weichselgartner, 2001). This is a long-term stage in which threats are always assessed and plans are set in place.

Next follows the preparedness (or readiness) stage. It is also a long-term stage, in which agencies responsible address two key issues: 1) preparation and stockpiling of essential supplies that might be needed by affected population, and; 2) planning and preparing their own staff members and public volunteers by developing and implementing training programs and by educating the potentially affected population (Dynes and Quarantelli, 1975). This is actually the stage and particular issue upon which this research is focused.

The next stage is the response to the disaster, in which agencies act on two levels: 1) manage the emergency by decision making using data gathered from various sources. These decisions mainly deal with prioritization of resources and coordination between participating entities; 2) deal directly with the affected population and supply it with essential items like food, water and shelter; and supply search and rescue services where needed (Der Heide, 1989). This stage is considered to be a short-term one and is designed to supply immediate answers to acute problems and not long-term solutions.

The last stage, recovery, is a long-term stage and is dealt with by authorities and affected population itself, as it involves rehabilitation of population, repair of infrastructure and tasks that are not in the focus of responding agencies (Berke et al., 1993). Sometimes this stage is linked back to the first stage, as mitigation and preparation for a future event is part of the lesson-learning process following a disaster.

As disasters are classified as low probability events (Alexander, 2003), there is no economical justification to employ large amounts of full time paid staff, therefore emergency management organizations have two types of staff: full time paid professional emergency managers, who comprise the managerial tier of the organization, and a much larger number of members of the public who are trained to act as volunteers when need arises (Stallings and Quarantelli, 1985, Waugh, 2000).

The managerial level deals with the control and management of the incident, and solely processes information and issues orders to involved entities. It retrieves information from various sources (i.e. in New Zealand, situation reports prepared by sector posts and sent through to the Emergency Operation Centre (EOC), media reports, public members reports, and other participating agencies reports). The information is processed into a "big picture", so that available resources can be deployed according to preset priorities.

The responders' level of an emergency management organization will deal directly with the affected population (however this might be done in collaboration with other authorities like welfare services or police that deal with population on a daily basis). The main tasks typical for this level can be search and rescue operations, evacuation of population from hazardous areas, managing of sector posts and welfare centres in which people will get basic needs (food, water, clothing, and accommodation).

1.2 The virtual world

1.2.1 What are simulations, models, and computer games?

Computer simulations are used in various scientific and non-scientific fields for various purposes that include discovery and formalization of rules governing a system, understanding of an examined system, prediction of events in a system, professional training of people in particular fields, as well as entertainment (Hartmann, 1996, Humphreys, 2004, Macy and Willer, 2002).

Computerized simulations can be defined as computer programs based on an algorithm that represents a model and includes dependant and independent variables, and the relations between them in the form of equations/formulas. The computer program can manipulate the various variables, either independently (by running different sets of values assigned to variables on each computational cycle), or by waiting for a triggering event to happen (such as input from a human user) in order to advance from cycle to cycle (Axelrod, 2005, Gilbert and Terna, 2000, Hartmann, 1996, Humphreys, 2004). A model in turn is described as a representation of the essential aspects of an existing system which presents knowledge of that system (Humphreys, 2004, Schmid, 2005). The system is simplified and left only with the main parameters influencing it, the relations between those parameters, and the assumptions we have relating the system. The relations can be represented as functions, equations, formulas, rules, or processes (Frigg and Hartmann, 2006).

Computer games fit the description of event driven simulations, as they depend on human input in order to progress from cycle to cycle. Computer games can be primarily for entertainment purposes; however they are used also for understanding of an examined system (for example: virtual economics (Castronova, 2002, Lehdonvirta, 2005)), and for training of people in particular professional fields (i.e. military or fire fighting simulators (Atkin et al., 1999).

Computer games sales have been increasing since the early 1980's, when the first Personal Computers (PCs) began to sell commercially and started to enter large numbers of households. Most computer games can fit into one of six genres: shooter, sports, action, adventure, strategy and role playing (Pinelle et al., 2008). Another important distinction can be made according to participating players numbers: a single player game where the game is played on a single computer by a single human user, or a multi-player game where a group of human users (from very few to a few thousands) can participate in the same game and interact with each other.

1.2.2 Simulation methods of human behaviour

Humphreys (2004) argues that computer simulations are sometimes problem specific and will work for a specific type of problem, and will not necessarily be applicable to other types of problem. Likewise, simulation of human behaviour is done for different research purposes and has several methods, according to the specific needs. In general, the evolution of human behaviour models is from simple models that treat the population as one entity (system/ dynamic world models), through models that differentiate between the population as a whole and the individuals that compose it (Micro-analytical Simulation Models (MSM), queuing models), ending with complex models where individual entities that simulate human beings interact with each other and demonstrate a learning ability (Cellular Automata, Multi-agent models, evolutionary models (AI and Neural Networks) (Gilbert and Troitzsch, 1999)). (A thorough description of the different methods and their disadvantages can be found in Table A1-2 in Appendix 1: Background).

Multi-user computer games (MMORPGs) can also be regarded as a tool for examining human behaviour and interaction, but with one major difference compared to the above methods: they do not have to program or define individual entities in advance to mimic human beings, because they use real people. The closest types of simulations they can be compared with are the ones that simulate individual human beings (i.e. multi-agent models).

The following table compares various aspects of human representation as they are expressed in multi-user computer games and in computerized multi-agent models.

Table 1-1 Comparison of human individual representation in MMORPGs and in multi-agent based computerized simulation methods

Parameter	Multi-user computer games	Multi-agent simulation methods
Technical issues		
Representation of an individual	A human participant	A computer program
Validity of data supplied by individuals	Validity of data depends on actions taken by participating players and their honesty.	Since these are synthetic environments, validity depends on input data quality and assumptions made before simulations are run as well as on analysis and "learning" mechanisms applied by AI agents. If based on human input than validity can depend on sample size and honesty of participating persons.
Complexity level of action taken by individuals	Almost indefinite. Human players choose how and what to do and are not governed by any parameters.	Determined by the parameters set by the computer program.
Interaction level between individuals	Almost indefinite. Players can interact freely with other players	As dictated by the designer/ programmer.
Learning ability of individuals	Since players are human they reflect the real learning processes taken by individuals	As dictated by the designer/ programmer.
Cognitive processes demonstrated by individuals	Only actions can be monitored. Complex processes taking place without a trace (thinking for example) are not documented	Only actions can be monitored. Even so called learning processes are described as "black box".
Human traits representation		
Autonomous action of individuals	A natural ability of the player. Can be monitored by composition of location, messages and proximity to other objects/ players)	As dictated by the designer/ programmer.
Social interaction between individuals	A natural ability of the player. Can be monitored only be linked actions (text messages, speech, proximity of locations over time, similarity in actions)	As dictated by the designer/ programmer.

Strategic planning demonstrated by individuals	A natural ability of the player. However can not be monitored since a cognitive process does not leave traces. Planning can be assumed after analyzing actions taken as response to certain events.	Limited. Depends on designer/ programmer of the simulation. Even improvisation needs to be programmed into the AI's. Action is based on planning and calculation, not emotions, improvisation or other human traits.
Perception of the environment by individuals	A natural ability of the player. Monitoring can be done by analysis of actions.	Limited. Depends on designer/ programmer of the simulation.
Communication and language	A natural ability of the player. All message types can be monitored (however, the easiest are textual messages).	Limited. Depends on designer/ programmer of the simulation.
Emotions	A natural ability of the player. Can not be monitored, but only deducted by analysis of players actions	Inexistent. Almost impossible to implement into a written computer program. By far the largest disadvantage since human beings actions tend to be governed by their emotions

The main conclusion from the table is that multi-user computer games are superior to computerized multi-agent models for the purposes of this research as they can demonstrate a participant's ability to express emotions and act according to his or her own free will.

Yee (2006a) points out the main advantages of multi-user computer games: *"MMORPGs provide a naturalistic setting where millions of users voluntarily immerse themselves in a graphical virtual environment and interact with each other through avatars (visual representations of users in a digital environment) on a daily basis"*. Castronova (2006) even coins MMORPGs as *"Petri dishes for social science"* due to their large number of participants and the controlled environment which enables a monitored research.

It should be noted that multi-user computer games, although an innovative research tool, cannot be applied to all aspects of human behaviour research, and their use depends on the research purpose. In case of the emergency response arena, this purpose might be training of field-level personnel in places where they might encounter a mass influx of needy individuals, or on the other hand observation of individuals' behaviour in an environment that cannot supply them with essential resources, so decision makers can determine what might be the minimum of supplies needed in case of an emergency, or when a need arises to trace the progression path of a pandemic among different densities of human population.

1.2.3 What are MMORPGs?

Multi User Dungeons (MUDs), Role Playing Games (RPGs), Massive Multi-user Online Role Playing Games (MMORPGs), Multi-User Virtual Environments (MUVEs), and Local Area Network (LAN) games, all refer to computer games that involve large numbers of human players that interact with each other inside a virtual world. These games have four significant attributes:

1) participants assume the role of a fictional virtual character, an Avatar, in order to interact with other human participants (the Avatar is not necessary similar to their real life character or physiognomy (Wolfendale, 2007));

2) the virtual world they exist in is persistent, and continues its existence along the timeline even when not all players are logged onto it, and;

3) changes made to the world by players cannot be undone, similar to real-life (Merrick and Maher, 2006);

4) these games are open-ended and players can do what ever they like; they are not confined to a linear plot line in order to achieve their game goals (missions, campaigns), as in some cases a clear plot does not exist, or is determined by the players themselves and not by the game designer.

These computerized games originated with a fantasy role playing board game named Dungeons & Dragons (D&D) that was invented in 1974 by Gary Gygax and Dave Arneson and that was inspired by books written by J.R.R. Tolkien in the 1930's. In 1991 America Online (AOL) released the first commercial MMORPG that used a graphical user interface and was called Neverwinter Nights (NWN). This game was officially licensed by D&D and had similar game rules and characters (Tyrer, 2008).

In these games a gamer usually interacts with other gamers, forms groups (parties) according to common interests, and interacts with other groups and other players as well as with Non Player Characters (NPCs, computer controlled characters). The more time the gamer spends in the virtual environment, the more experience his Avatar gains (more abilities usually), and this is expressed in his place in the virtual social hierarchy (Dickey, 2007).

It should be noted that examples like Second Life (www.secondlife.com) and World of Warcraft (www.worldofwarcraft.com) feature phenomena like virtual economies (Castronova, 2002), crime and other social traits that reflect the real world. This full interactivity is the main advantage when trying to simulate complex scenarios that require immediate feedback loops.

It has to be added that contrary to MMORPGs that have a governing narrative (adventures and quests), Second Life (SL) is much more open ended than a game per se and actually offers a virtual three dimensional (3D) platform in which users can roam around and do what ever they want to, a place where all conceivable types of human interaction can be tried out (Helmer and Light, 2007).

1.2.4 Differences between simulations to real life events

As one can understand, there are obvious differences between a simulation session (elaborate as it might be) to a real life event. The two main differences are: 1) the different time scales - a few hours for a simulation session vs. a few days or weeks in real life; 2) the differences in the demographic composition of simulation participants and the real life events' affected population.

The following illustrates the time scale difference. Individuals exposed to traumatic physical or psychological events such as armed conflicts, terror acts, natural disasters and even motor vehicle accidents (Neria et al., 2008) can demonstrate a variety of symptoms well after the event itself terminated, both negative (Post Traumatic Stress Disorder - PTSD: APA, 1994), and positive (Posttraumatic Growth – PTG ((Meichenbaum, 2006)). The transitions in behaviour (i.e. from shock and grief to acceptance, depression) are well documented in the literature (Base (2006), Johnson (2006), and Roy (2006); Napier (2006)) , and take weeks to months, therefore, trying to focus on short periods (days or hours) after a disaster will not demonstrate a wide spectrum of human behaviour.

The above should be taken into account when designing a computerized simulation that wishes to depict human behaviour after a disaster, because participants might not demonstrate behaviours that take a long time to develop, and similarly, if participants do not have a similar demographic background, they might not share the similar values or behaviours.

Moreover, anecdotal examples of human behaviour following a disaster that support the research findings and that relate to looting and violent behaviour can be found in Appendix 4.8, sections 4.8.2 and 4.8.3. These describe the post disaster situation in Samoa following the 30 September 2009 Tsunami, the 1991 Uttaranchal earthquake that occurred in the mountainous region of Garhwal Himalayas in northern India, the 2001 Gujarat earthquake in India, and the Gujarat Hepatitis B Plague in India.

1.3 Emergency preparedness training and education

1.3.1 Emergency management agencies training methods

Alexander (2003) observes that one of the signs that emergency management turns into a mature profession is its ability to offer training programs to planners and managers in that field. As such, this profession has to offer various programs that are targeted at different levels to suit its stakeholders, both to managers and decision makers and to responders.

Consequently it can be seen that for the two types of target audiences two totally different training approaches will have to be used. As the managerial level is occupied with decision making processes at the response stage, the proper training will consist of exercises with scenarios that supply fragments of information over time and can be given to participants orally, on pieces of paper, radio communications, or via a computer. Sometimes, the exercise can involve participants from various agencies, in order to examine their ability to collaborate. The information can include also resources available for deployment and constraints imposed upon participants. These exercises examine mainly the collaboration, work under time pressure and quality of decision taken. An exercise controller monitors participants, and the exercise ends with a debriefing session that sums the decision taking process and lessons learned. It should be noted that from the exercise I witnessed and from the literature (Haddow et al., 2007), it turns out that the most important factor that influences the decision-making is proper communication.

At the responders' level, the bottom to top approach is taken, as the interaction with affected population is its main issue. Two types of training exist:

1) technical training (search and rescue techniques, sector post operation, communication operation, etc.). This sort of training develops and maintains skills needed by volunteers, and has no direct dealing with affected population;

2) interaction with the population. This sort of training combines the technical skilled gained, and how they are applied when interacting with affected population members. The most popular training method that is widely used at this stage is role playing (e.g., volunteers open a Sector Post, and "casualties" arrive and are being treated, or "casualties" that are assessed and treated by first aid responders). This situation most closely resembles interaction with affected population on a one to one basis (personal experience). In its real-life version, one or more participants assume victim roles and other participants have to deal with them by questioning, observation, or reading notes attached to the "victims" which describe their health status, so they can act properly. The main problem this method has is the lack of volunteers to act as casualties, so in most cases these exercises end with a small number of participants, in a sterile environment unlike a real-life situation, where masses of persons might arrive at a sector post with various needs.

1.3.2 Gaming and emergencies

Gaming, in this research context, can be defined as activities that cause one human being to interact with other human beings. The concept behind it is clear – better learning will happen through action. A browse through the literature suggests that there are three typical types of games in that sense: 1) **role-playing games** which are abstract, and in which a participant assumes a specific role and acts according to instructions or perceptions typical to that role. The participant then has to interact with other participants, and actually experiences the "I'm in somebody else's shoes" feeling, and this is the main goal of that type of games. These games can be abstract (i.e. people sitting in a room, each has his own role/ instructions and once ready, input data starts to flow in and participants have to behave and decide according to their assigned persona), or played in a location where an actual event might happen, including the appropriate scenery (i.e. a sector post, with participants wearing proper gear). This sort of games can be used for training of field level staff (i.e. opening a Welfare Center, and assisting "affected" public members), and for managerial level staff (i.e. exercises like Pandora, run by New Zealand Civil Defence annually, and trains the Emergency Operation Centre personnel); 2) **board games/ table top games**, in which a group of users is arranged around a table, with a schematic map of a game. Each is given a representing figurine which is placed on the board, some resources, basic rules, a goal, and an advancing mechanism (dice, chronometer, or just taking turns). In some games each player has to compete against all other players, in some he can form allies, and in some all players have a common goal that they have to work towards together. These games are suited for managerial level training, as they deal with macro-level concepts, where people have to draw general conclusions just by assessing the game board (i.e. how to divide their resources, according to partial data they have), and not dealing with micro-level interactions, which are irrelevant at that level; 3) **virtual simulations**, which actually emulate the above methods, and use computer technology for the above purposes.

The above types are mentioned as viable educational tools and training options for personnel in various fields. A collection of literary sources is the International Simulation & Gaming Research Yearbook published annually by the Society for the Advancement of Games and Simulations in Education and Training (SAGSET hereafter). The 1998 edition, (Rolfe et al., 1998), which was dedicated to emergency and crisis management, features a variety of such methods for various fields, such as: board games about fire services crisis management, surgical emergencies, and air pollution in Mexico City, and a business oriented game; Role playing simulations of an airline crisis management, casualty handling after a disaster, and; virtual simulations used for policy development.

The goal in training and education in successful learning, and this can be achieved through proper feedback to participants. However, the above examples illustrate clearly the ways they provide their participants with feedback: performance in the game, conversations with participants, and participants' own assessment of events that happened while they were engaged in gaming. All these options fail to provide the game controller and the participants with accurate feedback, as gaming moves, decisions taken, status of gamers in each step, and the ability to replay a game in order to watch and analyze it cannot be recorded.

These drawbacks (which are natural to every game), can be easily overcome by a dedicated computerized application that can log data and later cross-reference it with alternative data sources logged during a gaming session. This data can be used for future analysis, feedback to participants, or to refine future simulation sessions.

1.3.3 Computerized training aids used by emergency management agencies

Numerous examples of commercial software packages dealing with various aspects of a disaster/emergency exist in the market. Although overview of commercial software is problematic because the information does not come from an objective source, a thorough report was written by Agrait (2004) that overviews a hundred different applications that were claimed to be used by agencies involved in emergencies. These applications are targeted mainly at the managerial level and include scenarios that range from aftermath of natural hazards up to terror acts and man made disasters (chemical spills etc.). The scenarios can be represented as two-dimensional maps of a city based on Geographical Information Systems (GIS) information, or a three-dimensional representation of a city. Some also enable layering of information on the surface maps. Potential users can also control virtual forces within the application (fire brigade, police, and CDEM units), as well as create limitation of resources. Some of the applications offer the ability to communicate with other participants in the simulation and send messages (where application is a multi-user one). However, in all programs reviewed the affected population is not represented as individuals but rather as a mass represented by a model (if at all). This "sterile" environment has problems of its own, for instance if an incident commander moves his virtual forces from point A to point B, it might be done seamlessly in a simulation, however in a real life situation a crowd of a few hundreds of people might block rescue vehicle's way for various reasons, and the crew will have to spend precious time in order to negotiate their way through, or decide on an alternative route. Computerized simulations for some reason do not take into account the influence that affected population has over the overall situation.

Some examples that are available online (websites visited on June 2008): Incident Commander, a crisis training simulation, www.incidentcommander.net. CRIMSON, urban crisis simulation, www.crimson.c-s.fr. SimGuard, a comprehensive incident management system, www.rontal.co.il. Ground Truth, urban incident management (proto-type/demo version), www.sandia.gov/news/resources/releases/2007/groundtruth.html. And HAZUS, FEMA's risk assessment software program for analyzing potential losses from floods, hurricane winds and earthquakes, www.fema.gov/plan/prevent/hazus/index.shtm.

It should be noted that even when simulation applications are targeted at the responder level, like military simulators that train soldiers (Fong, 2006), or medical simulators for health professionals (Marks et al., 2007) the virtual characters they interact with inside the application are still represented by Artificial Intelligence agents (AI's).

1.3.4 A short note about training

Professional literature and responding agencies' manuals provide an insight into their training goals and methods. However, in order to be able to assess and evaluate the needs of responding agencies in the training arena both at the managerial level and at the responder's level, I had to gain first hand experience. I did this in two ways:

1) in order to experience the managerial level, I observed the annual Pandora exercise that was held in Christchurch, New Zealand on the 15 and 16 of September 2007 and the following debriefing. This was considered to be the biggest New Zealand South Island-wide Civil Defence Emergency Management exercise, with more than 1,000 people involved (CDEM, 2007). The exercise goal according to the pan-Group Exercise Coordinator, Jon Mitchell, was to test a South Island-wide initial response to a major earthquake on the Main Alpine Fault;

2) in order to experience the responder's level, from 01 September 2009 to 01 December 2009 I participated in three training courses offered by the Emergency Management Training Center (EMTC) on behalf of the New Zealand Ministry of Civil Defence and the Christchurch City Council. These courses included:

1) CDEM Emergency Welfare, the goal of which was to prepare civilians to serve as volunteers in welfare centers (places to which affected population can reach following a disaster in order to get information, basic supplies, and further instructions);

2) CDEM Emergency preparedness, the goal of which was to prepare civilians to serve as volunteers in Sector Posts (places affected population can reach before going to a welfare center), and to familiarize them with the Coordinated Incident Management System (CIMS, also known as Incident Control System (ICS) in the U.S) that is used by agencies involved in emergency management;

3) the third course, Introduction to Urban Search and Rescue (USAR), prepared volunteers to become members of USAR teams, and introduced them with basic search and rescue skills (see appendix 10.1.1 for a table that lists the courses and their respective New Zealand Qualification Authority (NZQA) Unit Standards).

1.3.5 Potential uses of MMORPGs in improving the disaster and emergency management arena

The main justification for this research was the improvement it can bring to the emergency management training arena. This improvement can be attributed to two properties MMORPGs possess: 1) the accessibility of these games to potential players (staff/ managers in this arena), and; 2) the fact that these game can log the data of actions carried out by participants, that could be later on analyzed.

These two factors translate practically into these potential uses that engulf training of field and managerial staff, as well as education of the public:

- A relatively cheap and convenient training method for field staff that have to interact with affected population. Staff can log into computers from the comfort of their home and exercise different scenarios in a larger frequency compared with an exercise they need to be present in a real location (and from my own observation, volunteers numbers are not large, as they have many reasons that hinder their participation in such cases).

- As field staff does not need to be present in a real location, larger numbers of participants can be recruited from different places around town/ state, and better simulate a real emergency scenario.

- On a managerial level, a game enables policy makers to test their theories and assumptions in a real-time situation, and put to test cooping strategies they devise. The fact that they see immediate feedback enables them to change their planning while on the move, as might happen in real-life situations.

- The fact that all the data can be logged enables a very efficient debriefing procedure from which lessons can be learned and implemented.

- MMORPGs can also be used as efficient emergency preparedness education promoters. People are immediately rewarded by the game (i.e. survive for longer periods in the game) according to their actions and gaming strategy. These differs from an indoctrinated lecture they hear, and have no way to verify its validity.

- These games can reach sectors that are not reached traditionally by organizations such as schools, army or universities (where emergency preparedness can be offered), and can benefit from access to these games.

1.4 Massive Multi-user Online Role Playing Games (MMORPGs)

1.4.1 MMORPGs in the literature

Research regarding computer games exists from about the period computer games first emerged commercially in the beginning of the 1980's with the appearance of the first generation of Personal Computers (PCs) (for example, a study about computer game players dating to 1984 (Myers, 1984)). As MMORPGs first emerged in 1991 (Tyrer, 2008), just a decade after computer games and have been around for about twenty years before this thesis was written, one would expect to find a large amount of literature in the field. However, in 2005 a report by Bonk (2005) stated that less than a dozen research papers on MMORPGs existed, and this was later supported by Yee (2006b) who claims that there is very little quantitative research on MMORPGs or MUDs.

In order to get an indication as to how much relevant research (by relevant I refer to literature that deals with post-disaster scenarios and masses of crowds represented by human players) can be found nowadays, I used Google Scholar search engine (the results are relevant to the 2 January 2010). The first term searched for was computer game, and about 1,990,000 papers that mention that term exist. The second term, Computer simulation, yielded about 1,870,000 results. However, when typing the third term, MMORPG, the search engine returned only 5660 results. The same term without being abbreviated (Massive Multi-user Online Role Playing Games) yielded 1880 results. When typing MMORPG + emergency simulation, only 279 results appeared (non-abbreviated had only 171 results), and when typing MMORPG + disaster simulation, only 246 results were displayed (non-abbreviated had only 173 results).

In this context (excluding papers that surfaced due to typo results, like the combination MMO that appears in many papers), papers fall into the following categories: technical issues that deal with software and hardware aspects (i.e. (Caltagirone et al., 2002)), health issues caused by MMORPG use (Smyth, 2007), education and learning via MMORPGs i.e. (Helmer and Light, 2007), MMORPGs as a potential training platform e.g. (Gotterbarn),and MMORPGs as a potential military training platform (Bonk and Dennen, 2005).

In most of the papers browsed, researchers either review the MMORPGs arena, deal with the potential of MMORPGs as a platform for various applications (for example the potential use of MMORPG as a training tool for emergency preparedness (Jones and Hicks, 2004)), or are observing the social interactions and aspects of various human traits as demonstrated by participants in those games (i.e. the researchers did not create a specific virtual environment, but rather observed an existing virtual environment (e.g. Castronova, 2006, Yee, 2006a)). I found no paper that described an experiment undertaken similar to the one I was about to conduct.

The lack of literature that deals with the use of MMORPGs as emergency situation simulation tools can indicate a few things:

1) it is unpracticed and therefore undocumented;

2) it might be too costly to be created specifically for civil organizations (Jones and Hicks, 2004);

3) because all platforms of MMORPGs are commercial, the publishing companies are reluctant to let researchers to tap into their computers or reveal data that might have the potential to reveal commercial secrets, or disclose confidential information about their participants;

4) emergency simulation tools are used for practice purposes and not for observation of affected population purposes; 5) perhaps the examined field is too young, so no literature is available yet by the time this thesis was written (early 2010).

It should be noted that the context in which crowds of human individuals are mentioned in the literature has mainly to do with the use of AI agents and their ability to mimic human behaviour (Musse et al., 1998), as human participants in simulations mostly use them for training, and the AI's are used as random individuals that humans interact with.

1.4.2 User related issues

1.4.2.1 Motivations of gamers in MMORPGs

Motivation can be described as the activation of goal-oriented behaviour (Ford, 1992). It can be intrinsic, where a person performs an activity for no apparent reason than the activity itself, or it can be extrinsic, where performance of an activity leads to external rewards (money, change in status, etc)(Deci, 1972). Voluntary computer gaming is considered as an activity with an intrinsic motivation (Yee, 2007).

Voluntary playing in a MMORPG emergency simulation might be an activity similar to gaming, and therefore there are some features that have to be taken into account when designing such a simulation in order to motivate potential participants. Belanich (2004) and Yee (2007) both describe the main factors that motivate gamers:

1) a challenge or a goal;

2) ability to socialize and collaborate with other participants;

3) immersion: the level of engagement and enjoyment a player has from playing the game.

Below is an elaboration of the issues that might influence participants' intrinsic motivation.

1.4.2.2 Reimbursement of participants

If compared with computerized applications from fields other than gaming, the question is simple: can an online emergency simulation be crowdsourced (Howe, 2006)?

Recent research (Brabham, 2008) on motivations of crowds that are engaged in online activities and work sometimes for free (the most notable example would be open source software programming), shows that participants treat it as their hobby, they enjoy solving problems, have free time available, or can gain new skills (Howe, 2006). Monetary compensation according to Brabham (2008) is the strongest motivator (in his research 89.8% out of 653 people stated that their most important motivation was the opportunity to make money). In my opinion emergency simulations can be treated as any other online activity, and if its users indicate it is uninteresting an extrinsic motivator like money should be used in order to encourage them to play.

1.4.2.3 Continuity and attachment to one's Avatar

The concept of continuity is strongly embedded into MMORPGs as they are persistent worlds. This concept is emphasized also by the players' ability to create, customize and "raise" their Avatar over time, as they develop a long term "relationship" with their virtual character, that evolves over sessions (i.e. gets bonus points, gains new skills, and advances in the games' hierarchy)(Yee, 2006b, Yee, 2006a). If there is no continuity concept the user will not try to keep the Avatar safe from harm, as there is no long term gain from this action (Adams and Rollings, 2006). Emergency simulations, contrary to MMORPGs, might not offer the ability to create and customize a character, as they might not need that ability. Moreover, emergency simulations might not happen over a large number of sessions.

1.4.3 In-game behaviour

1.4.3.1 Human participants behaviour in MMORPGs

Technically, MMORPGs might seem to be a suitable emergency simulation tool as they serve as a platform that can host large numbers of individuals, however the main advantage of MMORPGs, which is the use of human participants, is also their weakest point, as in-game human behaviour might introduce problems of its own.

Research regarding computer gamers' in-game behaviour and motivations can be divided into two parts:

1) research on stand-alone computer gamers. These are partly responsible for portraying the "classic" stereotype of a computer gamer, that plays alone a game on his own computer without interaction with other people, being anti-social and introvert (Fisher, 1994, Grüsser et al., 2006, Squire, 2003);

2) research on online gamers and online gaming communities (Lehdonvirta, 2005, Yee, 2007). One major difference that is attributed to online-gamers is the social abilities demonstrated by them, as they are (and have to be) a part of a virtual community and have to interact with other people (Bonk and Dennen, 2005). It should be noted however that these researches describe voluntary engagement of participants in gaming (Yee, 2007).

These researches can serve as a good indication about behaviour types to be expected in a gaming environment in which people are engaged voluntarily, however a question that remains without an answer is: will participants of an emergency simulation demonstrate similar behaviours to a stand-alone gamer, to an online gamer, or perhaps to none of them?

I argue that the answer is:

1) situation dependent: are players participating voluntarily, or as a planned activity such that its results might influence them in some way, and then they might be motivated to perform in a certain way;

2) scenario dependent (i.e. if one of the gamers' goals is to support other gamers, they will have to socialize), and;

3) in general, without being scenario specific, if an emergency simulation is played by an existing online community (without considering how a long term community can be asked to "migrate" into a virtual world or introduced with an emergency scenario), the behaviour will reflect an online gaming community behaviour, which demonstrates a strong "tribal" behaviour (Brignall III and Van Valey, 2008), as players normally affiliate with "guilds" (Seay et al., 2004). The same behaviour might be expected if people that are acquainted with each other are asked to play a one-off emergency simulation session (like an evacuation of a building scenario played by the members of a specific department at a university). However, if the emergency simulation is a single session event and does not happen in an existing online community, so rather attracts random players, the chances are that they will tend to behave as stand-alone gamers (i.e. give priority to their own goals).

Another question that arises in that aspect is: are gamers (and online-gamers in particular) a realistic crowd to be used in emergency simulation MMORPGs?

The target audience that comes into mind as potential participants in emergency simulation based MMORPGs is that of online-gamers, as these are people that are willingly engaged three hours daily on average playing online computer games (Yee, 2007). Moreover, an online emergency simulation will want to target a community that is already familiar with the concept of complex interfaces, virtual worlds and role playing games. However, it should be kept in mind that gamers are used to high-end commercial products they are intrinsically motivated to play, whereas an emergency simulation might not motivate them similarly. I claim that if this is the preferred target audience, planners should look at motivating factors in order to create an attraction similar to a commercial game.

1.4.3.2 Goals of participants and content of an emergency simulation MMORPG

Computer games are a widely used entertainment form, and an economically large industry. According to an Entertainment Software Association (ESA) report (Siwek, 2007) the computer and video game industry's value added to U.S. Gross Domestic Product (GDP) in 2006 was $3.8 billion. This amount of money is generated by mainly one thing: computer game sales. In order to be successful, computer game development companies operate in a relatively known realm and often develop games that will suit specific target audiences and their habits (Kline, 1998), otherwise there is no excuse for their existence (Gee, 2003), so these companies emphasize solely gamers' satisfaction as their central goal.

Whereas the contents and goals of a commercial game include topics that might attract and entertain gamers (car theft, rape, shooting at police forces in Rockstar North's Grand Theft Auto game series, Combating and action in Activision's Call of Duty just to name two examples), or use of imaginary creatures (Trolls and monsters in Blizzard Entertainment's World of Warcraft), a browse through the literature (for example (Atkin et al., 1999)), shows that computerized emergency simulations by contrast to commercial games have different goals, and mainly emulate procedures and processes that happen prior to, or following a disaster (Pan et al., 2007). The goals presented do not always fit into the description of interesting content, or a plot that might attract participants, and sometimes can even contradict it.

1.4.4 Usability issues

1.4.4.1 Usage of game controls

Software applications that have to interact with human users do so through a program that displays information on a computer screen, waits for human input and provides feedback on it. The common name for this type of information display and its arrangement on the computer's screen is known as GUI (Graphic User Interface) (Yen and Davis, 1999). Professional software developers (Microsoft with their Office Suite, Adobe with their image processing Photoshop, just to name two) set standards that their software developers have to follow and these define items like location of menu items, appearance of certain components in the menu bar, or very specific keyboard shortcuts that will operate a function (Henneman, 1999). Innovations to the GUI in such software types mostly conservative, and will be in most cases cosmetic (i.e. icons that look different but are situated in the same location on the screen as the former version)(Microsoft, 2009). Game developers however do not impose such standards in the name of artistic freedom, as the GUI design is part of the conceptual design of the game (known as the Look & Feel) that intends to promote game flow by its participants (Johnson and Wiles, 2003).

Professional software products sometimes cater for more than one sort of target audience (i.e. both photographers and illustrators can use Adobe Photoshop) and therefore might contain a substantial amount of functions that will not be used by all user groups of that specific software, so that an interface might look complex at first glance, but after a while a user will ignore the irrelevant menu items (some products, like the modeling and animation software Discreet 3DStudio, also offer the seasoned user the ability to completely customize the user interface according to the desired functionality and their needs). Computer game interfaces will incorporate a large amount of information, but contrary to professional software that can cater for various crowds with various abilities, their target audiences are the players of a specific game, that will require most if not all of the interfaces' functions.

The most notable difference between professional software and computer games is the time stress factor. In most professional products, the user can explore the menu items, or can use a trial and error strategy and gradually learn the different menu items and functions, and most importantly he can use the "undo" function which by definition contradicts real-life time dependent situations. By contrast, an online multi user computer game that has a consistent virtual world whose existence does not depend on particular user actions, has a timeline of its own that flows in a linear manner, from past to future. This type of game lets a gamer experiment for a while in a tutorial session prior to the game session, however, when the game session itself starts a user is assumed to possess the knowledge of operation of the various menu components, and moreover in most cases he will need to do so under a time pressure, and with no option for a trial and error strategy (i.e. when a gamer's virtual character is attacked by another character, the time until a proper response is made will deduct the gamers' health points, and if an improper response is taken like a wrong keyboard shortcut is pressed – the attacking character will not stop his actions). This type of occurrence might cause novice game users to develop a negative experience and discourage that activity. This might be a concern when using non-gamers to play a simulation that is based on a computer game, as out of frustration they may want to quit the game.

1.4.4.2 Visual attention

Bearne et al (1994) claim that human visual attention can be compared to a spotlight, so that anything outside its beam is hard or impossible to see. Some of the arguments in their paper, which is a review of experimental psychological findings, are: the human ability to focus is best done on static menu items (which are not always present in dynamic computer games); when there is more than one item the user should have control over the appearance of information (which is typical to computer game menus); when more than one information item is presented the user should be familiar with the medium of presentation (which might not be the case when a player is first introduced to a computer game). As a computer game's virtual environment is rich in stimuli, an inexperienced user might reject or not notice inputs that are not in his visual focus.

1.4.4.3 Immersion

Immersion, although being difficult to define, is widely used by computer gamers, computer game critiques, and by game developers to describe their gaming experience (Brown and Cairns, 2004). It can be described as a situation in which a user is fully engaged in the game (Ermi and Mäyrä, 2005). Immersion can be linked to the psychological "flow" theory (Csikszentmihalyi and Csikzentmihaly, 1990) that describes a state in which a person is successfully and fully engaged in an activity he performs.

Brown and Cairns (2004) argue that it is an important quality, as the more a participant is interested in the game, the more he or she will adhere to the goals they face when gaming and treat the virtual environment they operate in as an extension to the real world. According to Brown and Cairns, immersion is constructed from a few stages:

initially the participant has to be engaged. At this stage he has to invest time, effort, and attention, and most important to prefer the specific game type.

Next, the participant is engrossed, and this is the stage that depends on the game construction and how it influences the player's emotions. Some gamers claim that the external environment should be modified at that stage (i.e. dimmed lights, loud volume), in order to prepare for the last stage which is full immersion.

At this last stage the important parameters are the player's empathy with and attachment to the main character, and the game's atmosphere created by the combination of the graphics (its realistic look & feel), plot (the coherence of the game's inner world, and its relevance), and sounds.

The most immersive games were role playing games (in which a player assumes the role of a virtual character that acts as his representation in the virtual world), and first person's perspective games (as they offer a realistic visual image, i.e. the player sees on the screen what he would see there if he was present in the virtual environment).

1.4.5 Drawbacks and possible solutions

As with all simulation methods, multi-user computer games have their drawbacks. The following table lists some of the problems they pose if used as a simulation tool, and some suggested solutions to these problems. I intend to incorporate these solutions into my experiment in order to bypass these problems.

Table 1-2 Multi-user computer games problems and possible solutions

subject	problem	Possible solution
Technical issues		
Monitoring of players interactions	In order to interpret players interactions and plans their actions (movement and messaging) should be monitored, correlated and linked in terms of proximity to events/ times/ objects.	A monitoring program that can: 1. Log movement patterns, their proximity in distance and time to other users/ objects/ events, 2. Log messages content and perform a search in them. 3. Log and recreate each individual's game play.
Simulation time cycle	Time frame of an emergency in reality differs significantly from a simulations' one. Effects of the emergency such as weariness cannot be simulated properly, as well as players logging off, not completing a simulation cycle	1. In a closed ended simulation time can be "compressed", so that a session will be carried out in a shorter time. 2. In an open ended simulation the users join a situation where an emergency already occurred. 3. Time effects on players (weariness, exhaustion, lack of energy) can be demonstrated by affecting the "life status" of player.
Simulation start time	Does the simulation start only when all players log onto the game, or is it a continuous event?	The answer is scenario dependent. However, an acceptable solution can be to let players logon and only after a critical mass has accumulated the "emergency" starts.
Depiction of reality	To what extent should the simulation be realistic (by its look & feel), and by the mental stress applied on the player	In order to achieve a realistic response from players, their experience should be as close as possible to reality. The mental stress is the most important parameter. The way that a computer simulation can cause it is by a realistic look, the surrounding sounds and the interaction with NPCs.
Objects in the simulation	What object types should be present in the virtual world (i.e. cars, weapons, food, drugs, etc.)?	The answer is mainly scenario dependant. If the scenario deals with evacuation/ petrol rationing than cars should be present, if survival is the issue, than "food" should be present. The more objects – the more complex and realistic the environment created will be. If the simulation has no special interest in a particular resource, than a generalization that can be made is the introduction of "aid" packages that represent scarce resources needed for survival.
Analysis of results	The connection between actions, interactions and the events in the simulation	The ability to query the data logged by the monitoring program
Continuity	What is a minimal continuous time a player has to play, and what happens if he wants to simulate sleep.	Both in open ended and closed ended simulations the player is penalized by reducing "life points" over time. Although contradicting real life situations, it can be agreed that while a player logs off his character is not vulnerable (however, it will still lose "life points").
Interactions	What can be done in order to trace interactions (that normally don't leave physical traces)?	1. "Planting" of objects into the players inventory that represent a specific interaction (coins/ keys etc.), similar to computer cookies planted into a user's computer by various websites and contain information about their actions within the website. 2. Logging of dialogs with NPCs.

		3. Logging of movements and actions.
User experience		
Data validity	Validation of data compared to other simulation methods	1. Running more than one cycle of simulation with different players in order to observe if behaviour patterns are consistent. 2. Comparing actions of different players for identical situations.
planning	Find evidence of planning or strategy taken by players.	1. Deduction according to actions taken. 2. Post-game questionnaire.
Emotions	Expression of emotions	1. Deduction according to actions. 2. Introduction of a "Motion Meter" that the player uses. Although this might be the only way to know the players mood, it is based solely on players' honesty.
Player reliability	Assurance that logical actions are taken and that player does not just amuse himself	1. Enhancement of user experience and players immersion into the simulation. 2. Automatic monitoring of actions. Issue of warnings, penalty points for undesired actions, detention of virtual character if it persists along the same line of behaviour.
players vs. simulated population contradictory characters	Contradicting: Ages, cultural and socio-economical background of affected population have a wide range. Players (especially gamers) might demonstrate a narrower range.	1. A player does not choose the representing character but rather is assigned a character that already has its traits. 2. Players can be chosen from a wider cultural background.
Resources scarcity	Shortage of food, lack of water or shelter, time span of health deterioration	Introduction of a "life meter" for every player to encourage him to increase activity concerned with survival. All environmental cues possible impact should be formulated and effect the life meter (i.e. weather conditions, health, etc.). The problem that might arise is proper formulation for each component and their mutual influence.
Questionnaires	Obtaining participants views about various issues related to their background and to their in-game performance	If the simulation is on a small scale and players are present than hard copies can be circulated. However most chances are that online players will not occupy the same space and therefore questionnaires can be "filled" by engaging into a "conversation" with a NPC inside the simulation – these can be verified by repeating the questions by various NPCs the player meets in the virtual world.
Debriefing and training of participants	Familiarizing the player with the virtual area, tools, etc., or directing him regarding game rules, or preventing him from certain actions.	1. In-game tutors played by Non Player Characters (NPCs), 2. In-game objects, like signs that display information when clicked on.

1.5 Data collection

1.5.1 Triangulation of data, and its accuracy

Data Triangulation is defined as the use of multiple data sources with similar foci to obtain diverse views about a topic for the purpose of validation (Kimchi et al., 1991). Cross examination of data collected is considered to increase its credibility (Johnson, 1997), and the rationale behind it according to Jick (1979) is that weaknesses of one method can be compensated by the other methods used.

There are a number of methods to achieve cross examination (Denzin, 1989):

1) data that can be collected by the same method (i.e. different questions relating to same topic in a questionnaire);

2) method triangulation: data collected by different methods that describe the same incident (i.e. questionnaires and observations of subjects);

3) several view points of the same topic (i.e. research done by different people on the same phenomenon);

4) use of more than one theory to examine the same event.

According to Jick (1979) method triangulation is considered the most popular and most reliable from the methods described.

In order to increase the credibility of data gained from MMORPGs, the method of recording the actions performed by participants can be cross referenced with other methods such as observations, questionnaires, interviews with participants, in-game interpretation to actions given by participants themselves and comparison to similar real-life events.

Triangulation of data accumulated through different means will enable an easy discovery of inconsistencies (i.e. actions in the game that contradict answers to questionnaires), compared with more traditional methods like questionnaire which rely solely on a subject's will to answer them honestly.

1.5.2 Types of data collected in the experiment

Note: for a full list of events logged see Table A2-5 (Appendix 2: methods).

The game collected both quantitative and qualitative data that related to the participants' behaviour. Quantitative data were all recorded and measured events (the actions taken by participants). Qualitative data were the tagging and speech texts used by participants, as well as observations and interviews. Each possible event that could have been registered had a script written that monitored its occurrence. Once an event happened, the script was run and the event was registered into the participant's log file. Data belonged to the following groups:

1.5.2.1 Quantitative data

- Participants' status events: participants' status was logged on each Heartbeat (six seconds) and on each event (if it happened between Heartbeats). This data was logged in order to supply a picture of the participant's location, health status, inventory status, virus infection, or if he was in combat.

- Global events: these events were logged in order to supply general statistics about the simulation (i.e. number of participants, minimum and maximum time for various game stages).

- Plot events: these were all the actions taken by participants. They were collected in order to compare them with the participants' status, and with qualitative data items (i.e. did the acquisition of a stick lead to more violence events than the average? Did younger participants take more risks?)

- Real-life case studies: the participants' in-game behaviour was compared with real life case studies in order to observe correlation in behaviour patterns in post disaster situations (i.e. violence level, honesty, altruism etc).

1.5.2.2 Qualitative data

- An in-game questionnaire: the game included a two part questionnaire, the first part (19 questions) dealt with the participants' demographic profile and recreational habits, and the second part (29 questions) dealt with usability issues and in-game behaviour. All questions were closed-ended, some were yes/no questions, some were multiple choice, and some were scaled. For a detailed list of questions see Table A2-4 (Appendix 2: Methods).

- Tagging: this method is used commercially in various software applications (image storage/blogs) as part of a search engine that lets users tag specific content according to their own perception and retrieve information in the same way, rather than relying on predefined search parameters. It was an innovative methodology of monitoring in this games' context that let the participants tag every interaction they were involved in and monitor co-participants' behaviour. It was introduced in order to bypasses more complicated methods that try to analyze behaviour patterns according to interaction timing, search for keywords in dialogs, or an attempt to analyze a pattern of behaviour (e.g. a pattern in which a player approaches another player slowly, interacts with him briefly, and then runs away might suggest a robbery; or on the other hand just an innocent information exchange, or cases where a monitoring program might pick up offensive language, but lacks its context). For use of tagging in the game see appendix 3: Users' manual, Section 5.11.

- Chat window content: The Chat Window was the only means of communication between real life participants (PCs) and its contents were logged, so all communication between PCs could be analyzed and compared (i.e. was a foul language incident the cause for a fight? Does a threatening conversation lead to an attack? Do players use this communication means in order to party and join efforts?). For use of the Chat Window in the game see appendix 3: Users' manual, Section 5.2.

1.6 Research questions

1. What is the reason for the scarcity of multi-user computer game emergency simulations?

2. Do games have advantages over computerized multi-agent models?

3. Is the data collected via this type of games reliable and consistent, and under which conditions?

4. What are the potential deployment areas for these games?

5. What types of information can be extracted from such games?

6. What are the technical problems related to the use of these games? (i.e. data logging and verification mechanisms, monitoring mechanisms)

7. What are the user-related problems of multi-user computer games (i.e. recruitment, reimbursement, usability, in-game behaviour)?

2 Methodology

As part of the research, an experiment was set up that included the creation of a multi-user online computer game. This chapter describes the methodology used for the game creation, experiment conduct and data collection and validation. Note that appendix 3: Users' manual gives the detailed background from the participants' perspective and includes valuable information regarding the use of the game.

Two options were considered in order to run that type of experiment:

- Run the experiment sessions in a dedicated computer lab.

- Run the experiment online.

The first option was chosen due to the following considerations:

- Target audience: when using an online experiment, only people that had a legal copy of the game could participate (this implied that only gamers would participate), whereas in the lab participants were not requested to have any gaming experience or knowledge and could be from diverse demographic background.

- Data collection: all data in the experiment was logged into a log file that was written locally onto the participants' computer. This raised privacy issues with an online scenario, as the file then had to be sent electronically by the participant who might be reluctant, or not know how to do it. If a commercial platform was to be used, the companies were reluctant to share information with a third party (i.e. research staff). In the lab, files were collected manually from the computers upon termination of experiment.

- Monitoring of the experiment: there was no way to coordinate a common login time for online participants, or to observe their behaviour. The lab provided a "sterile" environment that admitted only participants in a designated time, and forced them to behave according to university regulations.

2.1 *Methodology glossary*

Area A virtual Three Dimensional (3D) area that varies in size from a minimum of 1 square (10 X 10m) to a maximum of 32 X 32 squares (320 X 320m). Areas are connected by Waypoints and players can transfer between them according to game designer decision (i.e. if the player crosses a doorway from the street into a house – the house is actually another area). An area can consist of only one type of tile set.

Aurora Toolset A part of the NWN game package. It is a toolset that allows the creation of custom made content by users, that can be later on be played by other users. The output is a file called Module

Chat window Part of the game's user interface and the only means of communication between PCs. It is spontaneous contrary to the dialogs. A PC types in a message that is directed at another PC, or a group of PCs. For a detailed description see appendix "Users Manual" section 5.2.

Client The part of game software that runs on the user's computer. It can include all independent data such as the virtual world structure, its textures, dialogs and sounds.

CSV Comma Separated Value. A text file that has values written into it, separated by commas. This type of file can be read by an electronic spreadsheet program like Microsoft Excel.

Dialog/ conversation A pre-defined conversation that is the only means of communication between a PC and an NPC. Contains both the NPCs' part and the PCs' part. It is used to advance the plot in the game. The NPC has one part of a dialog, and the PC has one or more options to choose from as an answer. According to the choice the dialog can advance to different branches. Specific answers can trigger scripts or actions attached to them – like getting a key from an NPC after answering a correct answer. For a detailed description see appendix "Users Manual" section 5.1.

FPS First Person Shooter. A computer game genre in which the screen shows the world as seen through the main characters' eyes. The main objective in this sort of game is the use of virtual weapons to shoot most other creatures that move on the screen. A player advances through levels by shooting as many creatures as possible and gains new weapon types as (s)he advances. Normally a player has between three to five "lives" to lose before terminating the game.

Inventory A users' 'backpack' in which items can be stored. For a detailed description see appendix "Users Manual" section 5.6

Items Objects smaller than placeables that can be interacted with and taken by users into their inventory (i.e. food rations, gold pieces, food ration vouchers). For a detailed description see appendix "Users Manual" section 4.4/ 4.5

Module A NWN game. It contains at least one area with a virtual terrain, objects that users can interact with, Characters the users operate (PCs), Non Player Characters (NPCs), predefined dialogs and scripts that regulate and monitor all interactions in the virtual world.

NWN Script A computer program written inside the Toolset that monitors or executes an action in the game. Scripts in the experiment simulation can be divided into three types: 1. scripts that bypass the original game rules (as it is an action game, and its original aims are about killing various creatures thus adding to the main characters' experience and score), 2. Monitor the players' actions and status, 3. Write events to the players' log file.

Placeable Every object that can be interacted with inside the virtual world (i.e. chests, desks, signs). They cannot be moved/ taken by users. For a detailed description see appendix "Users Manual" section 5.7.

PVP Player Vs. Player – a setting used by the NWN server to determine the type of game played. Practically it means that all PCs are allowed to attack each other.

Server The physical computer that runs the software that manages the game and the software itself. It retrieves data from each participating computer, calculates the results of interaction between users themselves and between them and the virtual world, and transmits the updated data back to the participating computers.

Tagging The action a user takes in order to describe an interaction with another PC/ NPC. For a detailed description see appendix "Users Manual" section 5.11.

Tick/ heartbeat An internal NWN time unit according to which the game measures time. It can be set to a desired value in seconds. In the experiment a tick equals 6 seconds.

Tileset The building blocks of the virtual terrain. They contain the "real estate" and environmental objects used in the game (i.e. empty terrain, water elements, buildings, roads, etc.). Area tilesets available are urban, rural, interior or exterior.

Waypoint An object (can be a door or an area drawn on the terrain) through which a participant can cross between areas. Every Waypoint has to have a destination Waypoint assigned in the corresponding area in order to perform the passage. This connection can work both ways or only one way.

XML eXtensible Markup Language. It allows creation of customized tags, that enable definitions and grouping the data according to the tags used.

2.2 Minimum components needed in the virtual game environment

In accordance with the definition of a disaster (Chapter 1, paragraph 1.2.1), the experimental game included the following elements:

- An initiating event: two different events were chosen, one was food shortage following an earthquake scenario, and the other was a deadly virus in a pandemic infection scenario. In both cases, participants were told about the initiating event but did not experience it within the game, only the following events. The selection of an earthquake and a pandemic scenario allowed testing the MMORPG platform with two different (but similar in terms of food issues) hazards. This is important as it contributes to demonstrating the all-hazards capability of the MMORPG platform.

- An area: a dense urban area of about $0.1km^2$ named Disasterville was created using the NeverWinter Nights Aurora Toolset, where events took place.
- Affected population: this was the role played by the experiment's subjects (some virtual crowd and family members were represented by Non Player Characters - NPCs).
- Aid agencies: these were represented in the game by sector post officers, police officers, and health professionals. These characters were Non Player Characters (NPCs), which were computer controlled.
- Constraints: these were depicted by an algorithm that terminated food supply to the virtual city in one case, and by another algorithm that governed the infection spread in the pandemic scenario. Food shortage was chosen as a limiting factor as people rarely develop food supplies prior to the occurrence of hazard events. For example, Paton (2008) found that only 16% of Auckland residents had built up food supplies for use in a pandemic emergency, with the assumption that food would be readily available contributing to this behaviour.

2.3 Game design and creation

The advantage of creating the game from scratch was the ability to include only desired objects, thus creating a "sterile" environment in which distractions of participants were kept to a minimum and could have been monitored.

The game designed consisted of three parts: 1) The initial tutorial in which participants read some background material about the research, signed a consent form, answered a pre-game questionnaire, learned how operate the game controls, and were briefed about what they had to do in the game; 2) The game itself, into which the participants were teleported from the tutorial. There they had to find their family house, speak with their virtual family member that briefed them about the situation in the city. That family member supplied them periodically with vouchers that could be traded in the sector post for food. Participants had to head out into the city and get food in order to support their family member as well as themselves in order not to starve. After a while, food terminated in the sector post and participants had to be creative in order to obtain food (buy from merchants that had an expensive and limited supply, look in trash piles, steal from other participants, break into houses, or loot corpses); 3) The post-game questionnaire. Participants reached that stage once they "died" in the game, and had to answer the final part of the questionnaire in order to terminate the experiment. The pandemic scenario was identical apart for one change in the game stage which was the addition of a Virus Script that caused one of the participants to get infected and thus start the pandemic spread.

The game was created using a commercial computer game - NeverWinter Nights. This game was chosen for the following reasons:

- It offered a Game content creation utility (Aurora Toolset) that enabled the creation of a complex virtual environment.
- It had an embedded scripting language that enabled the development of monitoring and control tools over participants.
- The virtual environment supported network gaming ability thus enabling multi-player sessions.
- Enabled control over participants actions and session length.
- Supported by an online developers community.

The only concern I had was that this commercial program has the "Look & Feel" of a medieval environment that might distract participants (but in practice that issue proved not to be significant according to participants feedback).

Other commercial games were considered as well, however they had two major problems: no custom content creation ability, or if there was such an ability (online games such as Second Life, or World of Warcraft), company policy did not enable access to server and user data, and therefore no ability to collect their data.

2.3.1 Characters in the game (PCs and NPCs)

The characters that populated the virtual environment in all scenarios were: crowd members (affected population), family members, merchants, Police officers, sector post officers and health professionals. Both male and female characters were created from the same blue prints and apart for apparel, all characters looked similar. Characters belonged to either one of the following types:

1. Player Characters (PCs): these were the characters operated by experiment subjects and represented the affected population. The only role they fulfilled was crowd members. They were free to roam around all parts of the city.

2. Non Player Characters (NPCs): these were computer controlled characters that interacted with PCs and advanced the plot. NPCs assumed all the roles mentioned above. Some were confined to certain areas (family members were found only in the home area, sector post officers were confined to the sector post, crowd members and police officers were roaming around the city area, health professionals were found only in the hospital).

In order to keep the male-female balance within the simulation, participants did not choose the character they played but rather played a pre-assigned character. These were alternating between computers so half were males and half were females, so a balanced look and feel was created.

In the following, masculine-related grammar is used for brevity; no gender bias is intended.

2.3.2 Objects in the game: Placeables

Placeables were objects that could not be moved or taken by the participants, but only interacted with. These included:

- Signs: these could be read and supply some orientation.

- Information centers: these contained a dialog that has all usability and content branches. They looked like giant mushrooms – in order to look out of the plots' context so players could identify them easily.

- Doors: these opened either as a result of a dialog, or because the PC had an appropriate key (see keys – in the Items section below). Doors were considered broken into if made to open when the PC did not have an appropriate key.

- Pantry chests: one in each "home". Initially they were empty. This was the place a family member put vouchers into, and participants put food into for their family members to consume. They were used as storage spaces for items acquired by participants. Could be opened and locked by using keys, and were considered broken into if the inappropriate key was used (by default, every player had a key that served as his ID number and this number was also attached to house doors and pantry chests. When a door or a chest were opened, a script checked if the player had the appropriate key or not).

- Trash piles: these were scatted around the city in hard-to-locate places. They had a script that generated random content the first time the pile was examined. This script worked only once, so the pile could supply content only once. Items found could be either a food ration, a voucher or a trap (so participants knew after a while that there was some element of risk involved in picking the trash). Initially, participants did not know about these piles, however, when they gave a random crowd member a voucher, that crowd member tipped them off that there are trash piles that can contain food and are scattered around the city.

2.3.3 Objects in the game: Items

Items were objects smaller than placables and that could have been put by participants into their inventory. Items used in this game were:

- Gold pieces: this was the currency used in the game. Each player had an initial amount in his inventory that could have been used to buy items, however the amount given was insufficient for all types of items (the cost of the aid kit and the stick each equaled the total amount of gold, so the participants were presented with a dilemma if they wanted to acquire one of them).

- Food vouchers: given by family members at a constant rate. They could be traded for food or sold to merchants. They became worthless once the sector post ran out of food (there was one mapped sector post in the city centre, and another one in an unoccupied area that was not marked on the map. The reason for that was to see whether participants are roaming around the city and explore it in order to find food).

- Food rations: found at merchants' shops or the sector post, participants and their virtual family members had to consume food rations at a specified rate, otherwise they died of starvation.

- Aid kits (in the pandemic scenario): could heal a participant from the deadly virus. Were available for purchase from merchants or the hospital.

- Sticks: as the simulation wished to test, among other things the influence of the presence of weapons upon violence levels, sticks were introduced into the game. In order to observe this connection, but not turn the simulation into a violent action game, only two sticks were present in the game and had to be purchased.

- Keys: each participant was automatically given a unique key when teleported into the city. The key was used as an ID, that an NPC family member scanned and identified a specific participant as his family member; in all other cases he treated participants as burglars. Doors and chests were set to scan the key as well, in order to determine ownership or burglary situations.

- "Suicide pill": an object found in the inventory, which triggered a dialog that enabled the participant to quit the game when they wanted to do so, even if they didn't terminate playing. Its purpose was to immediately transfer a participant into another area (in the game module it was called "heaven") where he could answer the final questionnaire if he liked to do so, rather than just leaving the lab without doing it.

2.3.4 Communication in the game: Chat and dialogs

Participants could communicate freely amongst themselves using the Chat Window, or communicate with NPCs using predefined conversations called dialogs (See appendix 3: Users' manual, section 5.2). These dialogs were the only means of communication between Participants and virtual characters (NPCs). A dialog was a collection of conversation pieces (branches) that had the following properties:

- They could branch into various directions according to answers given by participants, so an illusion of a free, unrepetitive conversation was given.

- They could trigger scripts that caused an action to happen upon clicking a certain answer (like getting a key, buying an item or logging an event into a text file),

- A branch could be conditional and appear only if a condition was met (i.e. different participants had NPCs address them according to their status, burglars for instance).

2.3.5 Scripting

Around 200 scripts were used throughout the construction of the game. Scripts were attached to the module (the whole game), areas within the module (virtual areas within the game), objects (Placeables and Items) and dialogs. They were divided into three major groups:

- Scripts that bypassed the original game's characters' behaviour.

- Scripts that governed characters and monitored characters' actions (like the pandemic virus, burglary and fight detection, or food shortage creation).

- Scripts that logged data (all events that were logged).

2.3.6 Embedding of scenario restrictions: food shortage

The governing factor that determined the session length was actually the time participants were willing to dedicate to playing. In order to time the food shortage properly, a script that took into account the session length and number of participants was devised based on the following formula:

$$\frac{t_t n + t_t \mathrm{fn}}{t_r} = sp_{st} + M_{st} m + sp_{in} t_t$$

where independent variables are: t_t = total net playing time (in Heartbeats, 1HB = 6 seconds); t_r = Heartbeats a ration lasts; f = number of family members; SP_{st} = Sector Post initial food rations amount; M_{st} = Merchants' initial food rations amount; m= number of merchant characters in the game; n= number of participants in the session, and the dependent variable is SP_{in}= Sector Post incoming food rations per Heartbeat.

The left hand side of the equation states the total number of the food rations consumed over time by participants and their respective virtual family members. The right hand side is the stock of food rations available in all sources (apart from trash piles, which are a negligible source). Food shortage was created when SP_{in} (the only replenishable source) was smaller than needed to balance the equation.

Notes: the sector post was the only replenishable source of food rations, whereas the merchants had a finite stock of food rations. The total number of rations was determined by participants that actually started the game and were teleported into the city after finishing the tutorial.

2.3.7 Embedding of scenario restrictions: Pandemic virus

This scenarios' purpose was to illustrate pandemic outbreak patterns and their monitoring via logging scripts in order to show infection toll over time and spatial infection patterns. In order to demonstrate these abilities a "deadly virus" was designed that was transferred by air; therefore a prolonged exposure to an infected character resulted in an infection to the character standing in his proximity. In order to simplify reality the following virus infection was written as a script:

- Infection: the script checked proximity between carrier and potential victims every heartbeat by comparing their spatial coordinates; if the distance between them was 2m or less the script continued to the next stage.

- Infection time: after the spatial criterion was met, the script counted 6 heartbeats and then infected the healthy character by assigning him a Boolean variable of TRUE.

- Incubation time: the victim was able to infect other characters immediately; however he was unaware of his situation at this stage and thus did so innocently.

- Infection signs - reminders: the victim was notified by the script with a declaration over the characters' head after 20 heartbeats ("I don't feel well, I am dizzy…"). The declaration appeared every 5 heartbeats for duration of 2 seconds. At this stage the participant was aware to his health situation, and if he infected other participants, he did so knowingly.

- Visible infection signs: After 40 heartbeats the infected character started to puff green smoke clouds every 10 heartbeats, so other participants could see he was infected and avoid him.

- Death: 100 heartbeats after initial infection the infected participant's character dies. His corpse is left in the game and can be looted, however it remained contagious.

Notes: An "aid kit" could be bought from a merchant or from the hospital. It removed the infection if used. The described virus is an invented one, and is not based on a known virus in the real world, only a very general infection/ incubation pattern. Infection/incubation and death times were set according to a simulation session time frame, and not scaled down from real life situations.

2.3.8 Simulations' time frame

If properly scaled, an emergency simulation session that depicted a period of three days would take about 12 hours in game time (as the games' internal clock basic unit, the Heartbeat was set to be 6 seconds). However, this length of time was not realistically available to players, so all activities were scaled down to fit an average session length of about 120 minutes.

The table below summarizes the in-game activities and the average time users in the user studies groups spent doing them:

Table 2-1 Post earthquake/ pandemic scenarios in-game activities timeline

Average Accumulative time (min.)	Activity
0-7	Participants started in the tutorial area and read experiment background information, signed the consent form and answered the initial questionnaire.
8-34	Participants played a tutorial that taught them how to use the game controls and how to interact with other characters, then were debriefed regarding the game aims, background and rules.
35-55	Initial orientation time within the game (meeting family members, speaking to NPCs, touring around the city).
56-114	Participants were fully immersed and played the game.
115-127	Participants terminated the game (character died) and were transferred into a different area ("Heaven") to answer a final questionnaire.

Only once the participants were confident with the processes of communicating and feeding their family members were changes to the virtual environment such as food shortage made, in order to see how participants adapt and develop a coping strategy.

2.3.9 Rules, their enforcement and violence level control

In all scenarios participants were given no specific instructions regarding laws, but were rather informed that laws governing their real life apply in the simulation. Although the simulation had the technical ability to absolutely enforce laws upon participants, it was not done as that would not simulate reality.

The approximation to reality was achieved by utilizing a script that detected if a participant attacked or broke into a house in proximity (eye sight) to a NPC law enforcement officer patrolling around the virtual city. Only upon such detection was the participant punished.

Excessive violence was observed in preliminary user studies. This is a normal behaviour for people playing a computer game, however it contradicts reality. In order not to turn the simulation into an action game the following measures were taken:

- Participants were warned by the NPC tutor in the tutorial area that the simulation was a strategy based game and not an action game, and that a situation of constant fighting resulted in loss of "life points" until the PC died (in about 5 minutes), as NPCs defended themselves automatically (this was an in-game feature) and could harm the participants' characters.

- Contrary to a typical action computer game - a fighting situation did not gain the participants any benefit.

- Law enforcement, health and sector post NPCs were created with many more "life points" than participants and were immune to attacks. Merchant NPCs were created with the same strength as participants, but did not leave a lootable corpse, and when killed their food stock was removed from the game permanently, so by attacking them participants only aggravated their situation.

- Punishment for a detected violent event was teleportation to the jail area, removal of the offenders' inventory items, and a promise to the jailer not to repeat these actions again.

- After three terms of imprisonment for violence offences, the participants were removed permanently from the game.

2.3.10 Lessons from preliminary user studies

As with every creative process, the creation of a game involved initial ideas and intentions, implementation of these into a prototype, testing it on small scale user groups and changing it according to feedback. The groups used were 5-8 students aged 19-23, with no previous gaming experience, for seven sessions over a period of three months (May to August 2008); two more sessions were conducted with larger groups of 30 students in order to test server load and interactions between participants (end of August 2008). Three simulation sessions of the final versions were carried out in December 2008. Interviews with the groups were conducted after each session in order to get feedback. In order to be consistent, all user studies were run on the post earthquake scenario. Main issues that were resolved were:

- Module size (the virtual area): the initial virtual city layout of 14 areas (0.1 km^2 each, some rural and some urban) was too large, and people rarely had opportunities to interact with each other. As a result of this input the city was changed into one dense area of 0.1 km^2.

- Participants' patience and immersion level: if these factors were disturbed the result was loss of interest in the game and boredom. This led to a search for alternative interests in the game that included mainly initiation of attacks on other characters. In order to resolve these issues a few measures were taken: session time was limited, participants' aims and goals in the game were stated clearly, behaviour rules were put in place.

- Orientation and navigation around the city: in initial sessions the teleport point from the tutorial into the city was the city center. However, participants felt disoriented when asked to navigate from the city center to their virtual house entrance using the in-game map. This matter was resolved by changing the destination of the teleport point from the city center to the participants' family house doorstep, so he could locate himself more easily on the map provided.

- Tutorial session length and content: as part of design and experimentation, several tutorial versions were created; the maximum length of a very detailed tutorial (that included a few areas and an array of assignments) was over an hour. By that time participants were already losing their patience and when they reached the game stage they were on their last reserves of attention. An over-elaborate plot (that included a quest and very elaborate characters – similar to a commercial computer game) was too distracting as well. As a result the final version of the tutorial session was reduced to about 20-25 minutes, with very basic assignments only. By the end of it all participants could operate the game controls and function within the game.

- NPC character creation: "not all were created equal…", in the first trial runs it was observed that participants attacked all NPC service givers (law enforcement, health, etc.) for no particular reasons. Therefore all law enforcement characters were set to be immune to participant attacks.

- Humor: all traces of sarcasm and humor were removed from tutorial and game dialogs as they caused the participants to treat the game purely as an pass-time amusement. The only area in which two dialogs contained satirical lines was the "heaven" area, into which participants were teleported after they finished the game, as this served the purpose of resetting the participants from the "in-game" state of mind.

- Look and feel: the commercial game has a medieval look, however once participants were immersed in the game, they didn't report this as a distracting factor. The general look and feel was kept gloomy (dark alleyways, foggy environment) in order to intensify the participants' immersion in the game. The only place that had a lighter look was the "heaven" area.

- Questionnaires: the ability to edit a given answer to a question was part of the questionnaire design (technically only the question previous to the current one). Participants stated that this feature was not needed, but was rather confusing; therefore this option was changed to an offer by the NPC tutor once questionnaire terminated to repeat the whole questionnaire from the beginning.

2.4 Experiment setup

2.4.1 Recruitment

In order to recruit participants the following methods were used:

- Older participants: mainly university staff members and post graduate students - an email message circulated through each of the university's departments (a few departments each week). The message consisted of a short introduction, a link to a PowerPoint presentation that included elaborate information about the experiment and some screen shots of the virtual environment, and a link to a promotional website (www.crisistudy.com).

- Undergraduate students: Short 5 minute talks ("sales speeches") were given in lecture theatres before lessons.

- General audience (no specific age groups): posters on departmental billboards, article in the University's monthly magazine ("The Chronicle,") advertisements in the University's on-line diary, business cards that were handed out in University events, article in the Press (the local newspaper). All were short messages that contained the experiments' promotional website address (www.crisistudy.com) that included elaborate information.

2.4.2 Anonymity

In order to enable participants to behave freely within the simulation, it was emphasized that no private or personal data was collected. Anonymity of participants was maintained through the following means:

- No pre-booking via mail/ phone/printed list was made available.

- All computer login names and passwords were provided by the research staff,

- All game characters were pre-defined and had pre-assigned names,

- Consent form did not bear participants' details, but rather their player characters' names,

- No identifying data was collected via questionnaires,

- All feedback forms (Comments and Suggestions) were blank pieces of paper, with no need to leave any sort of ID.

- All data processed used random generated ID numbers to differentiate between various users' data.

2.4.3 *Consent to participate*

As with every experiment that involves human participants, participants in this experiment had to sign a consent form. When the participants first entered the game, their first encounter was with a tutor NPC that introduced them via a dialog window with the background material of the research followed by the consent form that had to be signed electronically. The participants had three options: agree, disagree, and re-read the background. The consent form answers were stored both as a statement into the player's log file, and as a variable within the player's database.

In the case that participants agreed to participate, the variable was set to a Boolean "true" and the participants could then proceed with the tutorial session and the game. If the variable was set to a Boolean "false" (i.e. the participants did not agree to participate), they were prompted by the tutor NPC either to leave the game or read the background material again and sign the consent form afterwards. Note that no actual participation occurred until the participants finished this stage.

2.4.4 *Lab setup and computers used*

The lab used was a 15 X 15 meters hall used regularly by students (for demonstrations, lessons, and as a place to work on their various assignments). It has two large glass walls with shades (to the south it is facing a service road, and to the north it is facing the main lobby and café of the building). Eight benches, each five meters long and about one meter wide with eight workstations on each occupy the room. Every bench has four computers on each side. People using the place generally kept quiet and were not allowed to bring food or beverages into the lab. In addition, non-participants were asked to leave the lab before experiment started. The experiment sessions were booked at 5:30 pm onwards, so significant distractions such as noise were reduced to a minimum. The lab had 64 computers with the following configuration: Processor: Intel(R) Core(TM)2 CPU, 6420 @ 2.13GHz; RAM: 2030MB; Graphic card: NVIDIA GeForce 8500 GT, driver version: 6.14.11.5822; Monitor: ViewSonic, VX2235wm LCD, resolution:1280x1024 pixels; Operating system: Windows XP v5.1 build 2600 Service Pack 2; DirectX Version=DirectX (9.0+) (4.09.00.0904).

2.4.5 *Experimental procedure*

The following procedure was followed during experiment simulation sessions:

- Promotional posters were hung outside the building in order to direct participants into the lab and attract potential participants. All non participants present in the lab were offered the opportunity to participate or to leave the room.

- Default gaming module and character files were loaded from a repository directory onto the server computer (as character files changed after each session due to player actions taken).

- The server utility was run from the server computer with its connection to the internet disabled, so only a local game is run within the lab. Server utility settings included: the maximum number of players, the name of module loaded, and the type of game – full Player Vs Player (PVP) – that enabled participants to attack other players. It should be noted that the tutorial and hospital were set to no PVP areas, in order to prevent participants from creating disturbances.

- All lab computers were logged into user accounts, then into the game (characters were chosen by research staff).

- Participants were admitted to the lab, given a very short introduction about the game, and were told explicitly that they can leave the experiment if they felt stressed, and that they can ask questions freely. After that they were allowed to start the simulation session.

- Research staff were present, answered questions and observed the experiment subjects.

- Upon termination (when last participant left the lab) all individual log files were collected from each lab computer, and then computers were logged off. Server utility was shut down, server log file was collected, and server machine was logged off as well.

- All files were saved to the same directory and the aggregator utility that compiles all separate files into one XML file was run (original files were left intact).

- Another script that converted the XML data into CSV files was run.

2.5 Data collection and validation

2.5.1 Data flow

The data collected from each simulation session produced two types of log files: a log file for every player that participated, and a single server log file. Every session's data files were aggregated by a computer program into a single eXtensible Markup Language (XML) file for every session. This file was then processed by another program that produced five Comma Separated Values (CSV) files for the specific session:

- Global data: this file contained a list of all events in the game over time and their parameters (i.e. game ID of the characters involved, numerical values associated with an event).

- Player data: this file contained a list of events associated with a specific player. This file enabled the monitoring of a single player's actions throughout the simulation session.

- Questionnaire answers: this file accumulated all the answers to the pre-game and post-game questionnaires for all players in the specific session.

- Tagging logging: this file accumulated the tags used by players in order to tag their interactions in the game according to their game ID and time.

- Speech: this file logged all the text used: both the dialog, and the free text used by players amongst themselves in the chat window.

The data was then transferred into an electronic spread sheet (Microsoft Excel), analyzed and sorted according to three main groups: global session data (timing and duration of events from measured actions), participants' character and in-game behaviour (gathered from actions, tagging, speech and questionnaire answers), and usability and user experience data (according to questionnaire answers).

2.5.2 Data analysis

All analyses were done using Statistix version 8, Analytical Software, Tallahassee, Florida and R, V-2.7.2, The R Foundation for Statistical Computing.

- In order to test whether more gamers than non-gamers participated in the simulation, I ran a Pearson's Chi-square test with a Yates' correction, assuming 50:50 participants of each group.

- Generalized Linear Models (GLMs) were used in the following tables: 3-2 (difference between age group 1 and the rest of the age groups), 3-4 (difference between participation reason 1 and the rest of the reasons), 3-6 (difference between option 1 for reimbursement and the rest of option), 3-8 (difference between option 1 for preferred venue for playing and the rest of options, 3-10 (difference between the success of recruitment methods 1 and the rest of options), and Table 3-12 (difference between Awareness option 1 and the rest of options).

- The above GLM tests were run using a Poisson error distribution with Chi-square significance tests. In Tables 3-3 (age groups of participants), 3-5 (participation motives of participants), 3-7 (reimbursement of participants), 3-9 (place and time of simulation participation) 3-11(recruitment methods) and 3-13 (Awareness of participants to emergency situations), the z and P values were taken from the GLM analyses, which shows the estimated mean change of the response variable for each answer compared to the first answer in that specific question. This 'estimate' parameter is tested for a significant departure from zero (i.e. a difference from the first answer) by means of a z-test.

- One sample t-test was done to compare whether returning players performed better than first-time players, and to test the main purpose of actions taken by players.

- Paired t-tests were done to compare the level of all attacks or violent events before and after resources ran out.

3 Results

This chapter presents the data collected through the experiment sessions of the research. The main findings are: people that participated in this experiment were mostly 18-23 years old (67.5%), and described themselves as gamers (87.5%). The initial hypothesis that the simulation could be used as an awareness promotion tool was supported (78.5% of participants said they would think or do something to prepare themselves for a disaster). Returning players performed better than first-time players (life span of 69.4% and 42.1% respectively), which indicates a learning curve that can support the hypothesis that the simulation can be used as a training tool. In-game behaviour revealed that participants were more violent when resources ran out, and that armed participants were more violent than unarmed participants. Armed participants survived on average for the longest period, however participants that were excessively violent had a shorter life span than participants that were only slightly violent. This was true for both the post earthquake and the pandemic scenarios. Spatial representation of participant movements in the game showed they mainly traveled from their house to city center, only very few roamed around other parts of the city, and most attack events occurred in areas with low police presence – similar to real life events. The pandemic scenario revealed that infection occurred in waves and that most infection events occurred in crowded areas, as happens in real life. Most importantly, the ability to triangulate different types of data, unlike traditional methods, revealed inconsistencies between participants in-game actions, and the accounts they supplied. The main findings of the research are reported below, additional data can be found in appendix 4: Results.

Please note: initially I have distinguished between gamers and non-gamers' results, as these can be considered two significantly different groups in the context of this experiment. This was done in order to examine differences in in-game performance, attitude towards the game, and the use of the game controls and interface. However, no evident differences in the results between these two groups were found, therefore results presented hereafter do not use this partition. Possible reasons for lack of differences in the in-game performance may be related to: 1) the small sample size of non-gamers of only 10 people (see Table 3-1), or; 2) the game design that did not favor seasoned action gamers over role-playing gamers, which enabled novice gamers and non-gamers to perform almost equally.

3.1 Participation

My initial hypotheses regarding voluntary participation were:

1) Gamers will be a larger part of participating crowd;

2) Younger people will be more keen to participate than older people;

3) People would agree to play multiple sessions if offered a reimbursement;

4) People will prefer to play on their own computers at their own time;

5) A computer game will attract a large number of participants;

6) Recruitment of participants via "sales speeches" will be the best way to recruit participants.

The research results support hypotheses 1 – 4, but not 5 and 6.

3.1.1 Gamers as the main participating group

Participants were considered 'gamers' if they played regularly or occasionally according to their questionnaire answers, whereas 'non-gamers' are the people who stated they do not play computer games at all (Table 3-1). According to this definition, significantly more gamers participated in the simulation than non gamers ($\chi^2 = 24.47$, $P > 0.001$, $n = 80$ assuming 50:50 gamers and non-gamers participants).

Table 3-1 Computer gaming habits of participants in all sessions presented in total number of participants and as percentages

	Total (n =80)	Total (%)
Playing regularly	43	53.75
Playing occasionally	27	33.75
Not playing computer games at all	10	12.5

3.1.2 Younger people as the main participants

About two thirds of the participants (67%) belonged to the 18-23 years old age group, the largest group of all group ages (Table 3-2 and 3-3).

Table 3-2 Glms with poisson distribution of the difference between age group 1 and the rest of the age groups, using a Chi square test. Significant values are in bold.

	Df	Deviance	Resid. Df	Resid. Dev	P(>|Chi|)
NULL			79	1212.32	
Age Group	3	2.17	76	1210.16	0.54

Table 3-3 Age groups of participants in all sessions presented in total number of participants and as percentages and z and p values from glm analysis of the different age groups compared to the first age group (18-23) using a poisson distribution.

	Group	Total (n =80)	Total (%)	z	p
Age group	18-23	54	67.5		
	24-29	10	12.5	-0.198	0.843
	30-39	14	17.5	0.983	0.326
	40-49	2	2.5	-0.949	0.343

3.1.3 Reasons for participation

The two main reasons that motivated people to participate were curiosity (37.5%), and their friends' participation (27.5%) (Tables 3-4 and 3-5), contrary to the hypothesis that people will participate in the experiment because it is a computer game (only 11.25% indicated this reason). There was no significant difference in the number of people choosing to play because they were curious and the number of people choosing to play because their friends did so (Table 3-5). On the other hand, there was a statistical difference between the number of people choosing to play because they did a favor to research staff, for no special reason or in organized activity (Table 3-5) and the number of people choosing to play because their friends did.

Table 3-4 Glms with Poisson distribution of the difference between participation reason 1 and the rest of the reasons, using a Chi square test. Significant values are in bold.

	Df	Deviance	Resid. Df	Resid. Dev	P(>|Chi|)
NULL			79	1212.32	
Reasons	5	163.48	74	1048.85	<0.001

Table 3-5 Participation motives of participants in all sessions presented in total number of participants and as percentages and z and p values from glm analysis of the different reasons compared to the first (because friends participated) using a Poisson distribution. Significant values are in bold.

Participation motive	Total (n =80)	Total (%)	z	p
Because friends participated	22	27.5		
Curiosity	30	37.5	4.361	<0.001
Like computer games	9	11.25	0.295	0.768
As a favor to research staff	10	12.5	3.255	0.001

No special reason, spontaneous.	4	5	-3.301	<0.001
Organized activity	5	6.25	11.496	<0.001

3.1.4 *Reimbursement for playing*

Significantly more participants (80%) agreed to play repeatedly provided they would be reimbursed, whereas nobody was willing to play for free (Table 3-6 and 3-7).

Table 3-6 Glms with Poisson distribution of the difference between option 1 for reimbursement and the rest of options, using a Chi square test.

	Df	Deviance	Resid. Df	Resid. Dev	P(>|Chi|)
NULL			79	1212.32	
Reimbursement	2	27.76	77	1184.57	<0.001

Table 3-7 Reimbursement of participants in all sessions presented in total number of participants and as percentages and z and p values from glm analysis of the different reasons compared to the first (would like to be reimbursed) using a Poisson distribution. NA- Non Applicable.

Would you play the simulation for a reimbursement?	Total (n =80)	Total (%)	z	p
Yes	64	80.0		
I might consider it	6	7.5	5.491	<0.001
No	10	12.5	0.709	<0.001
I'll play. No need for reimbursement	0	0	NA	NA

3.1.5 *Playing venue*

Most participants (91.25%) opted for the option to play on their private machines away from the lab, and about half of them voted for the option to play at their own time (Tables 3-8 and 3-9). There was a significant difference between the people that preferred to play in the lab at a set time and the people that preferred to play on their own machine at their own time or at a set time.

Table 3-8 Glms with Poisson distribution of the difference between option 1 for preferred venue for playing and the rest of options, using a Chi square test. Significant values are in bold.

	Df	Deviance	Resid. Df	Resid. Dev	P(>|Chi|)
NULL			79	1212.32	
venue	3	37.94	76	1174.38	<0.001

Table 3-9 Place and time of simulation participation in all sessions presented in total number of participants and as percentages and z and p values from glm analysis of the different answers compared to the first (in the lab on a set time) using a Poisson distribution. Significant values are in bold. NA, Non Applicable.

Given you could choose, how would you prefer to play this simulation?	Total (n =80)	Total (%)	z	p
In the lab on a set time.	6	7.5		
On my own machine (at home/ office) on a set time	35	43.75	-2.866	0.004
On my own machine, at my own time	38	47.5	-3.578	<0.001
NA	1	1.25		

3.1.6 Recruitment of participants

The research findings contradict the initial hypothesis, which was that "sales speech" would attract the most participants. As can be seen in Tables 3-10 and 3-11, most of the participants arrived either because of a promotional email message (35%) or because they heard about the game from friends (35%). 6.25% of participants came because of a "sales speech".

Table 3-10 Glms with Poisson distribution of the difference between the success of recruitment methods 1 and the rest of options, using a Chi square test. Significant values are in bold.

	Df	Deviance	Resid. Df	Resid. Dev	P(>|Chi|)
NULL			79	1212.3	
recruitment method	6	138.9	73	1073.4	<0.001

Table 3-11 Recruitment methods in all sessions presented in total number of participants and as percentages and z and p values from glm analysis of the different answers compared to the first (heard from friends) using a Poisson distribution. Significant values are in bold.

Method	Total (n =80)	Total (%)	z	p
Heard from friends	28	35		
An email message	28	35	1.520	0.129
Was in the computer lab	5	6.25	2.841	0.004
UC Diary	4	5	4.081	<0.001
A poster on a departmental notice board	6	7.5	-4.232	<0.001
"sales speech"	5	6.25	9.658	<0.001
Organized activity	4	5	4.160	<0.001

3.2 The simulation as awareness promotion and training tool

The initial hypotheses were: 1) People will become aware of the need to prepare for emergencies after playing the simulation session; 2) The simulation can be used as a training tool, and people that will play multiple sessions will get better over time, even though in-game situation vary from session to session. The research findings support these hypotheses.

3.2.1 Awareness promotion

Most participants reported they will either think of preparing themselves for an emergency or store food, whereas only 22.5% stated they will do nothing, either because they believe nothing will happen or because they believe Civil Defence will take care of all their needs (Tables 3-12 and 3-13). There was a significant difference between the different answers, specifically between those who trust the Civil Defence to help them and those who decided to store food.

Table 3-12 Glms with Poisson distribution of the difference between Awareness option 1 and the rest of options, using a Chi square test. Significant values are in bold.

	Df	Deviance	Resid. Df	Resid. Dev	P(>|Chi|)
NULL			79	1212.32	
Awareness	4	15.37	75	1196.95	0.004

Table 3-13 Awareness of participants to emergency situations in all sessions presented in total number of participants and as percentages, and z and p values from glm analysis of the different answers compared to the first (yes, I'll even store some food) using a Poisson distribution. Significant values are in bold. NA-Non Applicable.

Was the simulation helpful for you in terms of raising awareness for preparedness for disasters or emergencies?	Total (n =80)	Total (%)	z	p
Yes, I'll even store some food	29	36.25		
Yes, I'll think about it	32	40	1.761	0.078
No, civil defence will take care of me	6	7.5	-2.432	0.015
No, nothing will happen	12	15.0	1.761	0.078
NA	1	1.25		

3.2.2 The simulation as a training tool

Returning players performed better than first-time players and had a life span of 69.4% compared with single-time players that had a lower average life span of 42.1%, and this was highly significant ($t = 26.66$, $P < 0.001$, d.f. = 79), where the trend indicates a learning process of participants (Table 3-14).

Table 3-14 Average life span of in-game characters measured against returning and first time players.

Abbreviations: PQ- Post Earthquake scenario, PD- Pandemic scenario.

Group	Average life span of character in simulation (%)	
	PQ (n =64)	PD (n =16)
Returning players	69.4	59.7
First time players	42.1	48.2

3.3 Usability issues

The following table (Table 3-15) sums up all the usability issues and its implications are discussed below.

Table 3-15 Participants answers to usability issues

(Abbreviations: T- All participants group)

Question	T (n=80)	T (%)
Was the in-game tutorial helpful? – YES	64	80.0
Was the in-game tutorial helpful? - NO	16	20.0
Was the printed user-manual helpful? - YES	21	26.25
Was the printed user-manual helpful? - NO	59	73.75
Was the game interface easy to use? YES	51	63.75
Was the game interface easy to use? Hard at the beginning	20	25.0
Was the game interface easy to use? Hard most of the game	6	7.5
Was the game interface easy to use? No	3	3.75
Was the medieval environment distracting? - YES	15	18.75
Was the medieval environment distracting? - At the beginning	22	27.5
Was the medieval environment distracting? - No	43	53.75
Does a simulation like that need a plot? - YES	41	51.25
Does a simulation like that need a plot? - NO	39	48.75
Did the simulation depict a real-life situation – Yes, closely	8	10.0
Did the simulation depict a real-life situation - Yes, loosely	54	67.5
Did the simulation depict a real-life situation - No	18	22.5
Did you relate to the character you played? - YES	10	12.5
Did you relate to the character you played? – YES, SORT OF	34	42.5
Did you relate to the character you played? - NO	36	45.0
Overall impression of simulation – Very interesting	22	27.5
Overall impression of simulation – Somewhat interesting	33	41.25
Overall impression of simulation – Neutral	14	17.5
Overall impression of simulation – Somewhat boring	8	10.0
Overall impression of simulation – Very boring	3	3.75
length of simulation - Too long	9	11.25
length of simulation - Reasonable	26	32.5
length of simulation - Too short	45	56.25

(Note: n is calculated for all answers of each question independently)

As can be seen, most participants agreed a pre-gaming tutorial is a helpful tool. However, results show that the hard copy of the users' manual was not needed according to most participants. Only a minority of users found the games' interface hard to use, whereas 71 out of 80 people found it to be easy, or getting easy after a while. More than half of the participants found the medieval environment not distracting, and another quarter were distracted only in the beginning of the session.

Interestingly, half of the participants think a simulation like that needs a predefined plot, and more than three quarters of participants think the simulation resembles reality to a certain extent. There is a balance between participants that related somehow to their virtual character to those who did not. Almost 70% of participants thought the simulation was interesting to a certain extent contrary to about 14% who thought it to be somewhat boring.

3.4 Tagging of events by participants and chatting amongst participants

Although the tagging system was introduced in order to get the participants' own impression of events, the initial hypothesis was that most events will not be tagged. This was predicted to happen for two main reasons: 1) this action will distract the participants from playing, and the more they are immersed the less they will treat this as an experiment and tag events; 2) The tagging system was situated in the lowest part of the screen and out of the main focal point of the player (See Appendix 3: Users' Manual, section 3).

The research supports the hypothesis: only 163 events (out of a total of a few thousands) were tagged. Most of the tagged events were tagged during the initial phases of the game, and most tagged events were dialogs (which were relatively long events). (See Table A4-3, Appendix 4: Results, section 4.4.4 Tagging results)

Chatting events between participants in the game itself (after the tutorial part) summed up to a total of 102 events for all sessions. All sessions' chat files were examined manually and did not reveal any sort of coherent communication patterns between participants (i.e. no dialogs nor conversations), but rather random text fragments.

3.5 In-game behaviour of participants

The hypotheses were that:

1) People will treat this simulation as a game and do things they would not consider doing in a similar real-life situation;

2) As the simulation is an open-ended virtual environment, participants will demonstrate a wide variety of behaviours;

3) People will not share their resources with other participants and will not collaborate with them;

4) People will not buy food as long as they can get it free, only once they run out of free food they will buy food;

5) Violence level will rise once resources terminate;

6) In a chaotic situation such an emergency people will try to obtain a weapon either to defend themselves, or to use it against other participants in order to gain control over resources;

7) Armed people will be more violent than unarmed people;

8) People that perform only violent acts will survive less long than people that calculate their moves;

9) More people will be infected as time passes in the pandemic infection game.

Most of the above hypotheses were supported by the research findings.

3.5.1 Participants who treated this simulation as a game

The majority of participants (72.15%) admitted that their in-game behaviour was different to real world behaviour in a similar situation.

Table 3-16 Participant in-game behaviour patterns in total numbers and percentages according to questionnaire answers.

(Abbreviations: T- All participants group)

Question	Total	
	(n=79)*	(%)
Did you do things contrary to reality - YES	57	72.15
Did you do things contrary to reality - NO	22	27.85

(* In these questions one player's data file in one of the PQ sessions was partially corrupted, therefore n =79)

However, it should be noted that the in-game life span of players that behaved differently to real-life situation was 59.4%, whereas people that behaved similarly to a real life situation survived for 43.1% (53.2% and 50.7% respectively in the PD scenario).

Table 3-17 Average life span of in-game characters in percentages measured against different parameters.

(Abbreviations: PQ- Post Earthquake scenario, PD- Pandemic scenario)

Group	Average life span of character in simulation (%)	
	PQ (n =64)	PD (n =16)
Did things as in real life	59.4	53.2
Did thing that would not do in real life	43.1	50.7

3.5.2 Variety of behaviours demonstrated in the game

Contrary to the initial expectation that participants would demonstrate a wide range of behaviours, the data logged revealed that most behavioural traits were survival-oriented (i.e. getting food). The table below supports the findings, as significantly more participants were occupied with goods or information retrieval, rather than in socializing ($t = 17.60$, $P < 0.001$, d.f. = 78).

Table 3-18 Purpose of interactions in the game.

	Total (n =78)	Total (%)
Purpose of interactions in the game - Acquire goods or info	71	89.87
Purpose of interactions in the game – Socialize	8	10.13

(Note: two data files were corrupted, therefore n = 78)

3.5.3 Collaboration with other participants

As predicted, most of participants admitted they did not collaborate with other players. It can be seen from Table 3-19 that the majority of participants (75%) rarely or never collaborated with other participants.

Table 3-19 Collaboration between participants in the game.

	Total (n =80)	Total (%)
Collaboration with other participants - Always	9	11.25
Collaboration with other participants - Frequently	11	13.75
Collaboration with other participants - Rarely	26	32.5
Collaboration with other participants - Never	34	42.5

3.5.4 Altruism in the game

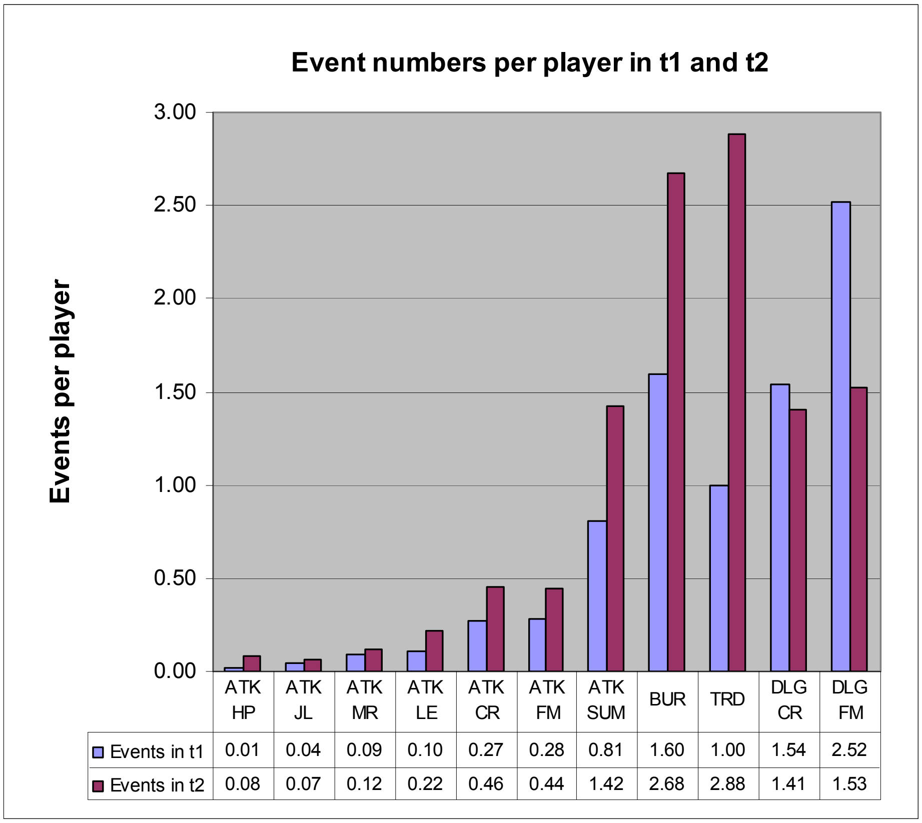
Crowd members received vouchers from participants only seven out of 34 times they asked for one. All of the vouchers were given in t_2 (the time in the game from the moment the sector post ran out of food until the end of the game), where they were practically worthless as they could not be redeemed for food in the sector post. Food rations, which were a much more valuable commodity, were given by the participants only five times out of the 39 times they were asked for. Interesting to note is the percent of females compared to males that gave a ration to a crowd member (Table 3-20).

Table 3-20 Altruism events in the game as performed by male and female participants in total numbers.

Event	Males (n =70)	Females (n =10)
Crowd member asked for a voucher	31	3
Crowd member received a voucher	7	0
Crowd member asked for a food ration	35	4
Crowd member received a food ration	2	3

3.5.5 *Trading events before and after resources terminated*

As can be seen from Figure 3-1 below, trading events almost tripled after the Sector Post ran out of food, this is because the merchants were the only alternative to the Sector Post for buying food.



	ATK HP	ATK JL	ATK MR	ATK LE	ATK CR	ATK FM	ATK SUM	BUR	TRD	DLG CR	DLG FM
Events in t1	0.01	0.04	0.09	0.10	0.27	0.28	0.81	1.60	1.00	1.54	2.52
Events in t2	0.08	0.07	0.12	0.22	0.46	0.44	1.42	2.68	2.88	1.41	1.53

Figure 3-1 Event numbers per player in the game before and after SP = 0.

Abbreviations: t1 – the time from beginning of the simulation session until the sector post runs out of food, t2 – the time from SP = 0 until end of the session, ATK – attack event, ATK SUM – sum of all attack events, BUR – Burglary event, DLG – Dialog event, TRD – trading event, FM – Family Member, CR – Crowd Member, MR – Merchant, LE – Law Enforcement character, HP – Health Professional, JL - Jailer. Note: number of players in t1 was 67, as some players started the game only in t2 after they finished the tutorial, and the number of players in t2 was 59 as some of the players did not survive after t1.

3.5.6 *Dialog Events before and after resources terminated*

Figure 3-1 above shows that crowd member dialog events stayed relatively stable before and after resources terminate. Family member dialog numbers dropped, as the main cause for these dialogs was getting a voucher from a participant's family member.

3.5.7 Burglary events before and after resources terminated

Figure 3-1 above shows that burglary events almost doubled after resources terminated, as participants were trying to use burglary as an alternative to food purchase.

3.5.8 Attack events before and after resources terminated

Figure 3-1 above also shows the attack events before and after resources finished. When running t-test to each attack or violent event separately, there was no significant difference between the level of aggression before and after the resources ran out mainly because of the small sample size of such events. However, when pooling all attacks together (larger sample size) there was a marginally significant increase in the level of aggression after resources have run out ($t = 1.47$, $d.f = 79$, $p = 0.073$) which indicates a trend of increased violence when no more resources are available.

3.5.9 Attempts to possess a weapon

It was illegal to buy weapons in the game, however they were available for purchase from the merchants as "illegal items", and cost the participant the total amount money he/she had in the beginning of the game. Table 3-21 shows that merchants were asked in t_1 (the first half of the game, where food was still available from the sector post) a larger number of times for a weapon than for food. It can be seen that in t_2 the amount of queries stayed almost identical and did not increase. It should be noted that still more than a third of events were requests for weapons.

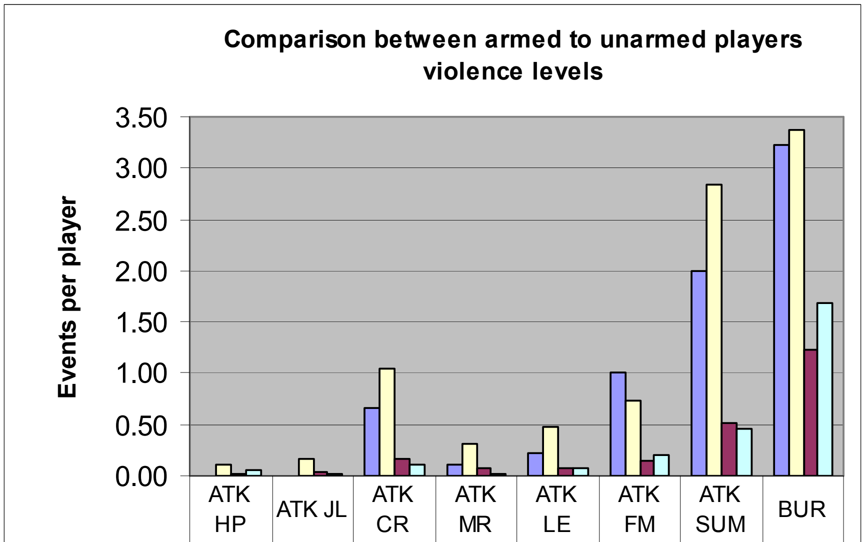
Table 3-21 Merchant dialog events per player according to scenario.

Abbreviations: t1- the time from first player in the game until the time where the Sector Post runs out of food – SP =0, t2- the time from SP = 0 until the death of the last player in the game.

Event	t1 (n =67)	t2 (n = 59)
Asking for legal commodities	67	170
Asking for illegal commodities	82	66

3.5.10 Violence level of armed vs. unarmed people

Figure 3-2 shows the number of violent events per player before and after resources ran out. It can be seen that armed people were much more violent than unarmed people.



	ATK HP	ATK JL	ATK CR	ATK MR	ATK LE	ATK FM	ATK SUM	BUR
t1 Armed	0.00	0.00	0.67	0.11	0.22	1.00	2.00	3.22
t2 Armed	0.11	0.16	1.05	0.32	0.47	0.74	2.84	3.37
t1 Unarmed	0.01	0.04	0.17	0.07	0.07	0.14	0.51	1.23
T2 Unarmed	0.05	0.02	0.11	0.02	0.07	0.20	0.46	1.69

Figure 3-2 Comparison between violence levels of armed to unarmed players.

Abbreviations: t1 – the time from beginning of the simulation session until the sector post runs out of food, t2 – the time from SP =0 until end of the session, ATK – attack event, ATK SUM – sum of all attack events, BUR – Burglary event, DLG – Dialog event, TRD – trading event, FM – Family Member, CR – Crowd Member, MR – Merchant, LE – Law Enforcement character, HP – Health Professional, JL - Jailer.
(Note: number of armed people in t_1 was 9 out of 61 and in t_2 19 out of 59. Number of unarmed people in t_1 was 52, and in t_2 - 40).

3.5.11 Life span of characters in the game according to violence level

Table 3-22 shows the life span of participants according to their violence level. When looking at the post earthquake scenario that had a larger sample size, it can be seen that the more violent a person was, the shorter his/her life span was (participation in a fight reduces “life points” of a participant, therefore the more fights a participant is involved in, the more “life points” he loses). However it can be seen that people that calculated their steps (i.e. attacked other participants only after they assessed their situation) had the second longest life span in the game. Armed people had the longest life span as the weapon they used did not let their opponent to cause them a sufficient amount of damage (compared with a fist fight which was the only other form of attack).

Table 3-22 Average life span of in-game characters in percentages measured against different parameters.
Abbreviations: PQ- Post Earthquake scenario, PD- Pandemic scenario.

Parameter	Average life span of character in simulation (%)	
	PQ (n =64)	PD (n =16)
With stick	80.1	72.3
Harming people only if participant is stronger	73.3	27.7
Sit and wait type	53.8	27.7
Did things as in real life	59.4	53.2
Not breaking into houses	53.1	37.1
Attacking only as a response	48.4	68.0
Harming only if no other choice	47	45.1
Attacking other players	46.5	63.5
No stick	36.6	44.9
Harming people in every situation	34.2	68.4

3.5.12 Ideal survivors' profile

All participants were divided according to various groups (see table A4-5 in the appendix for a full list of parameters). From data collected an optimal survivor had to be armed, attack other participants only if he had an advantage over them (weapon/more life points), a returning player, follow the same approach as he would for a real life situation and not taking unnecessary risks.

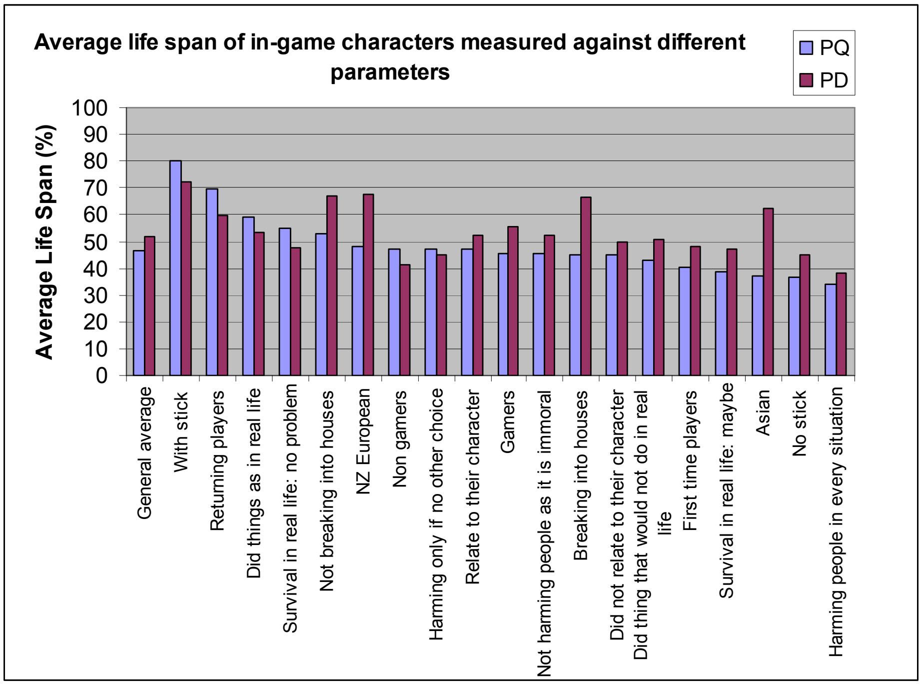


Figure 3-3 Average life span of in-game characters measured according to groups.
Abbreviations: PQ- Post Earthquake scenario, PD- Pandemic scenario.
(Note: see results appendix Table A4-6 for a full list of values).

3.5.13 Pandemic infection patterns

Figure 3-4 supports the hypothesis that as time passes more people will be infected by the virtual virus. The in-game pandemic reflects real life flu-based pandemic spread (i.e. by proximity to an infected person). Results shown in the graph count all infection cases in the game (participants and NPCs) over time. It can be seen from this figure that the infection rate at the beginning is very low, until a critical mass has established and then more parts of the population are infected in waves that can be clearly seen in all sessions. The last wave follows loosely this pattern as most of NPCs were already infected by this stage. A similar figure that describes baseline pandemic dynamics can be found in appendix 4: results, Figure A4-1C (Ferguson et al., 2006).

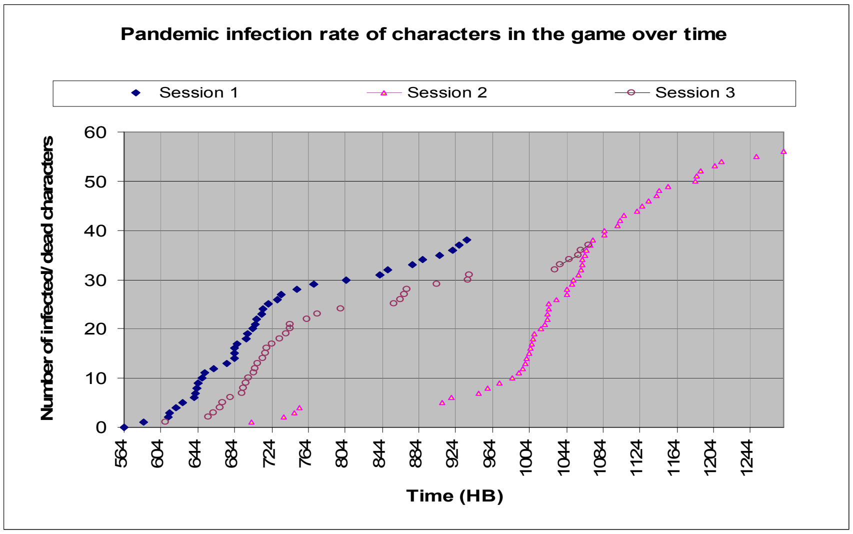


Figure 3-4 In-game pandemic infection rates of characters over time.

3.6 Inconsistency between in-game actions and questionnaire answers

This might be one of the most important findings of this research, as the fact that the game was able to detect these inconsistencies makes it superior to other methods that rely solely on a subjects' account of his deeds, and has no other way to verify their validity. This is significant, as policy makers that rely on surveys for their planning can now better validate their source data.

The initial hypotheses were: 1) People will lie regarding illegal actions they performed in the game; 2) the more severe the "crime" performed the more people will tend to lie about it.

The research findings partially support these hypotheses as not all participants lied (the "total" liars were only seven people out of 80, and "partial" liars were 13 people out of 80). However, it can be seen in Table 3-23 that 38.4% of participants lied regarding corpse looting (not a crime in itself), but about 76.4% of people that answered negatively regarding breaking into houses and attacking other crowd members lied (these actions were considered as a crime within the game and participants knew they could be arrested for committing them).

Table 3-23 Inconsistency between events in the game and questionnaire answers of participants.

(Abbreviations: PC- Player character – a participant, NPC- Non Player Character)

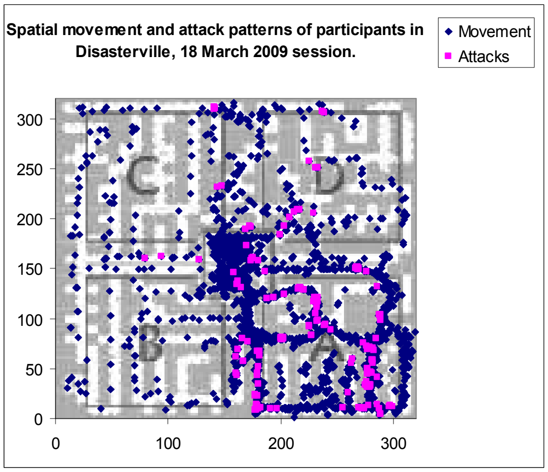
Event	Negative answer	Committed the act	Committed the act (%)
Looting corpses	26	10	38.4
Breaking into houses	17	13	76.4
Attacking PC/ NPCs	17	12	70.6
Answered no to all of the above	7	7	100

3.7 Spatial information collection

Part of the data logged with each event were the spatial coordinates of associated participants. This enabled the creation of spatial graphs where coordinates linked with particular types of events could be marked, and thus show a visual representation of trends. Below are the two most important event types that demonstrate that ability: attack patterns and pandemic infection spread patterns.

Figures 3-5 and 3-6 show the relevant graphs with the virtual city map as a background. Roaming patterns were taken from the player status sampling that occurred every six seconds. Attack patterns were taken from attack events associated with participants. Infection patterns were taken from the virus infection event of every victim.

Roaming patterns show that most participants chose to travel from their home to the city center (that contained the sector post and shops) and back home. Very few explored quarters they didn't live in. Attack events occurred mainly in passage ways that led to the city center and not in the city center itself as this area was constantly guarded by law enforcement NPCs that were programmed to jail participants that attack other participants, whereas other city streets were only patrolled once in a while.



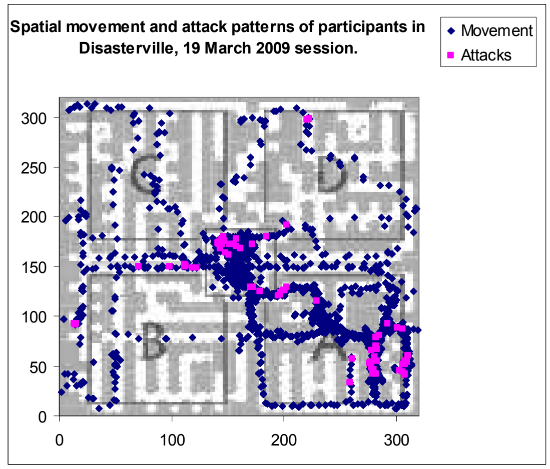
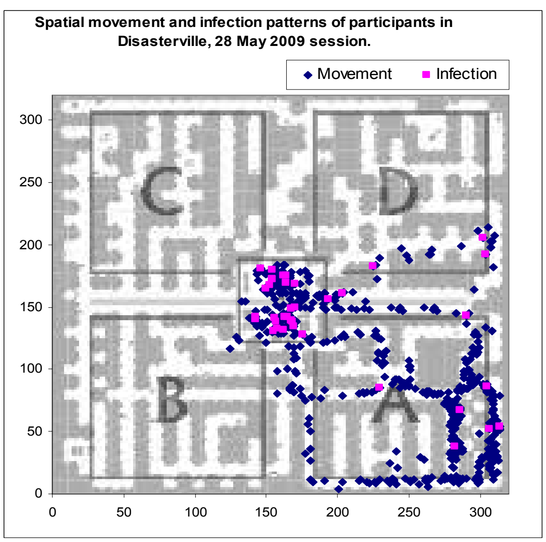


Figure 3-5A Spatial roaming and attack patterns of participants in Disasterville. Participants lived in area A

Figure 3-5B Spatial roaming and attack patterns of participants in Disasterville. Participants lived in area A.

The pandemic spread pattern can be seen in Figure 3-6A, B and C. Most of infections happened in crowded areas, where large people amounts were found (the city center accommodated the sector post, the merchants, hospital and police station). This echoes real-life situations in which most infections in pandemic cases tend to happen in crowded places (see Ramalingaswami, 2001 for example).



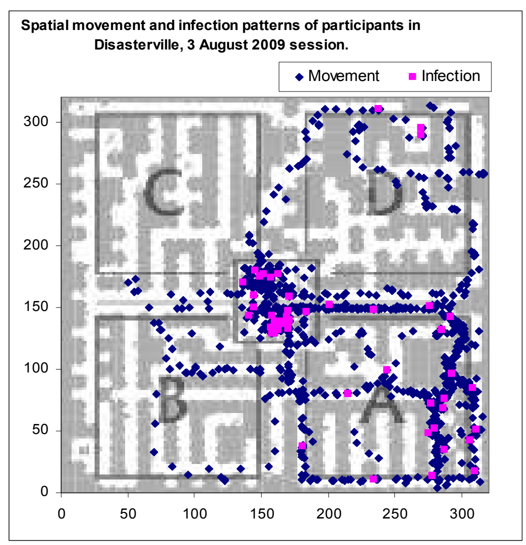
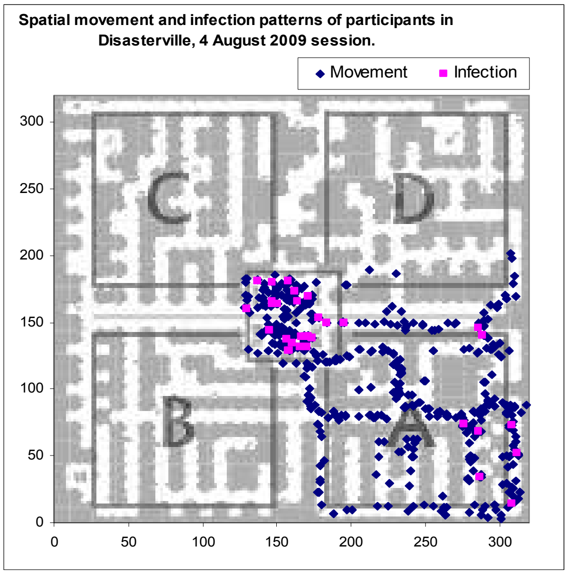


Figure 3-6A Spatial movement and infection patterns of participants in Disasterville for three sessions. Note that in all sessions all participants lived in area A.

Figure 3-6B Spatial movement and infection patterns of participants in Disasterville for three sessions. Note that in all sessions all participants lived in area A.



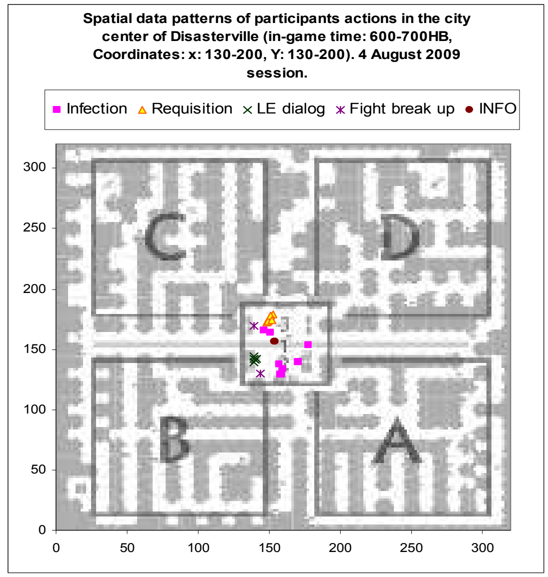


Figure 3-6C Spatial movement and infection patterns of participants in Disasterville for three sessions. Note that in all sessions all participants lived in area A.

Figure 3-7 Spatial data patterns of participants actions in the city center of Disasterville (in-game time: 600-700HB, Coordinates: x: 130-200, Y: 130-200). 4 August 2009 session. Abbreviations: Requisition- requisition of food from a merchant, LE Dialog – a player dialog with a law enforcement character, Fight break up – a detection of a fight by an LE character, INFO- a dialog between a player and an information center.

Another way of data quarrying is demonstrated below. Instead of using the events as a trigger, an area confined within designated coordinates was chosen and a list of events that happened in that area appears on the map. It should be noted that another way to narrow the data was to list only events that happened in a particular timeframe.

4 Discussion

This research examined technical and user related aspects concerning the use of multi-user computer games with human participants as individual affected population members, when used as disaster and emergency situation simulation platform. This chapter discusses these issues and suggests possible explanations to the questions raised in the beginning of this research using the experiments' results.

The chapter is divided according to the parts examined in this research:

1) technical issues: the simulation creation process, simulation time scale, abstraction level of simulation, data wealth, its collection, types and reliability;

2) usability issues: tutorials' necessity, games' look & feel, interface complexity, use of game controls, simulation content and plot;

3) user related issues: target audience, recruitment and participation, reimbursement, participants motivations, their immersion in the game, and their in-game behaviour.

At the end of this chapter there is a summary that lists the influential factors in the examined fields.

Notes to consider:

1) the game used was a LAN game and not a MMORPG (reasons are detailed in the methodology chapter), so a behaviour pattern that fits a stand-alone computer gamer was expected;

2) research findings relate to voluntary participation (i.e. not paid or otherwise reimbursed);

3) the simulation was not tested on an existing online community, but was created from scratch.

4.1 Technical issues

4.1.1 Lessons learned from the simulation construction process

Note that a full account of the simulation creation process can be found in appendix 5: Discussion, section 1.5.1 A recipe for a disaster.

The main conclusions that can be drawn from the simulation creation process are that there are three dominant factors in the simulation creation process:

1) thorough planning and specification creation, in which all requirements and relations between all participating entities are determined;

2) having a competent development team that can implement the planning specifications into the simulation and is knowledgeable with the suggested platform.

3) most important, in terms of participant recruitment is marketing, as without players there will be no simulation.

4.1.2 Simulation time scale

The experiment revealed that the main factor that governed the participants' behaviour in the simulation was their patience - as assumed in the hypotheses. The scaled-down timeline was probably the major factor that caused them to demonstrate a very narrow spectrum of behaviours, contrary to real life situations where a survivor's behaviour changes and evolves over significant time periods (Kaniasty and Norris, 1995).

I suggest that the scaled down time line influenced the participants in two ways: 1) the differences in time scale meant that the participant's cognitive and behavioural processes could not be scaled down, so only a few general behaviour types were demonstrated; 2) the participants were not exposed to the same mental pressure experienced in real-life post-disaster situations and therefore could not be expected to behave identically.

As this phenomenon was anticipated after the preliminary user studies, I introduced an in-game mechanism that encouraged the participants to focus on desired issues. This was done by a repeating message over a participant's Avatars' head that reminded him he has to get food once his "life level" points dropped below a certain level. These cues worked successfully, as from observations participants started to stress and verbally comment and ask where they should get food from.

One may argue that this is not an objective thing to do in an experiment, however since this experiment was not only about observation of gamers, but also focused on possible methods that can be used to influence participants behaviour so that it emulated real-life behaviour, I think it was a legitimate thing to do in order to assess the success of this method.

4.1.3 Abstraction level of the simulation

From observations of preliminary user-studies of this research, participants were very creative in their interpretation of objects found in the game's virtual environment, and used them as they wished (i.e. sticks, swords and knives that were part of a participant's Avatar's apparel were used for attacks on other participants). Once oblivious of the real environment in the later stages of the experiment, participants were more focused on their in-game goals.

In order to assess how participants' behaviour might change by inclusion of certain objects I included trash piles that had inside them random objects (food ration, gold coins, food vouchers, or a weapon). The trash piles were scattered in various places in the virtual city and once their existence became known to participants, the participants changed their behaviour and began to observe their virtual environment and look for trash piles.

My impression is that the "creative" use demonstrated in the preliminary studies was because participants were bored with the abstract plot and tried to fill in the gap and create themselves a more interesting environment, a behaviour that can be related to low immersion levels. The change in behaviour that happened when I introduced the trash piles can be attributed to the fact that these objects (sometimes) rewarded the players, so it was worthwhile for them to change their behaviour for that reward.

To follow Anton Chekhov's idiom "One must not put a loaded rifle on the stage if no one is thinking of firing it" (Rayfield, 1997), a simulation planner should include the items he thinks are necessary for the existence of the virtual world, and for the behaviours he wishes to observe, similar to a commercial game that will include objects that advance its plot (Adams and Rollings, 2006). For example: will the inclusion of cutlery items in every apartment be necessary? The answer might be positive if these items can be used by participants in a way that might influence the outcomes of the simulation, as in the case of people that will use cutlery items as weapons.

4.1.4 Data wealth, its collection, types and reliability

This research combined traditional qualitative and quantitative data collection methods (observations, interviews and questionnaires: (Strauss, 1990). However, other means of data collection which are innovative were also introduced, and helped to triangulate the collected data (Jick, 1979) by providing multiple view points on the same topics. The innovation derived partly from the collection of the data which was done on-the-fly, so participants were less distracted from their gaming goals, and partly due to the relationship between the various data types, as discussed below.

4.1.4.1 Comparison with traditional questionnaires

A computer game can actually be defined as an event driven simulation (chapter 1: Background, paragraph 1.2.1), in which the plot advances according to participants' actions. This means that the plot can be considered as a collection of various situations to which a participant has to respond. The following table summarizes the conclusions from the experiment and lists the advantages a multi-user computer game has over a traditional questionnaire:

Table 4-1 Comparison between computer games and questionnaires

Issue	Questionnaire	Computer game
Presentation of the questions	Static. Can be written or oral, the subject has to imagine the context of the situation.	Dynamic. It poses whole context situations to which a subject can reply/respond. No words are used, so the subject might be less intimidated.
Repetitive questions	Might annoy a subject, questions have to be rephrased in order to have a participant collaborate	Same type of conflicts might present themselves in different situations
Length of questionnaire	Has to be taken into account, as this is the subject's sole focus, and he might lose interest	The subject is immersed in a game and does not feel "questioned"
Time stress factor	Does not exist in most cases, therefore subject has time to think and calculate his answers according to the impression he wishes to leave on researcher	Exists in most cases. Subject does not have time to think about his impression and most times acts impulsively.
Objectionable questions	Can be avoided by subject, or answered in a deceivable way	As the question is presented as a non-verbal situation, the subject reacts to the situation, and might feel less intimidated.
Reliability of answers	As the subject represents himself and is observed, he might apply some censorship according to content asked	The subject acts through a virtual Avatar, does not feel observed all the time and acts as a response to events, therefore he can more easily justify his actions..

In my opinion, an analogy that can be made in this case is with an elaborate, repetitive, continuous and ever changing questionnaire. A traditional questionnaire is a collection of static written statements that describe events in a very general and short manner (i.e. "would you steal a loaf of bread?") and let the participant choose between a few given responses to the event (Strauss, 1990). In comparison, a computer game offers a dynamic environment in which altering situations and more elaborate scenarios are presented in a much wider context than just a textual only question (i.e. "would you steal a loaf of bread from an old lady, given that: outside is a cold, gloomy and rainy day, you were already chased twice by thugs, you are very hungry, nobody else is watching you, and you can get away with it?")

Typically, no time factor is introduced in a traditional questionnaire (especially if it is a questionnaire that is sent via post and collected at a later stage), and therefore the participant has time to imagine a situation, analyze it and think about an appropriate answer. A computer game however, has an embedded stress factor, represented by an inner game clock that emulates a real life situation that causes the participant to react more intuitively, without thinking or analyzing in depth what an appropriate answer should be, thus reflecting real life situations. In addition, in the game each individual experiences slightly different situations (by definition, ones experience does not include one as an independent PC); by contrast with a non-personalized survey questionnaire.

Some common problems in traditional questionnaires include asking objectionable questions that people may refuse to answer, the questionnaire length (Don et al., 1993), or asking repeatedly the same question to see if a person is consistent with his answers. The experiment's game environment however, bypassed these problems successfully (one out of many examples: instead of asking a participant 19 times in a questionnaire if he would attack another participant's virtual character, 19 separate attack events were recorded for participant PCID 9 under various circumstances on the 19 March 2009 session). This was done without disturbance to the gaming flow of participants and without having the participants annoyed, or refusing to answer a question. A point to address is that when analyzing questionnaires, there exists no way other than cross referencing questions and checking for inconsistencies in order to verify a participant's answer (triangulation of data; (Jick, 1979). In any case, it should be noted that even this in itself can only assure consistency of one's answers, not their truth.

4.1.4.2 Participants behaviour logging spectrum: from general to individual trends

This experiment used settings that enabled data to be logged on three different levels:

1) general trends that represent the whole population. These were quarried by looking for specific actions through all population members list (i.e. the rise in violence levels after food has run out in the sector post, Figure 3-1);

2) specific trends that represent parts of the population that have a common denominator, for instance when in-game questionnaire data was cross referenced with actions (e.g. survival data relating to participants that answered that they harmed other participants in every chance indicated they had survived for the shortest period in the game, Figure 3-3);

3) individual trends: when data is sorted according to a specific player ID and a specific action is observed over time, and can show a participant's behaviour change over time (e.g. aggression level changes over gaming time).

4.1.4.3 Spatial data and its implications

As shown in Chapter 3 Results, all data logged also contained spatial coordinates (x, y location on the virtual city map) that allowed a visual representation of event occurrence over time. This feature served three purposes:

1) supply a quick glance into the data gathered so it can be compared with similar real life situations in order to verify data accuracy. For example: figures 3-5A and B show attack event patterns in two different sessions. Both show that attack events happened in less policed areas (most of police forces in the game were situated in the city center, whereas in other parts of the city only random police officers were patrolling once in a while). Figure 3-6A, B and C show Pandemic infection spread in three different scenarios, with consistent patterns that indicate that most of infection events happened in crowded places, as might happen in real-life for a flu pandemic;

2) the ability to use this type of data to get quick feedback when using the simulation as a training tool that tests and verifies response strategies. An example for that is illustrated in figures 3-5A and 3-5B: it was seen that many attacks happened in the virtual city area X: 180, Y: 10-70 (a road that leads into the virtual city center) in the 18 March session, therefore a virtual Law Enforcement patrol officer was added, so that this street could be patrolled. As a

result, figure 3-5B shows that the attack events in that street declined to zero in the 19 March session;

3) the ability to extract data bi-directionally: once using an event type (figures 3-5, 3-6), and see where it happened in the virtual city, and once see what events happened in a particular area (figure 3-7) in a specific timeframe.

Other software types based on Geographical Information Systems (GIS) work on a similar principle (Goodchild, 2000). They represent data according to spatial information attached to it and that data can be Queried either through the visual part (eg. “get a list of people aged 35 and more that live in the area that is circled on the map”), or through the data itself (e.g. “Highlight areas on the map where people that have an income of more than a 35k per annum reside”).

However, the experiment’s computer game demonstrates a significant advantage over GIS based software – it has a virtual and interactive environment that produces the data in real time, whereas GIS based software will need the data generated by a model, or imported into its database before it can be queried (Lei et al., 2009). This is a highly significant advantage when using an emergency simulation computer game as a planning tool, as it bypasses complex prediction models that are used for data generation (and that might not always be available, or tailored for a specific task). This flexibility enables the planners to try out easily various strategies that can impact certain action types and get feedback for each strategy, as demonstrated in figure 3-5A and B.

4.1.4.4 Data collection summary

Although computer games demonstrate the ease of data collection, they still have the same problem every data collection method has: they can only record participants’ actions, not their intentions. Therefore, a question like “why did a participant choose to attack another participant?” will not have a clear answer. One has to cross reference the recorded data and check for indicators that can shed light on specific actions (i.e. in case of an attack event: look whether the Life Points Status of a participant was low, or he/she had no money that could have been used for food purchase).

I can conclude that trends (general and specific) can be easily traced and documented, however reasoning for specific actions stays more speculative but sometimes can be explained through data triangulation.

4.2 Usability issues

It should be noted that although this research was not a usability study per se, usability issues such as interface components, use of game controls, and content induction are common to simulations and to commercial games, and can influence participants performance. Therefore the notable issues have been examined in order to assess their impact.

Computer game usability can be defined as the degree to which a player can learn, control and understand a game (Pinelle et al., 2008). In this simulation the corresponding components included: 1) learning: in-game tutorial and necessity of a printed tutorial, influence of the medieval environment upon participants; 2) control: interface complexity (tagging and chatting); 3) understanding: existence of a plot and similarity to real life case studies.

4.2.1 Learning: in-game tutorial and printed tutorial

As predicted, most participants (80%) were satisfied with the in-game tutorial, and 73.75% of participants thought the printed version was not necessary (Table 3-15). These results reflect the advantages the in-game tutorial demonstrated: it was interactive, each player had an individual virtual tutor, users were taught step-by-step how to use the game controls, no time stress was introduced, participants could repeat lessons, and the area properties did not enable participants to attack each other. By contrast the printed version had to be searched and read if a participant wished to acquaint himself with a specific item, and if done while already in the gaming session itself, this activity had to compete for a player's attention with the gaming itself, so it was probably low in the priority order.

Avoidance of reading of printed material like user manuals and tutorials as demonstrated in this research is not a unique phenomenon. It is a common practice in the Information Technology (IT) industry (Novick and Ward, 2006), and the findings are supported by experiences with a military computer game (Belanich et al., 2004) in which graphical images and spoken text were recalled by participants more accurately than printed text.

4.2.2 Learning: the influence of the look & feel on participants

The emergency simulation created for the experiment purposes was constructed using a toolset that was part of an existing commercial game (NeverWinter Nights), one of the main features of which was its medieval look. As seen in Table 3-15, only 15% of participants found this distracting through all of their gaming session. As most of participants reported past exposure to computer games (Table 3-1), they were probably used to various interfaces and virtual environments according to game themes, so they could adapt easily and concentrate in the gaming process itself.

It should be noted that the medieval look had no effect on the simulation, as this concentrated on the interaction between participants, regardless of their environment. Had the experiment been about issues like traffic congestion following a disaster, this environment would obviously been unsuitable.

4.2.3 Control: interface complexity

(Note: apart for the image below, a thorough overview of functionality and images of the NeverWinter Nights interface which are discussed in this section can be found in Appendix 3: Users' Manual).

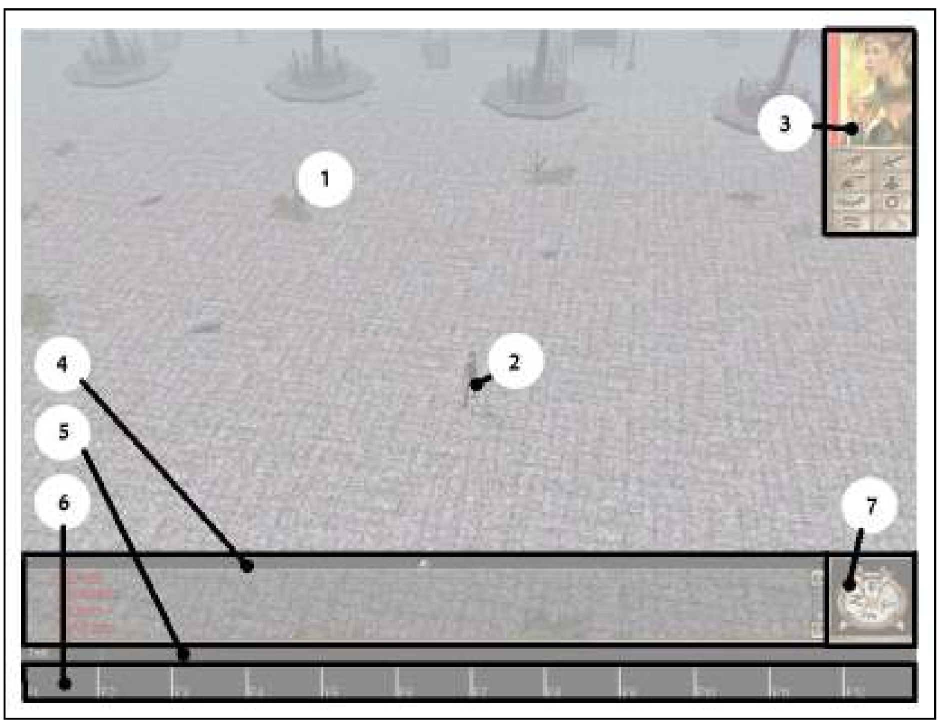


Figure 4-1 NeverWinter Nights user interface screenshot.
Where: 1) the virtual world the player interacts in; 2) the player's character; 3) the players menu; 4) the Message Window: it presents every action/ chat/ game notification; 5) the Chat Window: a one line window for communicating with other human players; 6) the Quick Access Bar (F1-F12): in this bar are stored tags (they look like books) used for tagging a players' impression of various interactions with other participants; 7) the Compass: tells the in-game date and time.

The observations and results of the experiments suggest that because participants were confronted with large amounts of information, an unknown virtual environment, an unfamiliar interface, and above all a time stress factor, they filtered out elements that were not high in their gaming priority: such as complex-to-execute or rarely-used functions, as well as interface components that were not in their immediate field of view or hidden between other, more noticeable elements of the interface. Participants tended to adhere to the less complex, known to them, and essential functions that did not interfere with the gaming flow. This behaviour was also reported by Bearne (1994), as mentioned in the background chapter. The experimental findings that are discussed hereafter are supported by these arguments.

4.2.3.1 Observations of participants in the lab:

By default, communication between participants and in-game characters (tutors, crowd members, and all non-human operated characters) in the NeverWinter Nights (NWN) environment was via dialog windows that occupied by default the top left of the computer screen. The computer monitors used in the lab had a wide format (30cm high by 55cm wide), and the dialog windows were about 10cm by 10cm large.

When participants started the game, their character was standing in front of the virtual tutor and the dialog window opened automatically. It was observed that participants did not look at this corner of the screen and rather focused on the middle part of it as they were fascinated by the characters and virtual environment. A short while after the session beginning (about 30 seconds) people started to raise their hands and ask the research staff "What do I do now?", whereas all they had to do was just direct their attention to the top left corner of the screen and follow the instructions written in the dialog window. Later, in the game sessions following the tutorial, it was observed that people in the same way tended to ignore the Message Window that was situated at the bottom of the screen and that displayed important game information, although they were told about it in the tutorial session.

In a similar manner participants ignored the tagging and chatting functions. Tagging and chatting were two innovative methods introduced in order to capture participants' subjective data (presumably their intentions could have been deciphered from their chatting with other participants, and their impressions of interactions with other participants/NPCs could have been logged via the tagging module). However, as mentioned earlier (Chapter 3 Results, paragraph 3.4 Tagging and chatting), tagging and chatting events were sporadic and insignificant in quantity compared with other event types.

4.2.3.2 Chatting

Chatting is a function embedded into the NWN environment, and is the only means of communication among human participants (dialog windows are used to communicate with Non Player Characters (NPCs)). As can be seen in Figure 4-1, the Chat window is a narrow one-line window almost hidden between two other information windows, and if it was not mentioned to the participants, they didn't notice its existence (as happened in the preliminary user studies). The operation of the Chat Window required the user to stop looking at the center of the screen, focus attention on the Chat Window at the bottom of the screen, type the message, look at the Message Window to see if it was sent, and then continue to look at this window and wait for a possible reply. As part of the tutorial session, this was given as a stand alone assignment to participants, and all of them performed well. However, within the gaming session this task competed with other events on players' attention, and as the results show, it was hardly used.

4.2.3.3 Tagging

Tagging is an existing concept used mainly by search engines as described in Chapter 1: Background, Section 1.5.2. However in this research context it was completely innovative. It is not a part of the original game's interface, but was rather improvised by using the Quick Access Bar that was situated at the very bottom of the screen (see Figure 4-1 above).

As mentioned in Chapter 3: Results, section 3.4, participants tagged only 163 events, almost all of which were dialogs. A possible reason for tagging mainly dialogs was that a participant spent a significant time (in game time) to read, understand and respond to a dialog, so he might have been less immersed and could dedicate enough time to tag his impression, as a dialog was not a time dependent event. To the contrary, other event types required him to take action as a response and were time dependent (i.e. when attacked by another participant). These actions were probably more attention-consuming than looking for an appropriate tag for an interaction, as well as more immersive than a dialog.

It was also noticed that most tagging happened in proximity to tutorial termination. A possible explanation can be that as long as the tutorial instructions were fresh in their memory, participants tended to tag events, even some time after the event itself. However, the longer the time that passed from the tutorial termination, the more the player was immersed and forgot to tag his impression from interactions. And as this trait was not reinforced by repeating messages to the players (as done with food acquisition), it lost its priority in the players' priorities scale.

The lack of tagging can also be attributed to the fact that the tagging, done via the Quick Access Bar, was situated at the very bottom of the screen, and like the Chat Window, participants considered it to be part of the interfaces' frame and not an active menu item.

4.2.4 Understanding: plot and similarity to real life situations

The issue of lack of a clear plot or specific content was observed in particular in the preliminary user studies, where participants commented about the abstract nature of the plot and demanded a clearer plot. This was later echoed by answers to the in-game questionnaire in which a relatively large number of participants stated they would have liked to see a solid plot.

This might suggest that a simulation that has only a background story, without any visual reminder of the disaster, but only a simple instruction "survive for a maximum of time" might be too abstract for some players; if they are gamers, they might want to see visual effects that represent such an event as they might experience in a commercial game.

Participants were asked whether the simulation content resembled a real life situation. As most participants (77.5%, Table 3-15) opted, this simulation resembled to a certain extent a real-life situation in their opinion. This can be correlated to the fact that most of participants (96.25%) had not experienced a real life emergency situation. One may argue that this does not suggest that the depiction created by the simulation is accurate, however it can be said that most people that will be attracted to play as affected population members in future applications will have to have access to broadband Internet connection, have time to participate, will possibly be gamers and therefore will share a similar background to that of the experiment participants, and therefore might think that such a depiction that relies on a background story and the aftermath is sufficient. This is supported by the fact that only 13.75% of participants found it to be boring.

4.3 User-related issues

4.3.1 Target audience

The research results (Figure 3-3) show almost no difference in performance between gamers and non gamers. This could be due to two reasons: 1) the way the experiment's simulation was designed, where strategy and common sense thinking were preferred over action gaming; 2) The games' pace which was slow and didn't require a thorough knowledge of the interface in order to survive compared to commercial versions of the same game that require these skills (e.g. cast specific spells that are in a sub-sub-menu, or open a players' inventory in order to draw a specific weapon, etc.).

Contrary to commercial games that emphasize solely gamers' satisfaction as their center goal (Gee, 2003), existing emergency simulations are tailored for specific purposes such as training and have their very own specific target audience (e.g. a simulation can be developed to train soldiers or pilots), and therefore proper "gamers" might not be a suitable crowd. When dealing with less specific target audiences, and where crowds are needed, gamers might be a suitable solution, however if the simulation is of a more specific nature its planners will have to consider recruitment options that will source the proper participants for their purposes, especially if they want to observe the influence of events upon human behaviour of specific crowds (for example: if one wishes to observe the effects of a disaster on a small fishing village, a crowd that belongs to the same community and has strong social relations might be more appropriate than a crowd of random gamers).

4.3.1.1 Using an online community

In literature reviewed relating to MMORPGs, the phenomenon of the online community is mentioned and observed. However, although very important technically, nothing is written about how to start a virtual community and what obstacles game designers and planners face in that regard.

From my past experience and from this game creation, I assume that this might be for three reasons: 1) all work written was done on existing communities whose virtual existence is taken for granted and is not an issue; 2) the creation and maintenance of such a community is not within the scope of scientists research; 3) these issues might be in the technical domain of game design and creation, and therefore kept secret by commercial companies as they may be considered sensitive information.

What dilemmas might the simulation planners face?

The problems can be in these areas:

1) interaction types that are desired: LAN games that demonstrate a stand-alone gamer attitude, or a MMORPG that is more likely to demonstrate a communal type relationship pattern. It should be noted that even a MMORPG might demonstrate a stand-alone game behaviour when its community members are not acquainted;

2) participation type: If participation is voluntary and random gamers can join, the chances are that the interactions will resemble a stand-alone computer game. If participation is part of an organized activity where members are acquainted the behaviour might resemble that of a community. If an existing online MMORPG community is used, behaviour will be along communal lines;

3) continuity: does the scenario require a persistent world, and for how long; is the event ongoing and replayed every few hours, or is the virtual community leading a “normal” virtual life and only then is the scenario played? What happens when people login or logout from the game, how many people are needed in order to form a critical mass?

According to the above criteria the simulation planners can decide whether they want to use an existing online community, or create one from scratch. If using an existing community its members need to be approached sensibly if the planner does not want to be rejected, the topic has to attract them, or alternatively they might be compensated for their time. The only question that remains open is whether community members “migrate” for a while into the simulation virtual world, or the scenario takes place in their own virtual world (considering the technical aspects of virtual world creation, and data gathering methods, if it is a commercial platform). If the planner wishes to use his own virtual world and establish a community from scratch, the best advice I can give is: be part of an online community before attempting to create one in order to know what the social dynamics are, or employ a person that has such a background and can attract new community members through his connections. In any case, in the beginning a key player should be recruited and paid, so that he brings in his community members. Only after the community has some time online and a communal social hierarchy is established, can the emergency scenario be applied.

4.3.2 Participation and recruitment

Participation rate for this research’s experiment showed that out of the whole University of Canterbury staff and students which were targeted by emails, posters and “sales speeches”, only 80 participants showed up. Moreover, although participants indicate they spent 1-3 hours daily gaming in their answers to the in-game questionnaire, it was noticed that after about 40-50 minutes in the lab they started to move restlessly and sometimes even express their boredom from the game verbally, and 90 minutes was about the maximum time they could handle without a break. When given the chance to play alternating scenarios (as was done with the preliminary user study group), people performed well, however towards the last sessions that had only minor changes introduced into scenarios, participants commented they were bored with the game.

This fact contradicts figures presented by other researchers that report large amounts of online gamers and long hours of gaming on a daily basis (Williams et al., 2008, Yee, 2006a). The difference can be attributed to two reasons: 1) these reports deal with existing communities that have been online for a relatively long time, whereas the present experiment was published only locally and was new; 2) the experiment took place in a brick-and-mortar lab and people could not play it from their homes as most of them opted in their questionnaire answers, as well as by numerous responses to the "sales" email that inquired about the possibility to play this simulation from a users' home; 3) it might be that the emergency MMORGP was not as attractive or interesting as a commercial game (i.e. if a simulation of a chemical contamination aftermath requires people to act as passers-by and aimlessly wander around in a virtual city for a few hours).

Recruitment techniques used in order to attract voluntary participants for this experiment are described in Chapter 2: Methodology, and their impact is shown in Chapter 3: Results. These techniques suited a game conducted in a computer lab, but have some relevance to future application recruitment of potential participants.

It is interesting to note the impact of word of the mouth that recruited more than a third of the participants (35%, Table 3-11) compared to that of email distribution. This impact echoes a similar marketing strategy, known as "Viral Marketing" that is successfully used for Internet marketing purposes (Leskovec et al., 2007), and that is based on circulation of a "testimonial mail" through a target audience group from member to member, a fact that tends to give the mail more credibility in the eyes of the recipient, as the source of the mail was allegedly another member of their mailing group and not an advertising agency.

In my opinion, any future application that will be used online (via the Internet), and targets gamers as its main crowd should adopt advertising and marketing techniques that commercial games use: dedicated online promotional websites (like www.bioware.com), online forums (i.e. www.gamespot.com/forums) and magazines (www.computerandvideogames.com), as well as printed magazines that gamers' community has access to (www.stuff.co.nz/technology), press releases that can be found on computer game companies websites, and sometimes use of international events like the E3 expo (the largest international event for interactive entertainment, www.e3.expo.com) that will generate media coverage.

Recruitment methods have to take into consideration the platform, the location the game takes place in, as well as the target audience. The most successful technique will be by viral marketing that is started by one of the senior members of the target online community, as these are tribe-like communities (Brignall III and Van Valey, 2008) that might be skeptical and suspicious when an unknown or new guild member tries to "sell" them something.

4.3.3 Reimbursement

This research supports Brabham's findings (Brabham, 2008) that monetary compensation is the strongest motivator, as 80% of participants in my research stated that they would be willing to play the simulation repeatedly if reimbursed, and moreover, nobody was willing to play it repeatedly for free (Table 3-7).

It should be noted that although the present research differs, the goals mentioned by Brabham might be similar (people define online computer gaming as a hobby, invest time and money playing them, are gaining new in-game skills, and share this interest via an online community that plays a similar or identical game. See www.bioware.com online forums for example).

The low voluntary participation rate suggests (amongst other things) that people did not have an intrinsic motivation. Therefore an extrinsic motivator like financial reimbursement is needed in order to boost voluntary participation rates, in particular where large numbers of participants are needed. As to the extent of the reward, I would argue that it is a matter of trial and error; however some parameters that can be considered by simulation organizers are:

1) it should be attractive enough to be a viable alternative to an hourly pay rate offered to the target audience sector;

2) it should take into account continuity issues (i.e. if it is a "one of" session or a sequence of a few sessions, and should the same people continue to play);

3) if feasible, run a few test sessions that will help to develop a "boredom" scale that determines the reimbursement rate according to the task given. As a general rule of thumb, the more boring the task, the higher the reimbursement should be.

4.3.4 Participants' motivations

Voluntary computer gaming is considered an intrinsic motivation activity (Yee, 2007). The voluntary participation rate in this experiment was low, people did not return to play again, and no community was created around the game (i.e. people that return, bring their friends, or turn the game into an after-hours happening, although the lab was open for three days a week for three terms). This can be explained by looking at two of the main motivators according to Belanich and Yee (Belanich et al., 2004, Yee, 2007): the challenge or goal that was relatively abstract according to participants, and the socialization that participants were not engaged in during the game (in the questionnaire answers most indicated that they played for survival). Furthermore, most participants indicated that they would rather play at home, on their own machines, at a time convenient for them and this might have added to the lack of motivation.

4.3.5 Immersion

Immersion is the third most influential factor upon gamers' motivation to play (Belanich et al., 2004, Yee, 2007). Participants in this research experiment were not asked directly if they felt immersed because of the term's ambiguity and as not all were assumed to be familiar with this term from the gaming arena. Alternatively they were asked leading questions that could indicate their immersion level (Table 3-15): did they feel that the interface was distracting? (Only about 10% found it so). Did they think the simulation depicted a real life situation? (Only 22.5% thought that it did not). Was the medieval look & feel distracting? (About 18% thought so). How did they rate the simulation length (only about 11% found it too long)? And finally, what was their overall interest level in the simulation? (About 14% found it to be not interesting).

The answers to the above questions suggest that participants were mostly immersed in the game in terms of time spent and their overall impression. I would also argue that beside usability issues, the minimal use of tagging and chatting functions (which in order to use, participants had to stop their gaming flow and dedicate their all of their attention to the operation of these functions), indicates that participants devoted more of their attention to events happening in the game and therefore were immersed in the game. However, if looking at the overall motivational factors, immersion alone cannot attract participants to play a simulation if other factors are not contributing.

Relation to one's Avatar can be another factor that influences immersion. In commercial MMORPGs a participant's character is initially designed and developed by him, and is the main attraction for many gamers. Attachments to one's virtual character (the Avatar) is described by Wolfendale (2007), and claims that this attachment is significant to the human user. I argue that the low bonding percentage with the virtual character demonstrated in the present game is justified since in this simulation participants did not create their virtual character nor did they choose it, and in addition played only one session. This low bonding might also have added to the wish of participants to see a more defined plot that would have kept them immersed.

4.3.6 In-game behaviour

Interesting to note is that although the experiment's gaming environment was open ended, in-game human behaviour spectrum was limited to very few behaviour types. Moreover, when the participants were observed, they were quiet and concentrated in the game and did not demonstrate any indications such as smiling, shouting or verbally communicating with each other. This can be attributed to the fact that the whole game was channeled to a "survival" mode and participants had no benefit from demonstrating a large variety of behaviours. It should be noted that one of the main features in a MMORPG is the socialization (as already mentioned in the introduction), and the lack of it is another indicator that participants treated the experiment as a stand-alone computer game. This assumption is supported by the fact that majority of participants (89.87%) admitted that their purpose in the in-game interactions was acquisition of goods or information (Table 3-17), whereas only 10.13% of participants said their purpose was to socialize. An example of a typical stand-alone gamer that participated a few times in the simulation sessions can be found in Appendix 4.8 section 4.8.1, which lists an interview conducted with him following the last session he participated. Another reason that could have caused this narrow spectrum of behaviour types is the human-computer interface that acts as a barrier blocking important indicators such as a persons' physiognomy or gestures, their body language as well as spontaneous verbal communication (which was replaced by a textual chat window).

Following are behaviour types that were observed during the experiment's simulation sessions and their possible explanations:

4.3.6.1 Lying

Lying was exemplified by participants on two levels: 1) in-game: to other participants, to virtual family members and to crowd members. Participants had the option to lie to other characters within the game. The dialogs were set so that one of the answers could be wrong, i.e. "I put some food for you in the chest", or "I don't have any vouchers or food to spare". The reason for choosing these answers by the participants is not clear, however I assume that participants reacted out of annoyance to repeated requests they could not, or would not, fulfill; 2) lying in response to the second part of the in-game questionnaire questions: contrary to the in-game actions and answers that were a part of the game flow, the second part of the questionnaire, although conducted inside the virtual world, was a post-game stage that participants could answer without time pressure. Table 3-23 sums participants' answers to the questionnaire questions that deal with illegal or immoral actions they may had performed. It can be seen that the more severe the act was, the more the number of participants that lied regarding its performance. I assume in this case that as these questions were objectionable (Don et al., 1993), the participants were more conscious and considered their positive image and how it might reflect in the questionnaire, hence the increase in lying percentage with the severity of the action taken.

4.3.6.2 Planning ahead

This behaviour was exemplified by two indicators in the experiment: 1) having a predefined gaming strategy; 2) stockpiling of items. From my observations and from the interview with a returning player, planning ahead was not demonstrated by the majority of participants, and this is supported by their actions shown in figure 3-1, that show a sharp increase in food purchase events after the sector post ran out of food, rather than a larger amount in the first part of the game, that would indicate stockpiling actions. Therefore, it can be said that people were reacting according to situations they faced more than planning ahead. This is also common to real life situations, for instance in New Zealand, where Civil Defence launched a campaign that encouraged people to stockpile and prepare an emergency kit but without a notable success (Paton, 2003), and as mentioned in the interview with Mr. J. Bind (Bind, 2009).

4.3.6.3 Family relations

Literature mentions that in real-life post-disaster situations people are helped by their relatives (Drabek et al., 1975). The relationship and dependence on next of kin rely on complex factors, and mutual caring depends on various parameters. As the simulation could not emulate exactly the same type of complex relationship (as participants had no prior acquaintance with each other or with their characters), a crude type of relationship system was introduced, and that gave the participants only one main incentive to care for their virtual family members and keep them alive and that was food supply. A family member starved to death if not given food for a while, so a participant had to constantly bring back home food rations for his family member. In order not to turn this into an unrewarding task, the family member had an important role that was the production of food vouchers that were used in order to obtain food rations. As long as a family member produced vouchers, the player had a secure source of food (until the sector post ran out of food). If the family member was neglected and died of starvation, the player's supply of food vouchers terminated. From my observations, participants were concerned about their family members and invested effort in keeping them alive by bringing them home food rations and caring for them. The spatial data that shows movement patterns in the virtual city supports that claim as it shows that roaming patterns were in most cases from home to a sector post, with no exploration of other city parts.

4.3.6.4 Altruism

Altruism is indicated by sharing food vouchers and food rations with characters other than a participant's family members. The crowd member asked for food, but did not mention he will give something back in return. I introduced an incentive for the participant in the following way: if he agreed to give a voucher to a random crowd member, the crowd member tipped off the participant that he can find food rations in trash piles scattered around the city. If the participant gave a food ration, the crowd member handed him back a food voucher (again, note that this is not an exchange, as the participant does not expect to get anything back, as the crowd member does not tell him in advance "if you'll give me food, I'll give you something else back"). Table 4-20 in the Results chapter indicates that people were reluctant to help characters they did not know, and only about 10% of their requests for a voucher or food resulted in giving. The vouchers given were all given after the sector post closed and they lost their value, which suggests that a participant would not go out of his way to do a favor to a person he does not know, and would only do so as long as this did not harm his interests. This is supported by Kaniasty (1995) who claims that in a worst case scenario, altruism after disaster events might be scarce. Another notable occurrence was that female participants were more compassionate than male participants in that respect and were more willing to share their resources when asked to do so by other characters. It is interesting to note that Wang (2008) in his research on online gaming communities in Taiwan claims that male users will more likely help female users, whereas female users will help other male or female users equally. However he notes that studies previous to his *"indicate that female participants because of socialization and life experience are more likely than males to help others"*

4.3.6.5 Cooperation with other participants

Cooperation: cooperation between participants in order to achieve a common goal was a phenomenon hardly seen in the simulation sessions. This was also admitted by participants themselves as seen in Table 3-19, where a majority of 75% said they did not collaborate with other players. Only in one case (on the 25 March 2009 session), I observed a situation in which three participants who were friends before the session and arrived as a group, chased away and later killed another participant. It should be noted that they did not use in-game communication amongst themselves (via Chat Window), but communicated verbally and consulted each other when performing various in-game moves.

The above observation suggests that cooperation is done when participants are familiar with each other (i.e. if they are a part of an in-game guild/party/tribe/community) and when they have a common strong enough goal that can cause them to unite (like a threat to their characters' life in the game). This assumption is backed by observations of Massive Multi-user Online Role Playing Game communities by Yee (2006b) in which participants are part of a guild and have to act as a group, and also supports the hypothesis that participants will treat these short simulation sessions as stand-alone computer games, as the game was not an existing community and people did not know each other sufficiently well to behave as part of a community.

Another aspect that can explain the lack of cooperation is the difficulty of communication, as use of a Chat Window may have been a time consuming or somewhat complicated task for people that are not seasoned users of computer games. It should be noted that Anderson (2001), in a review that analyzed 54 research papers dealing with video game violence, claims that pro-social behaviour is negatively linked with exposure to computer game violence, and violence levels in this simulation might echo his findings.

4.3.6.6 Aggression

Aggression can be manifest in various forms: armed and unarmed conflicts amongst participants themselves and with Non Player Characters (NPCs - crowd and family members), burglary of other players' homes as well as attempts to obtain illegal weapons. All of these traits were abundant in all simulation sessions, as shown in figures 3-1, 3-2, 3-3 and Tables 3-21, 3-22. As discussed in chapter 2: Methodology, following preliminary user studies barriers were put in order to decrease the possibility of typical computer gamers' behaviour and tendency to perform violent acts by participants.

Nevertheless, real life events indicate that following a disaster, violence, and negative human behaviour increase, especially in places where needy people are not acquainted with each other like large cities (Bagchi, 2009, Bind, 2009) and as presented in the media after Hurricane Katrina (29 August 2005) and the recent Haiti earthquake (12 January 2010). It can be argued however, that in places where a community of people that have strong relationships with each other (a small village, a part of a neighborhood etc.) people will not be aggressive towards other community members (Golan, 2009). This experiment's computer game in that relation, although used by small number of subjects in each session, can be treated as a place where people had no relations with each other, as most of them did not know their fellow participants at all, and were not part of the same online gaming community.

It can be seen from Figure 3-1 that burglary (the equivalent of shop and house looting in real life situations) took place almost twice as much as attack actions, presumably due to its ease, availability and low risk. This type of action can correspond with real life shop and house looting performed after disasters when a state of anarchy is allegedly present (Barsky et al., 2006). It should be noted that in-game corpse looting was not considered an illegal or violent act and people were not punished for doing it. It was not charted on the figures or tables, main reason being that a random and rare thing, contrary to burglary and attack events that were accessible to participants more frequent.

Computer games are often linked with aggressive and violent behaviour patterns (Anderson and Bushman, 2001). Therefore, in-game aggression was expected in the experiment's simulation, because violent acts were easily performed by participants (no real physical contact was involved, all virtual characters had similar physical characteristics so that participants could try and confront other participants, and no real-life consequences were involved). The in-game aggression patterns support these assumptions; however they also show some other trends, for example that attack events performed on authority representatives and service providers were low compared to those performed on characters that were part of the general population (crowd and family members). This is explained by lesson-learning from the preliminary simulation sessions, where service givers and authoritive characters which were Non Player Characters

(NPCs) were targeted by players. Although it should be noted that the preliminary studies' subject behaviours resemble real-life situations where an affected population turns its anger towards authorities out of frustration (Bagchi, 2009). As NPCs cannot demonstrate free thinking or acting and defend themselves (contrary to real life situations), and in order to prevent the simulation sessions from turning into a bashing tournament, these characters were given invincibility as well ability to automatically teleport participants into jail whenever they were attacked.

A notable trend that repeated in all violent events was their increase after the sector post ran out of food (referred to as t2 in all simulation sessions). This conforms with real life situations where a link between resource shortages and war is described (Ember and Ember, 1992).

Interesting to note is that participants sought to arm themselves, and the demand for purchasing of weapons was larger than that for food in the first part on the game (t1) instead of stocking up on food (Table 3-21). The second half of the game saw a decline in that trend, as people had to invest their financial resources in acquisition of food, but still more than a third of the player's requests from merchants were for illegal weapons.

In my opinion the demand for weapons illustrates their significance in the players' priorities scale, as they represented an advantage over other participants and some sense of security. Although in-game weapon possession was just a matter of their availability and purchase, and in real life a longer time span is needed to perform a similar purchase, this trend can be compared with a real life situation described by Cook (1997) that surveyed gun ownership patterns in the U.S.A. in which 46% of people surveyed possessed a firearm for protection against crime. Players that obtained weapons in the game turned out to be much more violent than players that did not possess weapons (Figure 3-2). This conforms with the positive correlation between illegal gun availability and violent crime rate as mentioned by Stolzenberg (2000).

4.3.6.7 Summary

Behaviour patterns demonstrated in the computer game sessions were somewhat skewed and resembled real-life behaviour patterns only loosely. The skewed behaviour can be attributed to the following reasons:

1) the computer game enabled participants to accentuate some behaviour types compared to the same behaviour patterns in real life, without having to bear the real life consequences;

2) the participants' virtual characters were not a precise representation of themselves, but rather an iconic representation that did not enable the full range of human behaviour to be manifest;

3) the participants treated the game as a stand-alone computer gamer, therefore much less socialization and much more "survival mode" behaviour was demonstrated, thus omitting non-useful (for them) behaviour types;

4) differences in time scales between the simulation and a real life situation, that prevented the demonstration of a full spectrum of human behaviour.

I would argue that if this data is to be used for modeling or real-life prediction purposes, calibration sessions should take place in order to determine a scale that can quantify the skew factor.

It is unclear to what extent the majority of participants in this research's experiment (77 out of 80) that had not experienced a prolonged disaster or emergency in real life demonstrated realistic post disaster behaviour in the experiment. I argue that in this experiment's case, when asked to demonstrate a sort of behaviour unknown to them (like stress following a large magnitude earthquake), participants tried to imagine how they should behave, or tried to recall the closest reference they knew (i.e. stories, movies, media reports etc.), and imitated that behaviour. This is supported by Eth (2002) who shows in his study that people exposed to media and television broadcasts that deal with violence and stress situations might develop PTSD symptoms without being exposed to the real event.

4.4 Summary

This chapter discussed main issues related to the creation, deployment and interpretation of emergency simulation multi-user computer games. This last part of the chapter to summarizes the issues examined and then answers the main questions that initiated this research. Note that the questions that relate to the technical and user-related constraints and the types of data that can be extracted have been elaborated already throughout this chapter.

The following table sums up the areas described in this chapter and lists the key findings relating each one.

Table 4-2 summary of key findings of the research

Factor	Key findings
Simulation creation stage	
Pre-planning of simulation	This is the stage where goals, aims and processes that compose the simulation are defined. The result of this stage is a specifications document that serves as a guide according to which planners and developers work. The clearer the specifications are defined, the easier the following stages will be.
Competent development team	Technically, the most crucial link. Its importance starts with the proper input at the planning stage and contribution to a well defined specifications document, and continues with the ability to actually create the simulation.
Marketing	The most important part that relates to potential user recruitment. Without successful marketing there will be inadequate participants and thus inadequate simulation activity. This stage should be initiated once a stable version of the simulation exists in order to preserve its momentum.
Technical issues	
Time scale of simulation	The differences due to the scaling-down in the simulation timeline mean that the full behavioural spectrum typical of an emergency scenario might not be demonstrated by participants. This can be partially overcome by using in-game messages that make participants aware of certain behaviours, however it should be noted that this might influence participants to behave in a certain way, and therefore if in-game messaging is used, it should be done in a balanced form.
Abstraction level	A simulation planner should include the items he thinks are necessary for the existence of the virtual world, and to the behaviours he wishes to observe. Unexpected behaviour or use of objects might bias the data from the simulation.
Advantages over traditional questionnaires	A simulation is a dynamic environment, where an elaborate, repetitive, continuous and ever changing "questionnaire" is presented to the player. The subject is immersed in a game and does not feel "questioned", and a time stress factor means that the subject does not have time to think about his impression and most times acts impulsively and operates fewer self-censorship mechanisms. The questions are presented non-verbally through situations a subject has to react to, so he might feel less intimidated.
Behaviour logging spectrum	Logging includes general trends, group specific trends, and individual trends. All of these when cross referenced add credibility to the data collected.
Spatial data representation	Spatial data supplies: 1) a quick impression of data collected as it is a visual representation of data; 2) ability to use it as a quick feedback for changes to the simulation; 3) ability to extract data bi-directionally: either type of event over the whole virtual space, or events that happen in a specific area.
Usability issues	
Learning to play: provision of a tutorial	An online interactive tutorial is sufficient. It should enable the participants to train in a time-stress free zone, where participants can repeat the lessons until they feel competent to play, and where other participants do not harass their avatar.
Look and feel impact	The look and feel will not impact players' performance if: 1) they are immersed; 2) the environment and the topics presented are coherent.
Use of controls: interface complexity	Participants will successfully operate the interface items if: 1) the game pace is slow; 2) they are familiar with menu items. Otherwise they will ignore complex-to-execute procedures, or items and menus that are not in their focus.
Understanding: plot and similarity to real life.	Lack of a clear plot or a too abstract a plot annoys participants and affects their immersion in the game, and therefore their performance. Similarly, differences between the scenario depicted and real-life situations can have the same effect.
User-related issues	
Target audience	Target audience should have similar characteristics (past real-life experience, communal relationship, etc) to the one the simulation wishes to depict in order to provide reliable data. Therefore, gamers or random people will not always be a suitable crowd.
Recruitment and participation, and using an online	The best recruitment is done within an existing online community, by a respected community member. Community type will determine the types of interactions (LAN games will be similar to stand-alone games, whereas MMORPGs will better emphasize

community	social interactions). Recruitment should be targeted at the proper target audience. A planner should aim to use an existing online community and not to create one from scratch, as this might take a considerable amount of time if achievable at all (as participants might be reluctant). Participation will depend on the marketing efforts invested, on the intrinsic motivation of participant, and on the venue and time the simulation takes place. The later seemed to be significant in this experiment's case.
Reimbursement	The major extrinsic motivator. The lower the intrinsic motivation demonstrated by participants, the higher the extrinsic motivation should be. This is true for simulations with an abstract or boring content. However, even if money is used, that does not guarantee reliable data, but only higher participation rate.
Immersion	The single most important parameter that ties together the motivation to play, and data reliability. The more the player is immersed in the game, the better he will perform. Immersion is influenced by the surroundings and the mood the player is in, as well as the content presented to him (look and feel, and plot).
Attachment to one's Avatar	For a seasoned online-gamer the attachment to his avatar is a crucial part of his immersion, the more he bonds to his avatar the more he will try to keep it safe from harm.
In-game behaviour	In-game behaviour might be skewed compared to real-life situations due to: 1) ability to accentuate some behaviours without having to bear the consequences; 2) differences in time scales between simulation and real-life; 3) inability to express one's desired behavioural spectrum; 4) treating the game as a stand-alone computer game, where one does not relate to the gamers community but acts as an individual; 5) lack of similar real-life experience. Solutions might include: preliminary sessions to determine if a skew factor exists, in-game monitoring mechanisms of participants.

5 Conclusions and further research

5.1 Answers to research questions

5.1.1 Why are emergency simulation multi-user computer games scarce?

There can be three types of reasons for the relative paucity of games used for emergency simulations:

1) **conceptual reasons**: either affected individuals' responses are not sought (especially if the simulation is targeted at a managerial decision-making level that does not deal with individuals), or computer-generated characters are a sufficient representation (in particular when it is used as a training tool, where an AI's limited repertoire of behaviour is adequate for the training individual);

2) **technical reasons**: this platform is not always easily created, as it demands technical abilities that sometimes are not available (a commercial game that can be used as a basis for the simulation, ways to extract data from the game, proper programming skills, etc). The creation process might be lengthy, very expensive and exceed an organization's dedicated budget. The need to host games on dedicated servers if using a commercial company, and to constantly monitor them when running;

3) **user-related reasons**: masses of human crowds are very hard to recruit, especially if the simulation is not as attractive as a commercial game, and if the planners have to create an online community from scratch. Users have to be intrinsically or extrinsically motivated to play, and have to be monitored while doing so.

4) **relevance of affected crowds to simulation goals**. Whereas reports of real-life situations might describe a post-disaster environment where streets are full of crowds, commercial applications both on managerial level and on the field workers level tend to ignore the population as an influencing factor and keep their virtual environment sterile (i.e. there are no riots, road blockages, stuck cars, crowds in the streets or other obstacles typical of a real-life situation). This might be for two reasons:

1) **irrelevance for simulation goals**. Simulation users want to focus on the issues they want to deal with (i.e. training of control and managing an event on a global level) and not be bothered with issues less relevant to their professional activity;

2) **time frame of a simulation session**. Typical behaviour factors of post-disaster population can be deducted from the literature and case studies ("angry mob" behaviour for instance). However, if these behaviour factors are included the end result might be that the in-game tasks will never be accomplished due to the populations' behaviour. Although this might be a true representation (as law enforcement and responding agencies are outnumbered by the general population), decision makers will prefer to deal with that type of incident when a real event happens, and use the simulation sessions' time frame for professional training.

5.1.2 Do computer games have an advantage over models?

Games have significant advantages over models as this experiment demonstrated:

1) **data triangulation**. Games have the ability to simultaneously generate, collect and verify (by triangulation) experimental data created by humans (a model can create the data, but cannot triangulate it via surveys or interviews conducted with the AI's). This data can be later used for purposes of mathematical model construction;

2) **extensive range of data created**. Logged actions, questionnaire answers, self tagging of events by participants, logging of all in-game communication, comparison to real-life case studies, and spatial data (player's virtual coordinates which enables data filtering according to location) that is associated with specific actions are all extracted from a computer game and cannot totally be created by multi-agent models. For example, and as the generated data can be cross referenced and triangulated, they might have better reliability compared with that from multi-agent models as well as supplying a holistic picture of a simulation session (i.e. participants that tag their own interactions can supply explanations of recorded actions and interactions – an action that cannot happen when using a model. Similarly, a triangulation between questionnaire answers to actions taken in the game cannot be obtained).

3) **games are open ended**. Participants have a wide range of actions they can take, and are not programmed in any way to perform actions according to governing rules or conditioning;

4) **spontaneous human behaviour**. The ability to serve as a platform for "Black Swans" appearance (Taleb, 2007), that enables individuals to change a whole scenario outcome. This ability however depends on the simulation's abstraction level, and I argue that the more detailed the environment (and lower the abstraction level), the more the chance for a "Black Swan" to appear (i.e. if the scenario includes everyday objects such as knives to be found in drawers in every house, someone may make use of them, whereas if the scenario does not mimic reality to such a precision the ability to develop "Black Swans" due to this branch of objects is eliminated);

5) **Guidance**. Games have the ability to give the participants relatively abstract instructions and expect them to fill in the gaps alone and behave as humans might do in a similar scenario. A model, in comparison, has either instructions/ conditions programmed into it, or relies on the models' autonomous agents to perform in a random and unexplainable way (for example: an instruction like "do your best to survive, however you also have to take care of your family member", or "beware of your neighbor" might be very hard to embed into a model).

6) **interactive training/ educational tool**. Whereas a model can serve as a prediction tool, a game can be used for observation, prediction, training and educational purposes.

5.1.3 Is data collected reliable and consistent?

Although disasters and emergencies on a large scale vary from each other, and clearly from a small scale simulated lab experiment, the data collected from the specific scenarios played in this research, showed similarity to very general real-life trends:

a) level of aggression increased following food scarcity (this included looting and attacks of participants by other participants). This trend resembles real life situations, as mentioned in the discussion chapter.

b) people in the game sought to arm themselves in order to feel more secure in a chaotic situation, a fact that is supported by the reasons for real-life firearms ownership, as mentioned in the discussion chapter.

c) initially people did not stock on food, but rather relied on free food given by the sector post, and when food shortage was applied, they started to look for food from other sources. This echoes real-life situations where the population does not stock on emergency supplies, but rather relies on Civil Defence forces to supply them with aid needed.

d) participants in-game behaviour resembled real-life situations where a family member is preferred over a stranger (all participants cared for their virtual family member, but very few were willing to give food to a random crowd member).

d) although different in the infection characteristics, the in-game pandemic infection patterns resembled real life situation where crowded places where the most likely locations for virus transfer from one person to another. The in-game pandemic also advanced in waves, as described in real-life situations.

Data reliability will depend on six major factors:

1) **scenario aims and settings**. The more the simulation can depict these accurately, the better the chance to produce reliable data as users will be more focused;

2) **time scale depicted in the simulation**. The similar the time scales of the real life scenario and in-game scenario are the better are the chances that the participants will have the time span to demonstrate similar behaviour. As human behaviour changes over time, particularly after disasters, where the initial shock of survivors clears and they have to change their behaviour into "survival mode", and only later on they might demonstrate Post Traumatic Stress Disorders (PTSD), whereas a simulation session with a much shorter time span, will probably not demonstrate the later behaviour types;

3) **in-game behaviour vs. real life behaviour**. The more the conditions participants of the simulation are exposed to (or experienced by them in the prior to playing a simulation session) are similar to those observed in a real-life emergency situation, the better chance the behaviour patterns will be similar (i.e. in order to demonstrate a behaviour of a starved person, a simulation participant may have to be deprived of food for a similar period as the scenario wishes to depict). However, in most cases this cannot be achieved due to time constraints or human ethics restrictions a simulation creator will self impose;

4) **coherence of data.** Data quality is governed by participants' in-game self-regulation, where participants act in coherence with the virtual world rules they are part of (which is demonstrated by long term MMORPG players);

5) **reliability of data supplied**. The difference between multi-agent models and computer games is a player's awareness that the basic "building block" (i.e. the individual) possesses and governs his actions. Consequently, the main advantage that games have over models is the ability to observe the behaviour of human beings that are guided by their own personalities and thus deduce things about general human behaviour patterns.

The concept of "the truth, the whole truth, and nothing but the truth" does not exist in games, and humans will use this same awareness to avoid reporting their intentions, especially if the topics dealt with are objectionable, as might be expected in more traditional methods like surveys. However, games still have a significant advantage as they distract the user, and once he is immersed in the game he might operate less self-censorship and reveal his true nature as demonstrated by gamers in this experiment. In addition, methods like surveys are static, whereas a game is a dynamic and ever changing environment. And, traditional methods not always enable data triangulation by various methods as games do, but only via the same method (i.e. multiple questions about the same topic).

5.2 Conclusions

1. It is feasible to use multi-user computer games, that use human participants as crowds, as emergency simulation situations platforms.

There are however conditions that should be observed in order to produce reliable data, and these are listed under section 5.3 Operative Recommendations below.

2. The simulation developed and run in this research generated data that were (i) self-consistent and (ii) comparable with corresponding data from real-life situations.

The data regarding human aggression (looting, attacking, possession of firearms) following food scarcity, pre-planning for emergencies (or the lack of it), preference of family members over strangers, and of pandemic spread patterns showed consistency with general trends demonstrated in real-life cases.

3. These games can replace multi-agent models where human input is sought after, and for specific purposes.

Games have some major advantages over models, mainly in the variety of data types they can produce, its extensive range, the fact they are open ended and enable spontaneous human behaviour with minimal intervention and guidance from its planners, as well as their ability to serve as an emergency preparedness training and education platform.

4. Information types extracted from this simulation type are richer and larger in number than these that are offered by traditional methods.

Unlike traditional methods, this game type can collect both qualitative and quantitative data that can be easily triangulated. A computer game enables its participants the ability to immerse, and therefore apply less self-censorship, so more of his true nature can be exposed compared to questionnaires for example. This issue is highly important, as in real life policy makers often base their estimates of what will take place on supposition or data (e.g., from surveys) of what people believe they will do.

Therefore, the demonstration of inconsistencies within the game between people's actions and their accounts of what they did really highlights the value of this study.

5.3 Operative recommendations

This short section sums up the practical steps learned from this research and that should be emphasized, as they can be helpful to people planning to use that type of games. The first three recommendations are the most important ones and significantly influence the outcome of multi-user computer game based emergency simulations:

1. Recruitment and reimbursement of potential participants. This issue was already discussed, however without participants, there is no simulation. One should have an idea from where the participants are recruited, and how they will be properly reimbursed for their time.

2. Determine the participants' "Attention span". This is the actual time they will be willing to dedicate to play the simulation. Never mind how important or expensive the simulation is in the planners' eyes, it should adhere to the time frame suggested by the preliminary studies as the proper "attention span". As demonstrated in the preliminary studies, people lose their patience and either leave the lab, try to "kill" their virtual character, or just abuse the game if they are out of their attention span. It is also important to determine at what time of the day/ night the simulation is run, and if it fits the participants attention span.

3. Preliminary studies/ "calibration" sessions. As already mentioned, these are highly important to run, as they reveal a significant amount of information about the ideal "attention span", game abuse and data skewing, range of human behaviour, and the desired composition of target audience.

4. Game abuse prevention. In-game mechanisms (rules and automatic scripts) that can monitor and filter out participant's unrelated behaviour/ game abuse by participants. This is important, as the abusive behaviour affects other participants, and skews the data.

5. Data logging and triangulation mechanisms. Creation of proper in-game data logging mechanisms in order to enable data triangulation and verification. When these mechanisms are properly set, an almost immediate result for a particular session can be seen, and problematic issues can be resolved on-the-fly.

6. Target audience demographic profile. When recruiting participants, they should fit a similar demographic profile to the participants of the real life event simulated. This should be done if one seeks similar reactions.

7. Target audience background. If participants are inexperienced in such events, a simulation planner has to embed proper instructions into the game in various forms (i.e. creation of a particular look & feel, textual messages, and sounds) in order to affect a participant's mood and hope that this would have a similar effect as a real life situation.

8. Difference in time scales between a simulation session to a real life case study. These need to be taken into account as some behaviour patterns or complex emotional situations might not be demonstrated due to the difference in time scales, as participants cognitive and behavioural processes cannot be scaled down to such an extent.

9. Attraction level of game to potential participants. Creation of a virtual world that is coherent and attractive to potential participants, so that when they play they are immersed and treat the simulation respectfully and not just as another form of entertainment. This behaviour will add to the probability that meaningful data is generated by participants;

10. Cognitive and emotional "detail level" (level of abstraction of the simulation). Creation of a proper in-game environment that will enable the participants to express desired behaviour.

5.4 Areas of possible deployment of emergency simulation multi-user computer games

This experiment demonstrated the potential MMORPGs have. Following are areas in which these games can be successfully deployed:

1) **for training purposes**. Where individual human interactive response is important on its own. The food shortage scenario could serve as an example that can be used to train sector post volunteers in interaction with a mass of individuals that suddenly arrive and demand food (amount of volunteers, their duties, location within the sector post, amounts of security persons needed, amounts of food needed, etc).

2) **as input data for a model**. A model can be generated after data is extracted from a specific scenario. The pandemic scenario played in this experiment could be used in order to extract the commuting patterns of humans (coordinates, time of the day, frequency, reasons for commuting, destination, and density of population) and their influence upon infection patterns of a pandemic.

3) **for relatively quick operational strategy evaluation**. In various areas where strategies need to be tested before a final version can be approved. A scenario can be set with specific parameters, observed, studied by policy makers, and changed in order to assess the influence of the changes be it one or more parameters and their mutual influence. The food shortage scenario was replayed once with the addition of a virtual police officer in order to see if violence level in a particular street dropped. Similarly this could be done in future scenarios in order to assess amounts of food and law enforcement personnel needed in order to keep population from rioting, or to check where the threshold lies.

4) **for educational purposes**, where large groups of people (that belong to the same organization, community, etc) can experience a possible emergency scenario, act in a way they consider appropriate and see how they fare. Later they can analyze their actions and replay the simulation in another way. This has the potential be a powerful demonstration, as the participant himself decides what to do, as happens in real life, so lessons learned might be long-lasting. This was demonstrated in this experiment, as one of the in-game questions presented to participants dealt with that issue, and people answered that they will think about emergencies and even store food.

Deployment in these areas, would without any doubt improve the disaster response and planning capabilities of participating agencies, and awareness of the general public.

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Appendices

1 Appendix 1: background.

1.1 Response and preparedness in disaster- modules table

Table A1-1 Example of emergency management training modules offered in New Zealand

Unit	Level	Credit	Module
7334	2	2	Introduction to CDEM
10425	2	2	Health & Safety
528	3	3	Personal Readiness
12355	2	2	Stress Management
7321	3	4	Process CDEM Information
3490	1	3	Incident Reporting
7336	2	2	Emergency Welfare
11282	2	1	Operate a Two-Way Radio
20388	3	2	Aircraft Safety
7317	2	2	CDEM Rescue Knowledge
22298	3	2	Flood Safety
22297	3	4	Flood Response
7128	2	1	Training Agreements
1304	2	2	Cultural Communication
23696	3	3	EOC Support
23695	3	3	Domestic Animal Welfare
20854	3	3	Operate a CDEM Comms System
20853	3	3	Establish and Maintain a CDEM Comms System
23692	2	2	Knowledge of CDEM Response Driving Legislation
23693	3	3	Navigate in Urban and Rural Areas
18426	3	4	Confined Space Awareness
7319	4	3	Mass Casualty Triage
6127	3	5	Medical Ethics & Rights
7332	2	4	Movement Control
17600	3	3	Height Safety
23694	3	4	Storm Response
-	4	3	Liaise with the Media
7335	2	2	Controller Powers
7326	5	3	Declare a State of Local Emergency

7330	4	5	Supervise a CDEM Welfare Centre
23691	4	6	Drive Emergency Vehicles in Operational Situations
16808	5	7	Rescue Tactics
-	4	6	Supervise Response
23698	4	8	Leadership
23690	4	3	Conduct Operational Briefings / Debriefings
9678	4	3	Conduct Formal Meetings
7327	4	5	Emergency Community Coordination
23703	2	2	Administer a CDEM Volunteer Section
23701	5	6	Recruit, Appoint & Support Volunteers
-	3	3	Knowledge of Volunteer Framework in NZ
23702	4	5	Manage Spontaneous Volunteers in an Emergency
23697	4	6	Exercise Management

(Taken from: http://www.emergencymanagement.co.nz/training/in-house-training/121-response-and-preparedness-in-disasters-rapid.html?layout=training)

1.2 Modeling methods and computer games

Table A1-2 Uses and description of simulation methods after Gilbert and Troitsch (1999)

Method	Uses and description
System dynamics/ World models	Prediction of a total system state The target system is described as a single entity. Although being discrete, these model aims to approximate continuous time.
Microanalytical Simulation Models (MSM)	Prediction of effects of aggregate measures upon individuals The target system is separated into an aggregate layer and a layer that represents individual human beings. Each individual has attributes and transition probabilities that are affected differently by the measures imposed by the aggregate layer. The model is a discrete one.
Queuing models (discrete event models)	Redesign of workflow or management and administration of business processes The target system is represented by “service givers”, “queues” and “customers”. This model type is event* driven (i.e. rather than a continuous timeline, an event triggers the simulation to proceed). The events can change some of the system variables, or call other events in turn. System complexity is determined by events level of interaction. Queuing models are stochastic. *event is an immediate occurrence in time that changes the state of the system.
Multilevel simulation models	Simulation of interactions inside populations The target system is represented by an aggregate layer and a layer that represents individual human beings. The aggregate layer determines and influences the individuals’ attributes. However, the aggregate parameters are influenced by the individuals, and therefore, after each simulation cycle new aggregate parameters are set and in turn assign new values to the individuals layer for the next cycle.

Cellular Automata	Prediction of outcomes at the aggregate level as a result of a large number of simple events on the individual level. The target system is represented as a uniform grid on which cells are located, each representing an individual. A cells' state is influenced by a universal set of rules as well as by its neighboring cells state. This method takes into consideration spatial location of individuals. A change in spatial location of an individual affects its state. The model is discrete and event driven.
Multi-agent models	Used for creation of programs which interact 'intelligently' with their environment The target system is represented by an environment, a universal set of rules, and networks of interacting agents that represent individuals. The agents are influenced by the rules; however they have a learning ability. With each cycle run of the simulation they adapt themselves to optimize their behaviour according to rules.
Learning and evolutionary models (AI and neural networks)	Used as a "black box" optimization technique for complex problems, and for modeling rational actions. This system is represented as a multi agent system. The difference is in the way the learning process is achieved. There are two methods to do so: Neural Networks work similarly to neurons in the human brain, where learning is achieved through forming neural "paths" which occur after training is performed. Genetic algorithms (GAs) use a process similar to the evolution of natural selection (i.e. only the "fittest" agents survive from run to run of the simulation). As the simulation runs parameters change, or even the form of the model itself changes (by learning and optimization), in response to its environment. It should be noted that neural networks have the ability to recognize input which is not identical to any of the training examples, but only similar.

Table A1-3 Disadvantages of simulation methods after Gilbert and Troitsch (1999)

Method	disadvantages
System dynamics/ World models	Describes systems on their macro level, does not describe individuals.
Microanalytical Simulation Models (MSM)	All probabilities applied in the model have to be calculated from empirical data. Validity of collected data.
Queuing models (discrete event models)	In complex models, there will be lots of event routines (which describe what is to happen at this event) and lots of interactions between event routines (that is, one event will schedule another). These might cause internal conflicts that cannot be solved by the program.
Multilevel simulation models	Allows only for an indirect interaction between individuals. Each individual evaluates the environment as a whole and reacts to it, changing the environment by his or her behaviour.
Cellular Automata	Rule setting for agents No direct interaction between agents
Multi-agent models	How to get agents to define their own subgoals relevant to the situation at hand. Difficulties in deciding how to manage several goals which may be of differing importance and relevance and which may possibly conflict. Most human action is driven by routine reaction to the particularities of a situation rather than by elaborately calculated plans. No Accurate representation of emotions and their role in the social simulation.
Learning and evolutionary models (AI and neural networks)	As above, and more over - the solution finding process is a "black box" and not always can it be analyzed.

Table A1-4 Simulation methods and their validity after Gilbert and Troitsch (1999)

Method	Data sources and reliability
System dynamics/ World models	Since data is on the macro level (a whole population), accumulated data is not made up from data obtained from individuals but rather from total trends. Data is obtained by statistical analysis of trends and from objective sources (i.e. electricity consumption over a period of time). The data is realistic and therefore can be relied upon, however since trends change over time – it should be used close to data accumulation time.
Microanalytical Simulation Models (MSM)	This method also presents data on the macro level; however, in this case data is composed from data relating to individuals. Sources can be statistical yearbooks or surveys. And as trends change over time – before using that data type it should be validated to see whether it is still accurate (i.e. a sentence like "a male, 35 years old smokes 2.5 packets of cigarettes per day" may be accurate to the time a survey was carried out, but due to population awareness or cigarette price increase it is not valid anymore). So in this case it can be said that the closer to the time data was obtained, the more accurate it is.
Queuing models (discrete event models)	Data used in this method can be taken either from measurements or assumptions. If using assumptions the data is not accurate and the simulation results might not reflect actual outcomes. If the data originated in measurements – than sample size can indicate data accuracy. The more samples the more accurate the data.
Multilevel simulation models, Cellular Automata, Multi-agent models	In these simulation types the "individuals" (agents) are programmed, and the aggregate layer is calculated accordingly. Problematic aspects are the assumptions taken when programming the "individual" and parameter values used, the rules used to create the environment as well as interinfluence between parameters. The mechanism that emulates learning ability is also programmed and not necessarily all parameters have the flexibility to change according to circumstances.
Learning and evolutionary models (AI and neural networks)	This simulation type bares the same inaccuracies as above and moreover its learning and optimization techniques are a "black box" and therefore can not be examined.
MMORPGs	This simulation method uses real human individuals; its inaccuracy leys within the data supplied by them (actions and responses to situations presented before them). As with methods that depend on individuals input (like questionnaires), this method should use the same parameters in order to bypass this inaccuracy. Therefore, the more individuals are used; their data can be examined and compared to screen out anomalies.

Appendix 2: Methods

2.1 Modules Properties

Module is the end product of the game editor utility. It is constructed from a number of areas, each having is own terrain type, so for example a module can contain a city exterior in which PCs roam around, and then they can cross into another area that is a building interior. A participant notices that, as the computer has a loading time of about 30 sec. when he crosses between areas. This also poses programming challenges as continuity had to be kept (monitoring of player actions in various areas).

Areas are the virtual terrain the module uses. The minimum size is one square of $10m^2$ and the maximum size of an area is a grid of 32X32 squares ($0.1km^2$). The larger the area and its details – the longer its loading time will be.

Every area has global properties that can be used in order to create audio visual effects (weather effects, background music and sound effects), or run global scripts (i.e. monitoring events induced by participants).

An areas' look (or terrain) is determined by the Tileset used for its creation (a tile set is a collection of objects that are placed on a virtual grid that is the area). About 7 generic tile sets are available, however for scenario purposes only three types were used: urban exterior (includes streets and generic buildings), urban interior (includes interior of all confined spaces), and rural exterior (used for the final questionnaire area). The following table lists all modules created, and their properties.

Table A2-1 Areas in the module and their properties

Area	Terrain type	Size (in grid Squares*)	Description
Tutorial	Urban	192	The area with which all scenarios start. An urban town center where participants are introduced with the game controls use concepts and the game's background. From this area they are teleported (one way only) into the city area.
City	Urban	1024	Player starts his game in front of his family house doorstep. This area is a dense urban town center, which includes a market square, hospital, sector post, police station and buildings. The area includes 64 doors distributed around the city and serve as a Waypoint to teleport into participants' family houses.
Home	Interior	4 (each house)	An area that stores 64 identical one room apartments each can be accessed from the city through a door. The house contains a virtual family member and a personal pantry chest. Participants can freely transfer between the city and home areas.
Hospital	Interior	20	Accessed from within the city. It offers the ability to be healed due to fights damage, or to buy an aid kit. This is a No PVP area
Sector post	Interior	20	Accessed from within the city. Here a participant can trade food vouchers for food rations.
Jail	Interior	20	Jail is only accessible through teleportation (in and out). A participant has a "correction" dialog with the jailer, is penalized and returned to the city (outside the Police station).
Heaven	Rural	96	This area is accessible by one directional teleportation only from within the game. This area's look & feel are like a tropical resort. It has a receptionist and customer care representatives that interview the participant and ask the final questionnaire. This is a no PVP area.

(* Each square measures 10^2m)

2.2 NPCs Properties and roles

NPCs are the Non Player Characters used in the game. In every scenario, apart for real life participants the module is occupied with NPCs that have a variety of roles and that advance the plot. When they were created, a few of their built-in properties had to be determined:

Class: in the original game each NPC can belong to a specific class, this fact lets the NPC master traits typical to that class (like spell casting for clerics). The scenarios needed all of these associations removed, and the easiest guild to do it for was the Fighter class – therefore all NPCs (and PCs as well) belong to that class.

Appearance: if they have a formal role (law enforcement, merchants, etc.) they had to be dressed properly so they are distinguishable.

Strength: all the service givers had to be stronger than PC characters, as they are part of the plot and are targeted by participants that try to "test" their abilities when bored with playing (as noticed in user studies).

Dialogs: every NPC type has a different dialog that had to be assigned to it.

Scripts: every NPC has default scripts that govern its behaviour. Some had to be changed (i.e. random movement patterns, or response to attacks, recognition of family members) so they fit the scenarios.

- Faction: in the original game every NPC can belong to a specific faction that can be friendly, neutral or hostile towards other factions. The default attitude can be changed by using the Faction Editor. However, factions are a dynamic property and can change while gaming by interaction between different factions members (i.e. faction A member attacks faction B member. From that incident onwards, the status between these factions changes from friendly/ neutral into hostile, and even other characters that belong to factions A and B will be hostile to each other). This trait is useful in action games, however not in the experiment scenarios were it led to undesired results (i.e. a crowd member can attack a PC just because another of his faction members attacked a crowd member in another part of the city). Therefore each of the characters has is own faction that is by default neutral towards all other factions, and is shared only with his NPC family members.

- It should be noted that whereas PC characters can roam between areas, NPCs are confined to the area they were first assigned to.

The following table lists all NPCs and their roles in the scenarios.

Table A2-2 NPCs and their roles

Area	character	Role
Tutorial	Tutor (male/ female)	Introduction and questioning of participant, guidance to player in the beginning of simulation, debriefing about background story, rules and regulations. Impossible to kill (trait modified after participants tried to do so). Is immune to virus (virus is not present in the tutorial area)
City	Crowd member (male/ female. Old, adult or children)	These populate the city and roam around. They can be either nice or nasty to participants (appropriate dialog branches appear randomly) in order to check if participant tags these encounters. If given food they will in turn give the participant a voucher (in order to associate a reward for altruism). Can infect any other PC/ NPC with a virus. Can be infected by virus. Can be attacked by participants. Will defend itself from PCs attacks. If killed, leaves a lootable corpse (with random content, so participant does not get an initiative to thrive only on attacks).
	Merchant (male/	Operate shops where players can "purchase" needed items. Will open a

	female)	dialog window that offers the participants to buy or sell items. Can infect any other PC/ NPC with a virus. Can be infected by virus. Can be attacked by participants. Will defend itself from PCs attacks. If killed the “shops” content disappears from the game (in order to discourage participants to attack merchants as primary targets).
	Police officer	These patrol the city. They have a script attached to their character that detects fights breaking and burglary events, in proximity to them. If an event is detected – the PC is teleported into jail. Attacking them leads the participant (after a warning) immediately into jail. Can transfer and get infected by virus.
	Health professional	Directs the PC into the hospital. Can be attacked by PCs. Can transfer and get infected by virus.
	SP officer (female)	Directs the PC into the Sector Post. Can be attacked by PCs. Can transfer and get infected by virus.
Home	Family member (male/ female. Old, adult or children)	Acts as a dependent that a player needs to support. If not given food in sufficient intervals – it will starve to death. Supplies the player with food vouchers (so if it dies, the voucher supply terminates for the particular PC). Houses unoccupied by PCs can be broken into, however there are no rations or vouchers in the house. This NPC has a few conditional dialog branches and can address a burglar, tell the “owner” PC the house was broken, ask for food when really hungry. Can be attacked. If killed no loot remains (in order to discourage participants from killing these characters)
Hospital	Health professional (female)	These can heal a participant from damage caused by fights, or sell the participant an aid kit. Immune to virus. (cannot be attacked by participant as area is set to No PvP, as well as the presence of a guard will send the PC immediately into jail)
Sector post	SP officer (female)	These characters trade the PCs vouchers for food rations, as long as they have them in stock. They might feed a starving person with a food ration if in stock. They can be attacked. They don’t leave a lootable corpse. Can transfer and get infected by virus.
Jail	Jailer (male)	These give the PC the “correction” dialog and penalize them, then teleport them into the city. If attacked by player they will kill its character. Can transfer and get infected by virus.
Heaven	Receptionist (a cow)	Greets the PC and directs him to the customer care penguins. Cannot be attacked (as this is a No PvP area)
	Interviewer (a penguin)	Asks the PC the final questionnaire, and then dismisses him into another island in the area (so he does not disturb other players) Cannot be attacked (as this is a No PvP area)

2.3 PCs Properties and Roles

In the original game, a PC starts with the lowest rank in its class. Only as he gains experience (i.e. wins fights) he can promote to a higher level. With every rank he can use more elaborate items. In order to have enough strength, and be able to withstand starvation and a few random fights all characters were created as Level 5 Fighters. PCs were created in the beginning by a "dressing room" module in which they were dressed and equipped (see Tagging), and then they attack a few times an NPC until they gain the 5th level experience. The character was then copied and renamed. Later on a program called Letto 1.69 (custom creation of PCs) was used. Characters were randomly named.

The following table lists the various roles PCs could play in each simulation. Note that participants only played as crowd members, and other roles were optional.

Table A2-3 PCs and their roles

character	Role
Crowd member	The participant can play a person in the city that experiences the shortage of food, or the outbreak of a deadly disease. That is the major use of this simulation module.
Law enforcement officer	PCs can exercise control and law enforcement strategies in the city.
SP officer	PCs (mainly civil defence) can exercise small scale commodities supply and dispatch in the city.
Health professional	PCs (mainly health professionals) can exercise small scale pandemic control tactics.

2.4 Questionnaire Questions List

Table A2-4 Questionnaire questions, answers and groups

Part	Question	Answers	Group	Question purpose
Initial				
	Is English your native language?	Yes. No.	DM	Does language proficiency affect gaming experience?
	Is this your first time playing in this simulation?	Yes. No.	DM	Does gaming strategy evolve the more people play the game?
	What gender are you?	Male. Female.	DM	Does gender affect gaming performance?
	How old are you?	18-23 24-29 30-39 40-49 50-59 60-69 70+	DM	Does age affect gaming performance?
	What is your marital status?	Single. De-facto relationship. Married. Divorced. Widowed.	DM	Do people with families take better care of their virtual family member?
	Is at least one of your parents (biological or foster) still alive?	Yes. No.	DM	Do people with families take better care of their

				virtual family member?
	Do you have brothers or sisters (biological or adopted)?	Yes. No.	DM	Do people with families take better care of their virtual family member?
	Do you have children (biological or adopted)?	Yes. No.	DM	Do people with families take better care of their virtual family member?
	Which option best describes your ethnicity?	New Zealand Maori. Pacific. New Zealand European. Australian African. Asian. North American. Central/ South American European. Middle eastern. Other.	DM	Does ethnicity influence gaming strategy?
	From the following, which best describes your occupation?	I am a full time student. I am a part time student. Full-time employee in a managerial position. Full time employee. Part time employee. Self-Employed. Unemployed. Retired.	DM	Do people that have an occupation plan better or survive longer in game?
	Do you perform some kind of physical activity on a regular basis (i.e. running, biking, climbing, etc.)?	Yes. No.	BH	Does physical activity influence gaming strategy?
	Do you go tramping or hiking that last longer than a day?	Yes, regularly. Yes, occasionally. No, not really.	BH	Assess whether the participant knows how to survive in a sustainable manner for a prolonged period
	Do you grow a vegetable garden?	Yes. No.	BH	Can the participant nurture himself from available resources during resources shortage?
	Are you engaged in any community or charity activity?	Yes. No.	BH	Correlation to altruistic acts (i.e. aiding other characters).
	Have you ever experienced an emergency situation that lasted for more than three days?	Yes. No.	BH	Does past experience influence gaming strategy of participant?
	Do you play computer games?	Yes, regularly. Yes, occasionally. No, not really.	BH	Is gaming strategy better in gamers?
	Do you play ONLINE computer games?	Yes, regularly.	BH	Is gaming strategy better

		Yes, occasionally. No, not really.		in multi-user games gamers?
	How many hours a day do you spend playing computer games?	None. 1 or less. 1-3 3-5 5 or more.	BH	Is gaming strategy better in gamers?
	When playing computer games, which defines best your gaming style?	I don't play computer games. I am a leader and people follow me. I am part of a group. I am an individualist.	BH	Is gaming strategy better in gamers?
Final				
	Did you find the in-game TUTORIAL part helpful for the gaming session?	Yes. No.	UE	Essential elements in a simulation creation.
	Did you use the printed USERS MANUAL?	Yes. No.	ES	Essential elements in a simulation creation.
	Was the game interface (i.e all the controls and menus) easy to use?	Yes. Hard at the beginning, easier later on. No, I had a rough time until I got used to it. No, not at all.	UE	Essential elements in a simulation creation.
	Did the medieval look of the gaming environment and characters distract you?	Yes, very much. At the beginning. Then I got used to it. No, not at all.	UE	Essential elements in a simulation creation.
	In terms of time spent gaming, was this session:	Too long. Reasonable. Too short.	UE	What is the optimal time for a simulation session?
	What was you overall impression of this simulation?	Very interesting. Somewhat interesting. Neutral. Somewhat boring. Very boring.	UE	Essential elements in a simulation creation.
	How did you hear about this simulation?	From friends. From an email circulated through the department/ workplace. I was in the lab and decided to join the session. UC Diary. Ad posted in the lab/ lecture hall/ billboard. A presentation given by a person before one of the lectures. Organized activity.	ES	Success of various recruitment methods.
	Why did you decide to participate?	Because my friends	ES	Success of various

		did. Because I was curious to see what it is all about Because I like computer games As a favour to the research organizer. No special reason, it was spontaneous. As it was part of an organized activity.		recruitment methods.
	Would you be willing to play multiple simulation sessions if you got compensated for your time (i.e. get a voucher for shopping or a small amount of money)?	Yes. I might consider it. No. I would play it for fun, no need for reimbursement.	UE	Will a financial initiative attract participants?
	Does a simulation like that need a predefined plot (like a quest type game)?	No, the interactions with other players are enough to keep it going. Yes, as interactions seem to repeat themselves.	UE	Essential elements in a simulation creation.
	How would you best define your gaming strategy?	Sit and wait. Use opportunities when they arise. Initiate moves.	UE	Correlation between in-game actions to questionnaire answers.
	Given you could choose, how would you prefer to play this simulation?	In the lab on a set time. On my own machine (at home/ office) on a set time. On my own machine, at my own time.	PB	Participant gaming profile.
	Considering the game limitations and its look, are you able to say that the simulation depicts a similar real-life situation?	Yes, closely. Yes, loosely. No, not at all.	UE	Essential elements in a simulation creation.
	Did you collaborate with other participants?	Always. Frequently. Rarely. Never.	PB	Participant gaming profile.
	Did you relate to the character you played?	Yes, very much. Sort of No. Not really.	UE	Essential elements in a simulation creation.
PQ/ PD	Did law enforcement presence in your proximity influence your plans or actions (i.e. burglary, attack, etc.)?	Yes. No.	PB	Violence level correlation with law enforcement presence
	How did you find the amount of law enforcement officers in the game?	Sufficient in all areas. Sufficient in part of the areas. Insufficient.	PB	Violence level over time/ participant's gaming profile

	Did you break into other players houses in the game?	Yes. No.	PB	Violence level over time/ participant's gaming profile
	Did you loot other characters corpses?	Yes. No.	PB	Violence level over time/ participant's gaming profile
	Did you initiate attacks on other characters in the game?	Yes. No. Just as a response to attacks on my character.	PB	Violence level over time/ participant's gaming profile
	What was the PURPOSE of most of your interactions with other participants in the game?	Acquire goods or information. Socialize.	PB	participant's gaming profile
	How would you describe the NATURE of most of your interactions with other participants in the game?	Very pleasant and positive. Strictly practical. Negative, possibly intimidating.	PB	participant's gaming profile in correlation to his violence level
	Did you allow yourself to do things you would not attempt to do in reality?	Yes. No.	PB	participant's gaming profile in correlation to his violence level
	How would you behave in an IDENTICAL real life situation?	I'd behave just like I did in this simulation. I'd follow a loosely similar pattern of behaviour. I'd behave differently to how I did in this simulation.	PB	participant's gaming profile in correlation to his violence level
	Do you think you can survive in a similar situation in real-life for a period longer than three days?	Yes, no problem! Yes, but I would have to struggle. Maybe, I am not sure. No, it's impossible.	PB	Correlation between real life to simulation.
	In a similar real- life situation, do you think you would harm (i.e. injure or kill) another person in order to get his food?	Yes. In every situation. Yes. But only if I am stronger than my opponent. Yes. If I have no other choice. No. Just because it is too risky. No. Because it is immoral/ illegal to do so.		Correlation between real life to simulation.
	In the Pandemic scenario, did you infect people with the virus after you became aware you were infected?	This is not the Pandemic scenario. Yes. Deliberately. Yes. But not on purpose. No.		Correlation between real life to simulation.
	In real life, would you infect other people, if you were infected by a	Yes. No.		Correlation between real life to simulation.

	pandemic virus and were aware of it?			
	Was the simulation helpful for you in terms of raising awareness for preparedness for disasters or emergencies?	Yes. I will consider storing some food. Yes. I'll think about it. No. Civil defence can take care of everything. No. Nothing will happen.	PB	Correlation between real-life to simulation.

(Notes: DM= Demographic, BH= Background and Habits, UE= Usability and user Experience, ES= Experiment Setup, PB= Participant Behaviour).

2.5 Recorded Events List

Table A2-5 List of all events according to their groups

(Abbreviations: PQ- Post Earthquake, PD- Pandemic)

Scenario	Event
Global events	
PQ/ PD	Player joined module.
PQ/ PD	Accept consent.
PQ/ PD	Player started tutorial.
PQ/ PD	Player completes tutorial and starts game.
PQ/ PD	Player left module.
PC status events	
PQ/ PD	Session ID
PQ/ PD	User ID
PQ/ PD	Timeline (HB/ sec)
PQ/ PD	Area name
PQ/ PD	Location (X, Y)
PQ/ PD	Life status (points)
PQ/ PD	Health status (points)
PD	Infected by virus (Y, N)
PQ/ PD	Inventory- Gold pieces
PQ/ PD	Inventory- Food rations
PQ/ PD	Inventory- Food vouchers
PQ/ PD	Inventory- Aid kit
PQ/ PD	Inventory- Stick
Plot events - food	
PQ/ PD	PC Gained food
PQ/ PD	PC Lost food
PQ/ PD	PC took Food from chest
PQ/ PD	PC put Food into chest
PQ/ PD	PC gave Food to crowd member
PQ/ PD	PC bought Food from merchant
PQ/ PD	PC sold Food to merchant
PQ/ PD	PC looted Food from PC corpse
PQ/ PD	PC got Food from SP (free)
PQ/ PD	PC takes Food in trash
PQ/ PD	Food eaten by FM

PQ/ PD	PC Eats ration
PQ/ PD	Food created in Sector Post
PQ/ PD	Food created in trash pile
Plot events – voucher	
PQ/ PD	PC Gained voucher
PQ/ PD	PC Lost voucher
PQ/ PD	PC takes Voucher from chest
PQ/ PD	PC puts Voucher into chest
PQ/ PD	PC gets Voucher from crowd
PQ/ PD	PC gives Voucher to crowd
PQ/ PD	PC buys Voucher from merchant
PQ/ PD	PC sells Voucher to merchant
PQ/ PD	PC loots Voucher from PC corpse
PQ/ PD	PC gives Voucher to Sector Post
PQ/ PD	PC takes Voucher in trash
PQ/ PD	PC gets Voucher from Family Member
PQ/ PD	Voucher created in trash
Plot events – aid kit	
PQ/ PD	PC Gained aid kit
PQ/ PD	PC Lost aid kit
PQ/ PD	PC takes Aid Kit from chest
PQ/ PD	PC puts Aid Kit into chest
PQ/ PD	PC buys Aid kit from Hospital
PQ/ PD	PC buys Aid kit from merchant
PQ/ PD	PC sells Aid kit to merchant
PQ/ PD	PC loots Aid Kit from corpse
PQ/ PD	PC takes Aid kit from trash
PQ/ PD	Aid kit used
Plot events - stick	
PQ/ PD	PC Gained stick
PQ/ PD	PC Lost stick
PQ/ PD	PC takes Stick from chest
PQ/ PD	PC puts Stick into chest
PQ/ PD	PC buys Stick from merchant
PQ/ PD	PC loots Stick from PC corpse
PQ/ PD	PC takes Stick from trash
Plot events – jail	
PQ/ PD	Law enforcement break up fight
PQ/ PD	PC arrested for assault
PQ/ PD	PC arrested for burglary
PQ/ PD	Jail confiscated stick
PQ/ PD	Jail took (gold, ration, voucher, aid kit)
Plot events – burglary	
PQ/ PD	PC Breaks into chest
PQ/ PD	PC Breaks in through door
Plot events - attack	
PQ/ PD	Family Member attacked by PC
PQ/ PD	Law Enforcement attacked by PC
PQ/ PD	Law Enforcement attacked by NPC

PQ/ PD	Crowd attacked by PC
PQ/ PD	Crowd attacked by NPC
PQ/ PD	Merchant attacked by PC
PQ/ PD	Merchant attacked by NPC
PQ/ PD	Health Professional attacked by PC
PQ/ PD	Health Professional attacked by NPC
PQ/ PD	Jailer attacked by PC
PQ/ PD	Jailer attacked by NPC
Plot events – virus infection	
PD	PC receives virus from NPC
PD	PC receives virus from PLACEABLE
PD	PC gives virus to another PC
PD	PC gives virus to NPC
Plot events - death	
PQ/ PD	Family Member died
PQ/ PD	Law enforcement officer died
PQ/ PD	Crowd member died
PQ/ PD	Merchant died
PQ/ PD	Health professional died
PQ/ PD	PC died
PQ/ PD	Jailer died
PD	PC died from virus
PD	NPC died from virus
Plot events – Dialog branches	
PQ/ PD	Tutorial finished lesson (1-8)
PQ/ PD	Family welcome
PQ/ PD	Family welcome + house broken into
PQ/ PD	Family warning to burglar
PQ/ PD	Family reminder when burglar is in-house
PQ/ PD	Family reminder
PQ/ PD	Family info usability
PQ/ PD	Family info content
PQ/ PD	Family casual + burglar in the house
PQ/ PD	Family member starving
PQ/ PD	Crowd asks ration
PQ/ PD	Crowd asks voucher
PQ/ PD	Crowd hostile
PQ/ PD	Crowd frightened
PQ/ PD	Crowd friendly
PQ/ PD	Health buy aid kit
PQ/ PD	Health injured
PQ/ PD	Health info virus
PQ/ PD	Health outside
PQ/ PD	(Informushroom) Info content
PQ/ PD	(Informushroom) Info usability
PQ/ PD	Jailer burglary
PQ/ PD	Jailer fight
PQ/ PD	Merchant PC buys
PQ/ PD	Merchant PC sells

PQ/ PD	Merchant PC wants illegal stick
PQ/ PD	Merchant casual
PQ/ PD	LE Patrol casual
PQ/ PD	LE Patrol player reports attack
PQ/ PD	Sector post outside
PQ/ PD	Sector post trade voucher
PQ/ PD	Sector post starving
PQ/ PD	Sector post info

2.6 Global Data List

Table A2-6 Global data per session according to groups.

General info (all scenarios)
Session ID
Timeline
Number of participants
Death toll over time
Aid kit use over time
Dialog events + area + PC location
General violence events
NPC Attack/ burglary + user ID + location + victim ID + has stick
PC Attack/ burglary + user ID + location + victim ID + has stick
PQ events
Ration decline over time: stock in Sector Post/ Merchant/ Trash pile
Food consumption over time: by PC + Family member
Voucher amount over time: PC acquired + PC sold to merchant + PC traded (SP)
PD events
Virus spread rate: vector (PC ID) + location + victim ID + location

2.7 Players' Data List

Table A2-7 Participant data per session according to groups.

General info (all scenarios)
Timeline
Area name
Location (X, Y coordinates)
Life status
Health status
Virus infected (by whom, transfers to whom)
Violence events
Attack + NPC victim ID
In combat +PC ID
Inventory status
Gold
Rations
Vouchers

Stick
Aid kit
Ammunition
Other events
Dialog events
Action events
Attitude tagging events
Questionnaire
Questionnaire part + Question No. + answer No.

Appendix 3: Users' Manual

Table of contents

Introduction

Some background first…

The Crisistudy project is carried out by Ilan Schwartz, a Ph.D. student at the Natural Hazards Research Centre, department of Geological Sciences, University of Canterbury, New Zealand, and is supervised by Assoc. Prof. Tim Davies from the Natural Hazards Research Centre, department of Geological Sciences, University of Canterbury, and by Dr. Richard Green from the Computer Sciences, School of Engineering, University of Canterbury, New Zealand. This project was granted an exemption by the University of Canterbury Human Ethics Committee Chair on the 12/06/2007.

Crisistudy aims to test and evaluate the use of online multi-user computer games as a simulation tool for human behaviour under conditions such as emergencies and disasters. In order to accomplish the above aims an experimental multi-user strategy game named DisasterVille was created with a number of gaming modules that include a Post Earthquake, Pandemic, and an Armed Offender scenarios. All gaming module were created using NeverWinter Nights (NWN) Aurora Toolset that enables creation of custom made content (hence the medieval look of the scenery).

Why a user's manual?

As it is assumed that not all participants have played computer games (and this one in particular), and some may be alienated by the fact that they need to act in an environment that is strange to them, this manual aims to familiarize you with the gaming environment, so you can focus on the game itself and not with its technical issues.

What does this manual contain?

Sections 1- 3 are the quick reference and contain the MAPS of the city and Student Village, a list of keyboard shortcuts, and screen layout, menus and their functions.

Section 4 is an overview of the various scenarios, items that can be found, characters you may encounter and places of interest.

Section 5 contains all the How To's of the game (i.e. how to walk, talk, chat, use your map, change your view point etc.)

Section 6 is the appendix and contains the transcripts of the background and consent form that appear in the game, as well as step by step instructions on how to start and quit the game.

What does participation include?

You are in the computer lab. In most cases, the computer will be already on and logged in into the game, so all you have to do start to play. Within the game you will do the following:

1. Read a short background about the experiment and sign an electronic consent form (about 5 minutes),
2. Answer the first part of a questionnaire (about 5 minutes),
3. Undergo a step-by-step tutorial that teaches you in a how to use the game interface and controls (about 20 minutes).
4. Play the game for as long as you can (this is what you're here for!).
5. Answer the final part of the questionnaire (about 5 minutes).

(Note that pilot studies show that the average time a participant spent in the lab was around 100 minutes).

A short synopsis of the game scenarios:

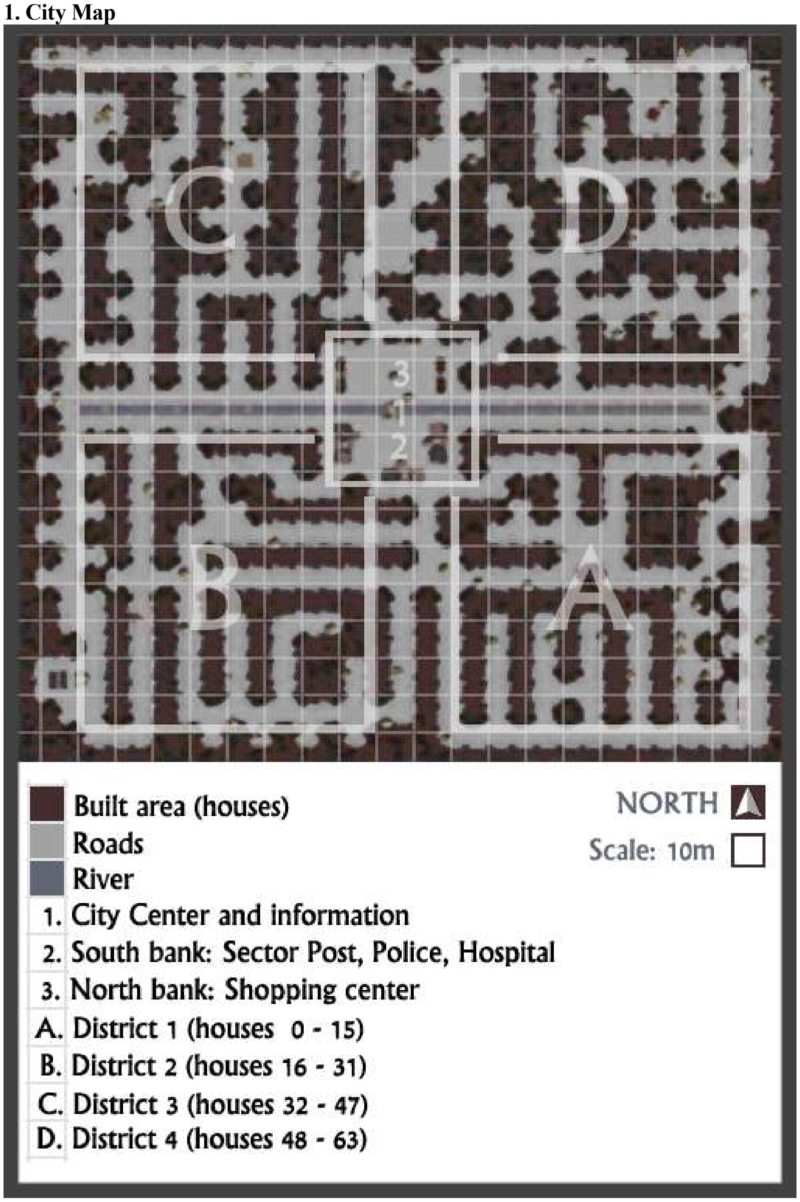
Post earthquake and pandemic: Disasterville is an old port city situated between the seashore on one side and an active volcano on the other. Historic documents state that the city was destroyed and rebuilt quite a few times during the last 200 years. Inhabitants experience the wrath of Mother Nature on a daily basis. You are a lucky person that got an invitation from his relatives in Disasterville to stay with them during the summer and explore the city. However, just a few hours before your arrival, a large earthquake hits the city…

…The city is left with almost no food or water, no municipal services, huge rats and garbage piled in the streets that are vectors for a deadly virus, and chaos is everywhere...

…You need to compete with other participants for that little left, and not only that - you also have to feed your relatives, who so generously invited you to stay with them. Here is where your big adventure starts…

Armed offender: in this scenario an armed offender enters into the university's student village. Depending upon scenario – you can play either a police officer, a first aid person, an innocent student, or the shooter himself.

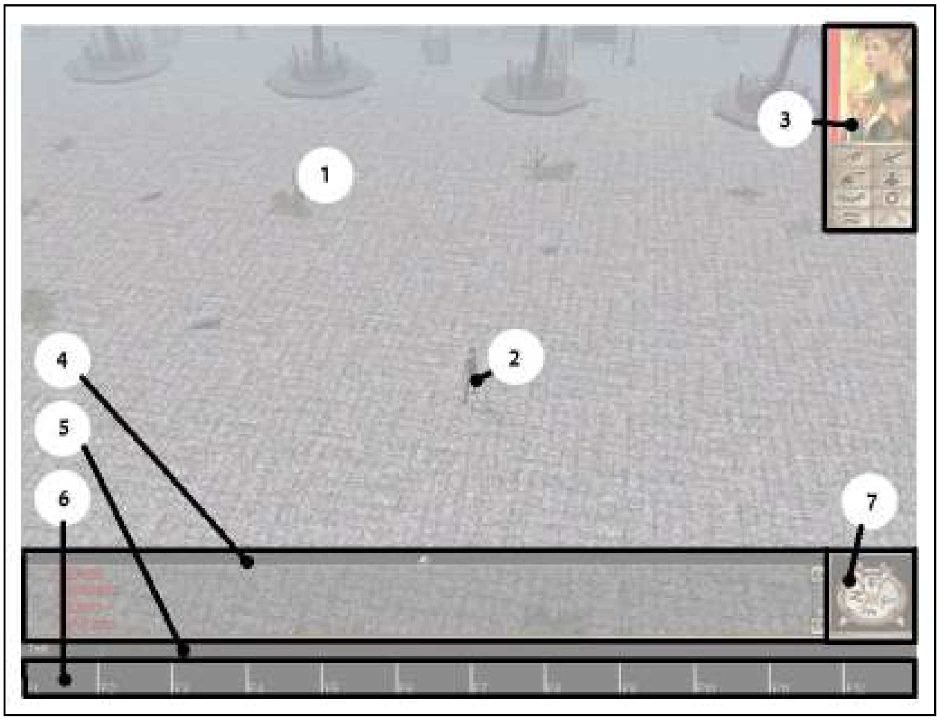
1. City Map


C
D
3
1
2
B
A
Built area (houses)
Roads
River
1. City Center and information
2. South bank: Sector Post, Police, Hospital
3. North bank: Shopping center
A. District 1 (houses 0 - 15)
B. District 2 (houses 16 - 31)
C. District 3 (houses 32 - 47)
D. District 4 (houses 48 - 63)
NORTH
Scale: 10m

2. Keyboard Shortcuts

Key	Action	Canceled by
General		
Space bar	Pause the game	Esc, Space bar
Esc	Closes an open window, pops up the options menu	
Enter	Enables the Chat window	
G	Quicksave of the game (irrelevant for this game)	
H	Hide all menus	H
Ctrl, Alt, Shift	Quick access bar slots (for tagging)	
V	Voice command (irrelevant for this game)	Esc
Players view angles (note that the term Camera refers to what you see on your monitor)		
LEFT ARROW	Rotates the camera left	
RIGHT ARROW	Rotates the camera right	
UP ARROW	Zoom in (closer to character)	
DOWN ARROW	Zoom out (farther away from character)	
PAGE UP	Rotates the camera to top view of the scene	
PAGE DOWN	Rotates the camera to side view of the scene	
HOME	Maximal zoom in point	
END	Maximal zoom out point	
INSERT	Maximal distance from top view	
DELETE	Maximal distance from behind the character	
Movement of character		
W	Character moves forward in a straight line	
S	Character moves backwards in a straight line	
E	Character moves right in a crab walk	
Q	Character moves left in a crab walk	
D	Character rotates right	
A	Character rotates left	
Players menu (upper right corner of screen) shortcuts		
M	Pops up the map window of the area	Esc, M
P	Pops up the players list window	Esc, P
O	Pops up the Options menu	Esc, O
I	Pops up the Inventory window	Esc, I
J	Pops up the Journal window	Esc, J
C	Pops up the character sheet	Esc, C
B	Spell book (not enabled in current game)	Esc, B
R	resting of character (not enabled in current game)	Esc, R

3. The games' screen and layout



Where:

1. The virtual world you and the other players interact in,

2. That's your character in the game,

3. The players menu (will be elaborated below),

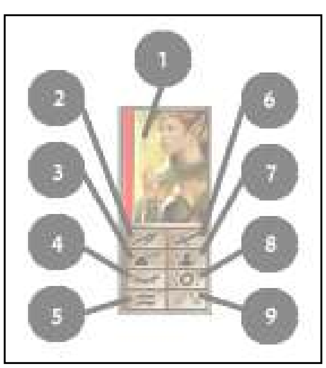
4. The Message Window: it presents every action/ chat/ game notification. It can be pulled upwards with the little golden triangle in its top middle, or alternatively scrolled up and down with the right hand side scroll bar.

5. The Chat Window: through this one line window you interact with all other players (humans only! computerized characters are addressed through Dialog Windows which popup when they start a conversation).

6. The Quick Access Bar (F1-F12): in this bar are stored tags (they look like books) used by you to tag your impression of various interactions with other participants (see also How to Tag).

7. The Compass: when you hover over it, it tells you the date and time in the game.

3.1 The Players Menu – General Information



Note that each button pressed will open a different window that can later be closed either by pressing Esc on your keyboard, or by clicking the X at the top-right side of its frame.

1. Your character's portrait. Hovering over it will tell you your character's name and your location. Clicking it will open your Character Sheet (item 7 in this menu). The red bar on its left side is your Health Status and tells you how much life you have got left.

2. The Game's Map: Click this button to open the Map Window with the game's top-down map (alternatively you can press M on your keyboard). The map shows the whole area a player roams in. It has map notes (little Golden Diamond shapes) that when hovered on with your mouse will popup their names (building, house numbers, etc – but not street names). The player is represented by a Golden triangle that faces in the

direction the player faces. You can use the arrows in the top left corner to zoom in or out.
3. The Journal: Click this button to open the Player's Journal. Consider this as an in-game notepad into which you can write your notes.
4. The Rest option: this option is disabled in this experiment.
5. The Options menu: Click this button to open a window that contains all gaming settings (camera angle, sound, etc. This menu also appears when you press the Esc button while playing (it can be closed with another press on the Esc button).
6. Your Inventory: Click this button to open a window with your Inventory content. You can think of that as your backpack. It tells you what you carry around with you.
How to use it - see section 5.6
7. The Character Sheet: Click this button to open a window with your character sheet. You can later close the window independently. This is your status report. You can check it from time to time. It will tell you your health status.
8. The Spell Book: This option is irrelevant for this experiment purposes
9. The Players list: (exists only in multiplayer mode), clicking on this button will open a window with the screen names of the other players.

3.2 The Options Menu – general Information.

This menu appears whenever you press the Esc button on your keyboard. If you press Esc again – this menu will close.
It contains the following options:
Load, Save, Save Character – these are relevant only in a single player game (and therefore irrelevant in the experiment as this is a multi-player environment).
Game Options, Video Options, Sound Options, Controls – these will open sub-menus that enable you to adjust various settings like volume, screen resolution etc. They are somewhat irrelevant for experiment purposes.
Exit to Main Menu – this is the Quit from game option. If pressed, it will pop up the main menu that will ask for confirmation. Press Esc again and this menu will close and you will resume game.
Resume Game – press this button and the game will resume, or just press ESC on your keyboard.

4. About the various scenarios
4.1 Rules
There is no written set of rules to follow within the game. However, it is assumed that everyday rules regarding law and order apply in the game environment. There are also Law Enforcement Officers present within the game and if you commit offences like attacking other participants, or breaking into other houses within a reasonable distance from such officers – you are sent to Jail. In Jail you are fined and some of your possessions are taken away from you. On repeating offences, you get larger penalties until at some stage you are removed from the game. As in real-life, you can try your luck, but be prepared to pay the price…

4.2 Aims and gaming strategy
There is only one aim to the game – SURVIVE for as long as you can!
(And don't forget that you have to feed your relatives as well, which turns this into a more complicated task). In order to survive in the game you will need to eat. Therefore, you will need to obtain food from various sources, some legal and some not….
Strategy: some people might just sit and wait (this will give them around 20 minutes of gaming); others will choose to attack all other players (this gives them even less time – as they lose health points during these actions). It really depends on your personality, but as long as you think of this as a problem you need to solve and devise some kind of long term strategy and not a set of impulsive actions, most chances are that you will be able to extend your survival period.

4.3 Characters and their role
Characters in the game can be of two generic types: either Player Characters (PCs): that means human participants like you, or Non Player Characters (NPCs): all the rest of characters that populate the game. You can distinguish between PCs and NPCs easily: NPCs can communicate with you only via Dialog Windows, whereas PCs will Chat with you through the Message Window, and NPCs have a somewhat limited set of behaviours.

NPCs and their role:

- Your Family Members: these can be found only in your house. They will collect vouchers for you, and in return you will have to feed them – if not fed they will perish.
- Crowd Members: these can be found roaming around the streets. Some will be nice to you, others less. They might sometimes give you something if you're nice to them.

- Law Enforcement: they are dressed blue. There are three types: Static Officers, Patrol Officers that patrol the city and Jailers (only inside the jail). If you commit an offence within a reasonable distance from them – you will end up in Jail.
- Sector Post Officers: they are dressed red, and are found in the Sector Post. They will trade your vouchers for food until the food supply is finished.
- Health Professionals: they are dressed white, and are found in the Hospital. They can sell you an Aid Kit or heal you if you are wounded.
- Merchants: they are dressed blue and yellow, and are roaming around the Shopping Center. They will buy from you items you don't need, or sell you items you really need at double the price. Don't forget to ask them about the "illegal specials".

4.4 Items in the game

ITEMS you can find in the game (in your or other people's inventories) and that can be taken, given, bought, or sold are:

- Food Rations (far left in the image): these are bought by you for money from merchants in shopping centers, or traded for vouchers by the Sector Post Officers (as long as they have food supply…). You need to eat at regular intervals as well as feed your relatives. When food runs out you will need to be creative as to potential supply sources.
- Food Vouchers: these are collected for you by your relatives in your home. You will find them in the Pantry Chest. Note that they can be traded by the Sector Post for food, or be sold to a merchant for money. If your relatives pass away for some reason – the voucher supply will terminate as well. On occasion, a crowd member might give you a voucher, or you might find one thrown in the street. Just open your eyes!
- Aid Kits: these can be bought only. Either from merchants or from the hospital, they can heal you from a pandemic, if you got infected.
- Gold Pieces: you have an initial amount in your inventory which you can use in order to buy items you need from merchants.
- Old Baseball Bats: illegal to carry around and very rare to find them.

4.5 Places of importance in the game

Here is a list of places you find in the city of Disasterville, and their role (for their exact location look at the CITY MAP):

- Your Home: inside you will find your relatives waiting for you. Upon your first arrival to the game you land just in front of their doorstep. Once you enter into the house you will be debriefed by them regarding the situation in the city. You will find that you need to feed your relatives (see also How to Eat). Another important item is your house is the Pantry Chest – in which you will find vouchers that are collected for you by your family members. Into this pantry chest you will put the food rations you bring home, and your relatives will take them from there independently.
- Sector Post: Situated in the city center. Here you can trade your vouchers for food rations.
- Hospital: Situated in the city center. Here you can buy Aid Kits that can heal you from a pandemic, or get healed by the staff in case you were wounded.
- Jail: Situated in the city center. You enter jail when you commit crimes such as attacks and burglaries (see also RULES of the game)
- Shopping center: Situated in the city center, it's an open market style center and the merchants roam around and will be happy to sell you everything and buy from you things you don't need.

5. Tutorials: all the How to's and their respective menus

5.1 How to talk with computerized characters: the dialog window

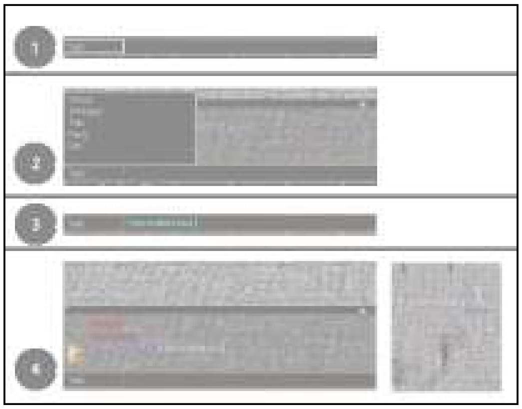
When you hover your mouse over a computerized character (NPC - Non Player Character) it will change to a profile of a human with an open mouth. Now you just have to left click that character in order to start a conversation. As this happens, a Dialog Window will (always) appear at the top left of your screen.

A Dialog Window contains two parts:

1. The computerized character's part - appears in white and occupies the top part of the window, just right to its portrait.
2. The human player part - appears in light blue at the bottom of the window.
3. A dialog is always advanced by the player. That means that whether it has a few answers or just one - you must click on one of the answers in order to proceed to the next part of the dialog (or terminate). If you don't click an answer, the computer will restart that bit of dialog again and again, so remember to click the text that represents your answer(s) in order to terminate the dialogs (even if it's just one word like: "OK"...).

The dialog content also appears in the Message Window, with the Characters portraits in the left of the line, followed by their name and by the text spoken by them.

5.2 How Chat with real players: the Chat and Message Windows



This is your main means of communication with the other participants in the experiment. When you want to write a message to another player:
1. You first click the left side (where you see the word Talk appear). A menu (2) will popup, from which you have to choose between the different modes available:
Shout – this will make your message appear in the whole area. Whisper – this will make your message appear in a very short distance (approximately one meter). This is what you will use in a private conversation with another person. Talk – this will make your message appear within a medium distance (approximately 20 meters). Party and DM are irrelevant for this experiment.
Once you chose the method (3), you click to the right side of the word Talk, you will see a light blue cursor flashing. Now, type your message. When finished press Enter on your keyboard. The result is: 1) the message you typed appears over your character's head within the game for a few seconds and; 2) appears in the Message window with your name and user icon to its left.
Note: messages sent to you by other players are viewed in the Message window – so remember to check it frequently. The messages are also color coded, so they are easy to distinguish between.

5.3 How to walk, open doors, and cross between areas

Walking: The game uses intuitive movement and the only thing you need to do is left click a place you want your character to move to. If the place is accessible, the character will go there, if not the mouse cursor will change into an X shape and your character will stay in place until you form for it an alternative route. If you continuously left click the mouse button and drag the mouse - the cursor will change into an arrow and your character will start to walk faster towards its direction.
Doors: Your movement involves also a lot of entry to and exit and from places, so here is a short guide about using doors:
1. How to open a door: left click the door. It will open. Now you will notice something like a purple/ brown surface that stretches on the doorway, hover your mouse over it (the icon also changes to a door with an arrow). Left click this "curtain" again in order to cross the doorway.
2. Doors will open for about 2-3 seconds and then close again, so be quick, or try again.
3. Doors can be broken only via a dialog (they cannot be bashed).
Areas in the game: Each place (i.e. the city exterior, your house, sector post, etc.) is actually a separate area within the game. All doors are actually used to cross areas. Every time you cross between areas, the computer has to load each area - this takes time, so just relax and be patient (sometimes up to a minute where nothing happens on your screen apart for a loading screen with a static image and messages that belong to the original game).

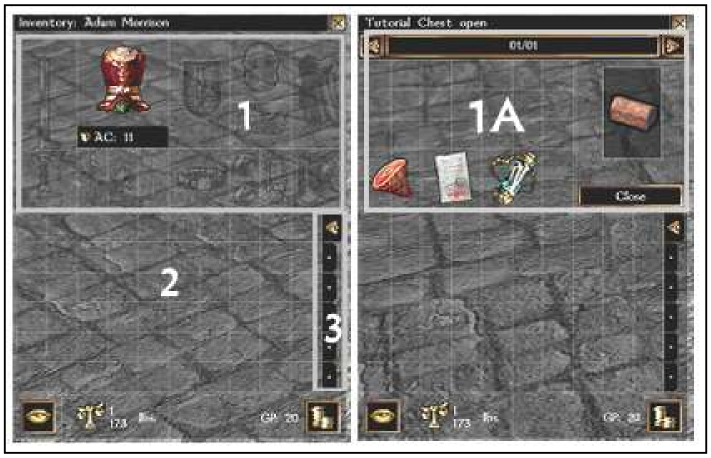
5.4 How to change your point of view

While you play, you will sometimes want to change your point of view in order to see more of the scene (i.e. when your character goes behind a building) - to do this:
1. Use the mouse wheel to zoom in or out,
2. Move the cursor (without clicking anything) to touch the left or right side of the screen. This will rotate your point of view and enable you to look around.

5.5 How to use your map and navigate in the game

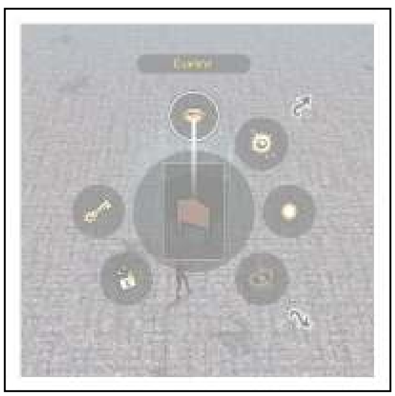
The game automatically generates a top down MAP for the gaming area. In order to see the Map Window press the letter "M" on your keyboard.
On the map you will see the following:
1. Map Notes:
These are little golden diamonds that when you hover your mouse over them they pop-up a text bubble with their name. They are used to indicate: house numbers, Information centers, Sector Post, Shopping Center and Hospital locations.
2. Yourself:
You are represented as a golden triangle, its head points to the direction you face and it moves around on the map as you do inside the game.
On the top left of the Map Window's frame you will note two little arrows that enable you to zoom-in or zoom out according to your needs. Sometimes you will have to use this option - in order to see the whole city, for instance, and locate your family house.

5.6 Your Inventory



You might not be familiar with this term - it's used a lot in games, and just means your backpack and the things you are carrying. The image to the left shows the two forms your Inventory can take: either as your own backpack (left side), or as a chest's Inventory.
To see your Inventory, press the letter "I" on your keyboard. The left hand image shows your Inventory, the top half (1) of the Inventory Window shows items you are currently using or wearing. The bottom half of the window (2) shows what's in your backpack (including the gold you have left - at the right bottom of the window).
The "backpack" has 6 "pockets" that can be viewed by clicking the 6 tabs (3) at the right hand side of the Inventory Window (the active tab has a golden arrow, and the other are just golden dots (if you don't see items in your inventory, the chances are that you need to click another tab, as you look at the wrong pocket).
The view of your Inventory changes when you encounter chests or containers as they have an inventory of their own. In cases like these the Inventory Window will open and show in its upper part the chest/container's contents (1A on right side image), and in its lower part your inventory.
How to use your Inventory: most of the time Items will appear or disappear from your inventory as a result of dialogs (like when buying or trading items). However when you actively want to give or take items (from and to chests for example) - you can drag items from top to bottom of the window (thus taking items into your possession), or drag items from bottom to top (thus putting items into a chest – i.e. when you want to give food to your relatives).

5.7 How to interact with objects



Any object in the game that can be interacted with will be highlighted light blue when you hover your mouse over it. The objects that can be interacted with in the game are: chests, signs, doors, and other characters.
When you left click an object, a default action will be performed on it: a sign - a window with its description opens, a chest will reveal its contents (if it's no locked), a door will open (if not locked), and a computer controlled character (i.e. not a human like you) will talk to you
If you right click on any object or character - the Radial Menu will open and show a circle of possible actions around the object in question that you can perform. Left clicking on one of these actions will make your character perform that action.
For example: if locked, a chest or door can be lock picked, or a character (even those controlled by other players) can be attacked (by using the knife icon).

5.8 How to give, trade, buy or trade items

- Buying or trading items: Items that you buy or trade (food rations, vouchers, aid kits or the occasional baseball bat) – will appear in you Inventory or disappear from it only as a result of a dialog (either with a merchant, or with a Sector Post Officer or a Health Professional). The appropriate gold amount or vouchers will be added or subtracted by the computer. You don't have to physically do anything. Notice that you might also receive items (such as keys) in the same way.
- Give items: open your Inventory (press the letter "I" on your keyboard), drag the desired item from within the Inventory Window to a place on the screen (the ground near your character's feet).
  Watch how your character performs an animation sequence that illustrates that (it kneels and put a bag on the ground). Now anyone (including you) can pick that item up.
- Take items: (two methods)
  A. Left click once the item (see that your mouse cursor changes into a grabbing hand). Your character will perform an animation sequence of picking up a bag off the ground, and the item will be added to your inventory.
  B. Open your Inventory (press the letter "I" on your keyboard), drag the desired item from the ground into your Inventory Window. Watch how your character performs an animation sequence that illustrates that (it kneels and takes a bag from the ground).
  Note that the game has a built in option of bartering – however, it will not be discussed here.

5.9 How to eat, feed your family member and heal yourself

- How to eat: Open your inventory and double click the food ration. You'll see a visual effect (a ring of light sparks around your character). That's it! You're fed!
- How to heal yourself: Open your Inventory and double click the Aid Kit. You'll see a visual effect (a ring of light sparks). That's it! You're healed!
  Note that Aid Kits can only be bought from merchants or the hospital, You can not heal your family members, only yourself.
- How to feed your family: Just put the food in their Pantry Chest. It will be taken by them when they need it. You do not need to actually feed them.
- More about food: If you (or your family members) don't eat, you will eventually starve to death. You should eat regularly (about once every 5 minutes) - it takes you about 15 minutes before you'll actually starve. If you're hungry, you'll see complaints appearing above your character's head from time to time. If you see these, you've got about 5 minutes before you'll starve.
  To obtain food, you can buy it, you can trade it for vouchers, or sometimes, you can find it stashed around the city. Given the limited rations available, a lot of your time will be spent worrying about where your next meal is coming from…

5.10 How to tag your interactions: the Quick Access Bar

This is actually a part of the EXPERIMENT. Whenever you interact with other players, you should use one of the tags.
To do this, just hover your mouse over the books in the Quick Access Bar at the very bottom of your screen. Each represents a different impression you had of the interaction – left click only once the one that is most appropriate, in your opinion. That's it!

(Note that it might be that these BOOKS will be only available in the game itself and not in the tutorial session. So if the slots are empty while in the TUTORIAL – don't bother about it).

6. Appendices

6.1 Transcripts of research background and consent form

Background information: The aim of this project is to look into the use of multi-user computer games as simulation tools for emergencies. Your involvement in this project will be by playing as one of the characters in the game, and answering a questionnaire within the game during about an hour or two. You have the right to withdraw from the project at any time, including withdrawal of any information provided. In the performance of the tasks and application of the procedures there are no anticipated risks, however you should note that other participants characters can freely interact with your character in the game in an unsupervised manner that might include use of impolite language, or attacks by other characters in the game. The results of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation, as no identifying data about participants is collected in order to ensure anonymity and confidentiality. The project is being carried out as PhD research by Ilan Schwartz (isc34@student.canterbury.ac.nz) and is supervised by Assoc. Professor Tim Davies (tim.davies@canterbury.ac.nz) of the Department of Geological Sciences and Dr. Richard Green (richard.green@canterbury.ac.nz) of Computer Science and Software Engineering. They will be happy to discuss any concerns you may have about participation in the project.
The Consent Form: (Note that the signature of agreement is electronic. The simulation is coded so that the session starts ONLY after the participant has read and agreed to the above terms and conditions from within the game). I have read and understood the description of the above-named project. On this basis I agree to participate as a subject in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved. I understand also that I may at any time withdraw from the project, including withdrawal of any information I have provided. I note that the project has been exempted from additional scrutiny by the University of Canterbury Human Ethics Committee.

6.2 How to start the game

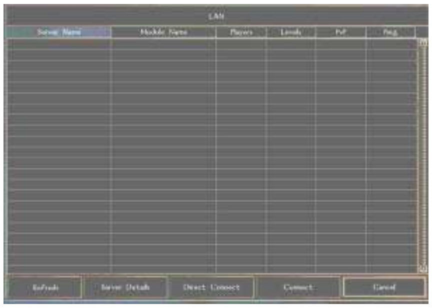
<table>
<tr>
<td>1. You have to login onto the lab’s computer:
The user name is: cosccXXX (where XXX is a number between 801-850)
The password is announced by the tutors
And the computer’s domain name is: UCONT.

2. On your desktop you will see the following icon in the middle of the screen: Double click it.
</td>
<td>3. a menu will appear from which you choose the first option “Play”
4. Now press the Esc button about 4 times on your keyboard

in order to skip the original introduction movies of the game.</td>
</tr>
<tr>
<td>5. Now the main menu will appear from which you will choose the Third option from top: “Multiplayer”.
</td>
<td>6. …And the following menu will appear on top of the previous menu. Insert any user name and password you like. Make sure that the “Remember Password” Checkbox is UNCHECKED ! and then click “OK”.

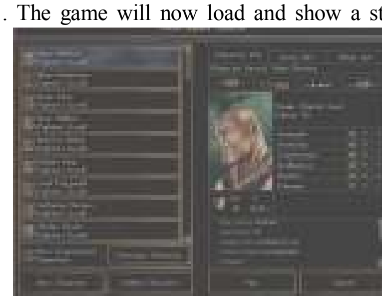
</td>
</tr>
<tr>
<td>7. The computer will pop-up on top of the menu a window with the following message: ”Authorizing player name” and then “think” for a while and pop-up this message: “Could not connect to a Master Server, some multi-player services may not be available”. Click “OK”.</td>
<td>
8. This menu will appear from which you need to choose the Fourth option - Join LAN Game.</td>
</tr>
</table>

9. Next will appear a list of LAN games from which you will choose the first (and only) LAN server that appears, which will read "Disasterville". At the bottom of the window click Connect (first option from the right).



10. A menu that reads: "Choose available character from the list" will appear. You have to choose a character from the list (you can scroll down the list as there are 64 characters to choose from). Once you click a character – its Character Sheet will appear on the right. Click the "PLAY" button (second to the right at the bottom of the window).

11. The game will now load and show a static load screen



until it is loaded. Now you are in the game…

6.3 How to quit the game

When in the game: press the Esc key on your keyboard – the Options menu will appear. You choose the Exit to Main Menu option

A confirmation window will appear and you will be asked if you want to quit. Press the Yes button if you do want to quit. Next, the main menu (shown at section 5) will appear. There you will choose the Exit option (first from bottom).

…and that's it!

Appendix 4: Results

4.1 Sessions Facts

The experiment ran a total of 12 sessions (nine post-earthquake scenarios and three Pandemic scenarios). An average session took 61 minutes, out of them 23 minutes were dedicated to play the in-game tutorial and 38 minutes dedicated for playing the simulation itself.

Participation: a number of 86 people participated in total (75 males and 11 females). Out of them 80 data files were valid (56 males and 8 females for the post earthquake scenario, and 10 males and 2 females for the pandemic scenario). 14 males and 1 female participated in more than one simulation session, and out of them 11 males described themselves as gamers that played computer games for three to five hours a day (i.e. only 1 male and 1 female from the group that participated more than once were not gamers). 9 males and 1 female defined themselves as non-gamers.

4.2 Participants' Demographic Data

Following is a table that lists the demographic profile of the participants in all simulation session. As it can be seen from that table, majority of participants (67.5%) were young, single (85%) adults that were full time students (83.75%).

Table A4-1 Demographic characteristics of study subjects

Item	Group	Male	n	Female	n	Total	n	Total (%)
Ethnicity	NZ European	41	70	3	10	44	80	55.0
	Asian	8		3		11		13.75
	Middle Eastern	3		0		3		3.75
	European	7		1		8		10.0
	Maori	2		1		3		3.75
	African	1		0		1		1.25
	N. American	1		1		2		2.5
	S. American	2		0		2		2.5
	Other	5		1		6		7.5
Age group	18-23	48	70	6	10	54	80	67.5
	24-29	9		1		10		12.5
	30-39	11		3		14		17.5
	40-49	2		0		2		2.5
Marital status	Single	60	70	8	10	68	80	85.0
	De facto	3		0		3		3.75
	Married	6		2		8		10.0
	Divorced	1		0		1		1.25
Occupation	Full time student	59	70	8	10	67	80	83.75
	Part time student	8		1		9		11.25
	Full time manager	1		0		1		1.25
	Full time employee	1		0		1		1.25
	Part time employee	1		1		2		2.5

4.3 Participants' Computer Gaming Habits

Table A4-2 Computer gaming habits of participants

	Total (n =80)	Total (%)
Playing regularly	43	53.75
Playing occasionally	27	33.75
Not playing computer games at all	10	12.5
Playing online games occasionally	19	23.75
Playing online games regularly	30	37.5
Not playing Online games	31	38.75
Time spent gaming: 1 hr or less	24	30.0
Time spent gaming: 1-3 hrs	11	13.75
Time spent gaming: 3-5 hrs.	45	56.25

4.4 Tagging Results

The following table sums all tagging events in the simulation. Note that most events related to dialog events and all had a time lag from the event itself.

Table A4-3 Tagging of events in the simulation

Events by type	n	Average delay time from nearest event (HB)	Relevance to event
Annoying	10	1	Used for dialog events, some were long like tutorial/ family intro
Friendly	15	2	Used for dialog events
Fun	18	3	Some were used for burglary actions, eating rations and mainly for termination of the tutorial dialogs
Informative	26	2	Dialogs, mainly Information and tutorial
Misleading	11	2	Tutorial lessons dialogs, SP_outside,
Not useful	14	2	Mainly tutorial lessons dialogs, some crowd dialogs
Rude	18	2	Mainly tutorial lessons dialogs, some crowd dialogs, SP_info
Threatening	12	NA	No events associated
Useful	39	2	Tutorial dialogs, family dialogs, health professional dialogs, ration eating by PC or FM

4.5 Participant gaming Profile

Table A4-4 Participants in-game behaviour patterns according to questionnaire answers

Question	T (n=80)	T (%)
Gaming strategies taken by participants - Sit and wait	8	10.0
Gaming strategies taken by participants - Use opportunities when they arise.	35	43.75
Gaming strategies taken by participants - Initiate moves.	37	46.25
Collaboration with other participants - Always	9	11.25
Collaboration with other participants - Frequently	11	13.75
Collaboration with other participants - Rarely	26	32.5
Collaboration with other participants - Never	34	42.5
Purpose of interactions in the game - Acquire goods or info	71	88.75
Purpose of interactions in the game – Socialize	8	10.0
Nature of interactions in the game – Positive	12	15.0
Nature of interactions in the game – Practical	44	55.0
Nature of interactions in the game – Negative	23	28.75
Law enforcement characters amount – Sufficient	17	21.25
Law enforcement characters amount - Partly sufficient	47	58.75
Law enforcement characters amount – Insufficient	15	18.75
Did you do things contrary to reality – YES	57	71.25
Did you do things contrary to reality – NO	22	27.5
Behaviour in an identical situation in real life – Same behaviour	10	12.5
Behaviour in an identical situation in real life – Loosely the same behaviour	33	41.25
Behaviour in an identical situation in real life – Differently	36	45.0

4.6 Performance of Participants in Simulation Sessions

A simulation session included a tutorial period and a game period. All time and resources management mechanisms for the gaming period were initialized only after the first player in the session terminated the tutorial and was teleported into the gaming zone. Therefore this was determined as t =0 for a session (this was when the first PLAYER_JOINED_MODULE event was recorded). The termination of the simulation session was determined by the "death" of the last participant (the last PC_DIED event recorded in the game). The following table presents the average survival percentage of participants according different groupings.

Table A4-5 Average life span of in-game characters measured against different parameters

(Abbreviations: PQ- Post Earthquake scenario, PD- Pandemic scenario)

#	Group	Average life span of character in simulation (%)	
		PQ (n =64)	PD (n =16)
	General Average	46.8	51.8

1	With stick	80.1	72.3
2	Returning players	69.4	59.7
3	Did things as in real life	59.4	53.2
4	Survival in real life: no problem	55	47.5
5	Not breaking into houses	53.1	67.1
6	NZ European	48.4	67.5
7	Non gamers	47	41.1
8	Harming only if no other choice	47	45.1
9	Relate to their character	46.9	52.4
10	Gamers	45.3	55.3
11	Not harming people as it is immoral	45.3	52.2
12	Breaking into houses	45	66.5
13	Did not relate to their character	45	50.0
14	Did thing that would not do in real life	43.1	50.7
15	First time players	40.3	48.2
16	Survival in real life: maybe	38.6	47.0
17	Asian	37.1	62.5
18	No stick	36.6	44.9
19	Harming people in every situation	34.2	38.4

4.7 Baseline pandemic dynamics

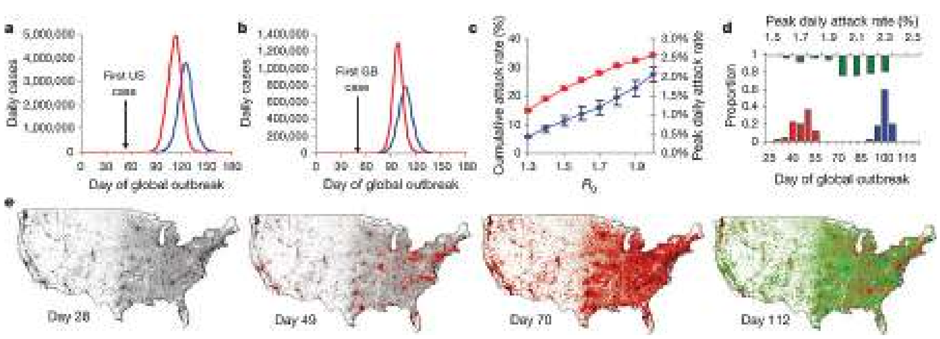


Figure A4-1 Baseline pandemic Dynamics (taken from Ferguson, 2006).
Note that the relevant figure for the pandemic spread is figure C that shows the peak daily attack rate.

4.8 Interviews

Although the literature provided support for the research results as was seen throughout this document, I find that the following interviews add some real-life evidence that backs up the research as well.

The first interview was done with a repeating player that actually fits the stereotype of a stand-alone computer gamer. He was interviewed in order to assess whether he developed a gaming strategy, and to examine his participation motives.

The two latter interviews deal with human behaviour following a disaster. The first of these two interviews was conducted with two people that visited Samoa after a Tsunami struck the area and includes their personal observations, and the second interview was conducted with a person that held managerial positions within the Indian government, and so has a wider perspective about human crowds behaviour.

4.8.1 Interview I: a returning participant

In the post earthquake sessions conducted was a repeating player that participated voluntary in about 5 sessions. He was nicknamed by the research staff “The Shark”, as from observations, he developed a survival strategy that helped him to finish most of the sessions as the last player standing. His answers to questionnaires were not traceable as the answers of every session were aggregated together. However, after the last session, he was willing to be interviewed given no identifying details were disclosed. He was interviewed in order to understand his motives and gaming tactics.

Background: single child, lives with his parents, Masters student at the University of Canterbury. Seems to be 30±5 years old. A keen gamer that performs no physical activity. Heard about the game from an email circulated through the department he studies in. Due to his enthusiasm he was asked to bring along his friends and was offered extra chocolate bars to motivate him if he did so, however he always came alone and ignored that subject even when asked directly. Gaming habits: plays on average 3 hours a day, on his computer. Does not play online multi user games.

Interview:

Q: Why did you play more than once?

A: It was a challenge. I wanted to see if I can beat other players. It’s not like playing against the computer. You can’t save the game and the other players have their own will.

Q: Could you tell me what was the thing you liked the most?

A: That the game is unpredictable.

Q: Didn’t it bother you that the game does not have a plot and that the environment is sterile?

A: No, because you interact with the other players.

Q: What disturbed you the most in the game?

A: The tutorial. It was too long. You should add the option to skip it.

Q: Where you happy to come to the lab?

A: Yes. It was a break from my studies. After I finish here I go back to the department. Besides I could see on their monitors what other players do and plan ahead.

Q: Could you describe me your first session?

A: Yes. I played the tutorial and then was teleported into the city. There I took my family members' vouchers and bought food, until the Sector post ran out of food. Then I tried to look in trash piles for food, and broke into a few houses. Ran away from players that tried to attack me, looted a corpse I found, and then starved to death.

Q: How was your second session?

A: I went quickly through the tutorial, as I knew it already. In the city I tried to buy a stick from a merchant. I restarted the dialog with the merchant until he offered me a stick. I went home and took the vouchers that waited for me and exchanged them for food. I looked for trash piles in the city to find more rations and vouchers. I exchanged the vouchers for food in the sector post. I attacked a few players and looted their corpses. I stocked my inventory with food and vouchers, so I could survive until the game terminates.

Q: In your opinion, what would be the best strategy to win the game?

A: First, get a stick. This way nobody picks a fight with you, and if they do – you have an advantage. Then look in trash piles throughout the city for more vouchers and food, and do it before other players do so. Then break into houses and into personal chests. Don't attack the family members as it decreases your Life Points. In the city don't attack people – for the same reason. If you see a fight, wait for it to end and then attack the last survivor – he should be weak enough not to cause you damage, especially if you have a stick. Then loot all the corpses. I didn't attack people if I didn't need too. You will have enough rations and vouchers even if the Sector Post runs out of food. You can also sell all your vouchers to a merchant.

4.8.2 Interview II: Human behaviour following a disaster- 2009 Samoa earthquake

Background: on the 30 September, around 8:00 local time, a 5 meter high tsunami hit Samoa and American Samoa following an 8.0 magnitude earthquake in the south of the main Samoan Island chain. Villages, houses, buildings, and communication lines were damaged as sea water surged inland. As of 9 October, the official casualty count was: 138 dead, 310 injured, and 6 missing (WHO, 2009).

I conducted an interview with two people that traveled to Samoa after that event. Mr. Golan (2009), a documentary photographer who traveled to Western Samoa three days after the event and stayed there for ten days in order to document the destruction and damages and stayed at the capital, Apia, and commuted daily to the disaster area an hours travel from there (Apia was not affected by the disaster, I.S.). Mr. Bind (2009) who traveled as part of the New Zealand National Institute of Water & Atmospheric Research (NIWA) delegation of scientists that its purpose was to document the disasters' damages for future research. Mr. Bind traveled ten days after the event for a duration of ten days, and was at the beginning in American Samoa, and later in Western Samoa.

Affected areas in Samoa have a strong traditional communal sense, and village mayors are seen as the village "fathers" that have to take care of their "sons" (i.e. the villagers). Because of the societal structure many villagers have family ties with each other and can be seen as an extended family. I asked both about survivors' behaviour, and as it seems people were shocked immediately after the disaster as they lost relatives and property, but they were not sad or depressed, as they claimed that their lives have been saved. According to Mr. Golan, villagers were cooperative and friendly during his stay and he didn't hear about aggression or looting incidents. Mr. Bind however, claimed that in American Samoa, where the disaster hit an urban area (in which people were not family related), looting was a fact because people needed food, and therefore looted shops, however this behaviour was not demonstrated in Western Samoa. He added that the delegation members were warned not to stroll with no supervision of a local representative, as locals might be hostile, however he did not experience any hostility.

4.8.3 Interview III: Human behaviour following a disaster- Various case studies

Following is a summary of an interview that was conducted with Mr. S.S. Bagchi (2009), who I met at a New Zealand Civil Defence Induction course held during September 2009 at the Christchurch City Council. Mr. Bagchi's background includes a long tenure in the Indian civil service in various roles, mainly as an advisor to several governments in number of areas including internal affairs and national security. As part of his role he was involved also in disaster prevention and management.

The interview conducted covered observations from four case studies in which Mr. Bagchi was involved in as a member of the National Disaster Management Authority of India: 1) The 1991 Uttaranchal earthquake that occurred in the mountainous region of Garhwal Himalayas in northern India, in which 2000 people died, about 1800 were injured, and about 18,000 houses were damaged (USGS, 2009); 2) The 2001 Gujarat earthquake in which approximately 20,000 people died and 166,000 were injured (USGS, 2009); 3) The Gujarat Plague, in which a Hepatitis B Plague (pneumonic Plague) in the city of Surat, India claimed more then 60 lives from late August 1994 to mid October 1994, and during which a state emergency was declared for prevention and control of the event (Ramalingaswami, 2001); 4) The 1999 Orissa Cyclone, that was the first storm to be given the new meteorological label "super cyclonic storm" by the IMD (India Meteorological Department). Its impact was heavy torrential rain over southeast India, especially in area of the coast of Orissa, traveling up to 20 km inland, causing flooding in the coastal low-lying areas. The storm surge was 8 meters. Its death toll was nearly 15,000 people (Francis et al., 2001).

Mr. Bagchi was asked about the general human behaviour patterns in each case and the following paragraph summarizes his observations: 1) immediately after the disaster (up to 48 hours): panic, confusion (elderly people sometimes demonstrated apathy), and shock were demonstrated by affected population. Aid efforts started immediately by members of affected population. Official help (NGOs and authorities) started to arrive about 36 hours after disaster. It should be noted that the delay in aid arrival was due to objective reasons (landslides, collapse of infrastructure, and weather conditions); 2) after about 72 hours from the disaster impact: emotions turn into anger and frustration, mainly due to absence of authorities and relief aid; 3) later on, once population is aware to its condition: aggression and hostility towards authorities (these stayed for a few years later in part of the cases), political unrest (unrest that started spontaneously, but was embraced by political opposition parties), looting that started out of necessity turned into organized looting of businesses done by criminal organizations. At this stage a substantial amount of resources was dedicated to calm down the civil unrest and maintaining public order rather than aiding the affected population. Affected population members kept most of the resources to themselves and did not share them with others that were not part of their family, they cooperated only at the neighborhood level (i.e. less violent and more community oriented), and started to stockpile food only after they experienced a disaster. In the case of the Orissa Cyclone, people were aware of the approaching cyclone (media announcements that were published about 48 before arrival of cyclone), however they opted to stay in their home where they thought they would be safe, and not leave the area, as cyclones were a regular phenomenon in that area (Thomalla and Schmuck, 2004).

Mr. Bagchi also notes the use of female army officers to handle affected population in the case of Gujarat Plague, as they were considered to be more compassionate to affected population, as well as due to cultural traits they were less prone to be attacked by public members.

Appendix 5: discussion

5.1 A recipe for a disaster: a personal account of the simulation construction process

Following is a personal account of the simulation creation process as I experienced it. The working process on this simulation deserves to be mentioned in this document as it was a crucial part of the research although it was not a scientific component, however it contributes to the knowledge base of future applications and can aid researchers and future emergency simulation planners, in particular those unfamiliar with software project management.

From past experience in the computer game industry, software project management and recent experience in creation of the experiment's simulation session, I can conclude that online emergency simulation creation is a creative process very similar to that of a computer game creation. The following work flow was devised as a result of lessons learned from this experiments' simulation construction.

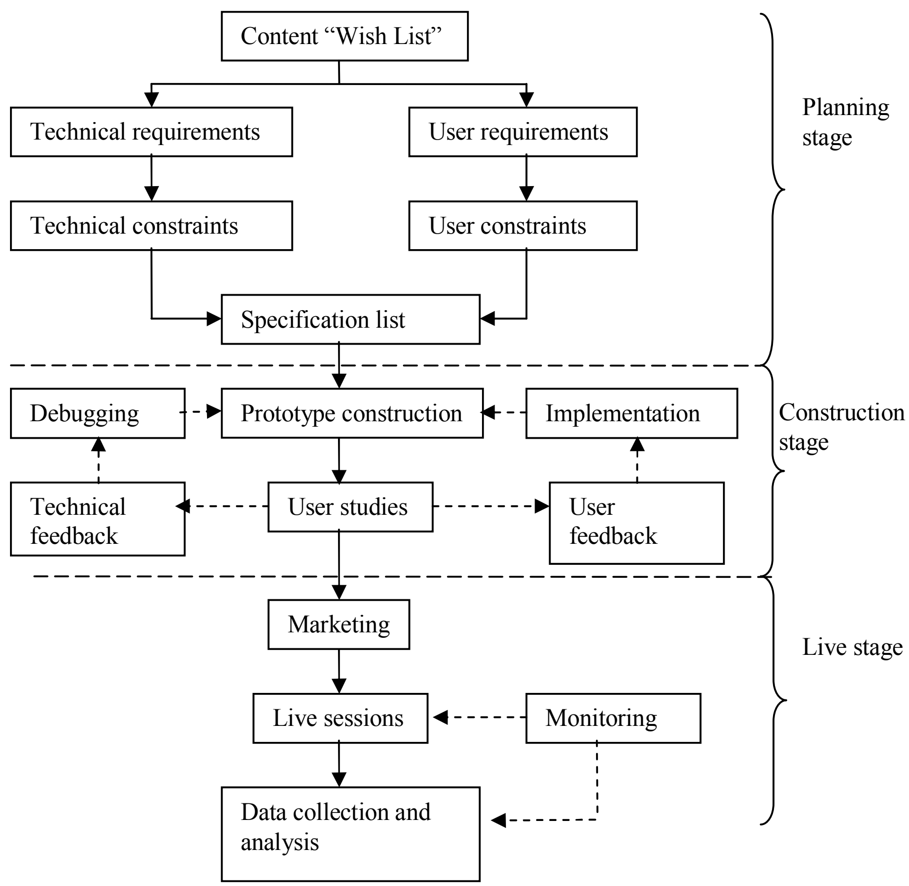


Figure A5-1 A generic emergency simulation workflow

An online emergency simulation construction process consists of three distinct phases:

1) the preliminary planning process which is the most important stage, and its outcomes will determine the quality of the other stages;

2) the construction stage, during which the simulation is prototyped, tested and changed according to feedback, and finally;

3) the Live stage in which the final version is used in order to produce the required data.

In each of the above phases the three main "building blocks" of the process have to be addressed. The "building blocks", which are interlinked between themselves, are:

1) the content "wish list" that sets the boundaries of the simulation. It contains a detailed scenario with:

- the event(s) that initiate the simulation (i.e. a disaster and its magnitude),
- their impact upon participating entities (i.e. in what form does the disaster's impact express itself),
- the affected population (their number and demographic profile),
- other involved parties (responding agencies etc),
- the relations between all involved entities (e.g. what are the conditions that trigger aid supply),
- the scale of the simulation (i.e. duration of emergency),
- the timeline of the scenario (where do participants begin the game, how much time can they dedicate to play, and at what stage does it terminate for them),
- the goals of each of the involved entities (i.e. survive for a maximal period of time, etc),
- what are the parameters that need to be examined by the simulation and how are they incorporated into the simulation (e.g. how does one measure community bonds, does this need a scale to be devised and incorporated into the game), the abstraction level of the simulation (what will the level of detail be, and what details are necessary in order to advance the plot), and if any,
- real life examples that can be relevant (these can be used to calibrate the above parameters, or to compare the logged data to);

2) the technical domain that is the materialization of the content part. The "wish list" is taken apart and every broad statement is examined and turned into a detailed list of requirements (e.g. "The virtual characters should fall as a result of the earthquakes' impact", "Every character inside a house should have his life points reduced by 50 %").

From this list all the parameters that are needed are defined in order to be able to monitor them and extract data from them. It is necessary to identify specific data that needs to be logged (e.g. what is the Health Points Status of each participant), what mechanisms need to be defined in order to log that data (a simple script, an external program, etc).

Once the above list is ready, it should be examined by a technical expert who will highlight the technical constraints and suggest the following:

- a suitable platform for development (whether an existing commercial game or a program that will be developed from scratch),
- the ability to create each of the "wish list" items, prioritization of each item (from the easiest to create to these that will require major work), changes that need to be made to items in order to create them. And most important of all,
- the time estimations for each item creation and approximated costs;

3) the users that are the target audience that will actually supply the input data. The requirements for this section are important as these are actually the data generators, so they should fit closely to the simulations' specifications. After the requirements have been determined, they are matched to potential real-life target audiences in order to see what constraints govern the target audience. For example: if a scenario that deals with the impact of a tidal wave upon a fishing village is constructed, and it is known that the affected population has strong communal relationships, the target audience of potential players needs to be composed of people that are well-known each other as it will better depict a real life situation. Another issue is the time that participants can spare for participation, and this should be observed carefully in order to obtain a reliable response. If the simulation planner aims for a three hour session and the players are totally bored after one hour, they might quit playing in the middle of a session. This time frame can be initially assumed, but more accurately determined after the user studies. The most important issue concerning the users is the marketing strategy that needs to be applied in order to attract as many as possible suitable participants. At this stage market research should be conducted, so that when the Live stage is reached, the simulation will have enough participants.

When all of the above "wish list" items and constraints have been re-evaluated the "Spec", or specifications document, can be written. This document should be very detailed and address all issues in all sections mentioned above: content, technical and user issues, as it will serve as a guideline for the simulation creation. The technical part should be written with the aid of a person with understanding of all technical issues, preferably a member of the development team, as it will be targeted mainly at the developers. The more detailed and clear this part is, the easier it is to obtain an evaluation of the costs and time frame needed for construction. Any conflicting issues should be resolved at that stage and not linger into the following stages. It should be noted that no changes should be made after this document is accepted by all parties, as changes might add complications and unforeseen work for the developer's team. The Spec should also state milestones agreed upon by parties (date for the first prototype, date for user tests, etc). The estimated length of this phase can range between a few weeks to a few months, depending on what scenario and detail level are chosen.

Once the Spec is finalized, the actual process of simulation creation can begin. This is usually the longest phase in the simulation construction process and can take in some cases more than a year to complete. Due to its length, regular meetings with the development team should take place in order to monitor progress, as well as to clarify technical issues, or supply moral support, this way problems can be solved as they arise and not accumulate or wait for prolonged periods of time. The construction phase consists also of Quality Assurance (QA) cycles in which the simulation is run and tested for its stability and for debugging purposes. Once stable enough, the simulation can be tested by human users, other than the development team. According to input from the human testers, the prototype can be debugged, or its content adjusted. It is notable that gamers in particular are valued testers and an effort should be made to recruit them for initial testing sessions, as they will try to "break" the game by performing actions that were not in the scope of the original simulation/game designer, as well as explore the virtual environment more than non-gamers, and as they are exposed to a variety of games, their input can be valuable.

The third stage, the Live stage is the period the experiment runs and data is collected. Its length can be determined by the time frame needed for sufficient data to be collected, or by monetary constraints such as web hosting or reimbursement budget. As mentioned before, the most important issue to address at this stage is summed in one word, marketing. As this type of simulation depends on large numbers of human users, its marketing should be done as professionally as possible. In reality, people involved in creation and development are generally not good marketing or salespersons, so if needed, a marketing budget should be allocated in order to attract participants, as without them there will be no simulation. Marketing can include a spokesperson who is acceptable to the target audience, promotional websites and posters, etc. Marketing however, should not start before a final version of the simulation exists, as the momentum created by the marketing will decline if it is aimed at some near future time that has no actual date.

Data collected, even if not analyzed immediately, should be monitored on a daily basis so that a rough picture of results can be seen. Problems with sample data can indicate bugs that need to be fixed without delay, otherwise precious data might get lost. Internet traffic rates (in case of a web game) should be obtained from the hosting company and monitored in order to verify that the game runs as it should both on the game servers, and on the client side.

A research staff member should log into the game in every session, so that the game can be monitored from inside for irregular behaviour demonstrated by participants. When such an example arises, it is strongly recommended that the offending participant is removed from the game. In order to do this efficiently he should preferably login as a "power-user" (Über-user/ Dungeon Master (DM)) that can actually remove or ban a player from within the game.