Survival in Dangerous Landscapes - A Game Environment for Increasing Public Preparedness

Ian BISHOP, John HANDMER, Angelinie WINARTO, Eric McCOWAN

1 Introduction

In developing our processes for design, planning and management of the landscape we are increasingly recognizing the temporal dimension (BASTIAN et al., 2006, DENG et al., 2009), although (STEPHENSON, 2010) argues that landscape analysis is still dominated by static perceptions. While progressive changes are being recognized in the landscape literature, sudden changes are seen to be in the domain of other disciplines. Landscape changes, on a temporal scale of hours rather than years, are typically destructive in some form and frequently lead to loss of life (human, stock and wild), habitat or property. We think of these rapid changes as rare and abnormal occurrences and consequently they are inadequately considered in landscape planning. Often flood maps, fire risk maps or seismic zones find their way into land suitability analysis and sometimes they have an effect on development patterns, but even in countries with sophisticated technologies and planning regimes people still settle in areas of high risk. Brisbane, the third largest city in Australia was extensively flooded earlier this year because large areas of floodplain are built upon. Less than a year earlier devastating fires killed 173 people mostly within commuting distance of Melbourne. Just as a flood plain can expect floods, so a dry schlerophyll forest can expect fires. They are a part of the landscape. If we are unable to mitigate the risks associated with these landscape then we must seek ways to adapt to them and give the landscape residents the best chance of understanding the processes at work, their potential effects and how to best respond when sudden change occurs. The remainder of this paper is focused on fire as a landscape element, but much the same approach could be taken to community awareness of other hazards.

A fundamental part of Australia’s community bushfire policy is the “Prepare, stay and defend or leave early policy” (2009 VICTORIAN BUSHFIRES ROYAL COMMISSION, 2010). Implementation requires that those at risk know what to do and know what to expect. So far, material available to householders explains what to do and how to do it, but is weak on what to expect during a fire. Those who have been through the experience often comment that they were taken by surprise by the noise, smoke and heat of the fire. Worse, this sometimes leads people who have decided to stay to change their minds and flee at the last moment – a dangerous action.

This gap in awareness is reflected in much current risk communication literature (BURNS et al., 2010, OLSEN & SHINDLER, 2007). Publications continue to make recommendations for public hazard education little different from recommendations made decades ago. Brochures and written material cannot provide an indication of the experience. Part of the difficulty for residents is that they (a) are not sufficiently aware of the necessary
preparations, (b) have no direct experience of what it will be like as the fire front approaches then arrives at their home, or (c) do not understand the many different ways in which a house may be made vulnerable and begin to burn. While the preparation may be set out in detail in a brochure, they are not necessarily remembered in critical situations. Ways are needed to provide a vicarious, and hence safe yet memorable, experience of the arrival and passage of a fire front.

Increased awareness can only improve the efficacy of the relationship between resident and landscape. The next section gives a brief background on the vulnerability of houses in fire prone landscapes. We then detail the objectives of the game environment, the development tools and procedures and a sense of the game experience. A brief conclusion looks at options for extension to other landscape learning situations.

2 House Vulnerability in Fire Prone Landscapes

There are three ways in which a bushfire can ignite a building (RAMSAY & RUDOLPH, 2003): embers and burning debris carried by the wind; heat radiation from the fire; and direct flame contact. Damage by strong winds, which are typical in fire conditions, can exacerbate the situation by allowing entry for burning debris.

Of these three modes, attack by embers and burning debris appears to be the major means of ignition (BLANCHI et al., 2006). Burning debris is produced as a result of burning of vegetation, buildings and other ignitable materials such as woodpiles and fencing, and is carried by the wind that accompanies bushfires. Showers of burning debris may attack a building some time before the fire front reaches that building, during the passage and for many hours after the front has passed. In contrast, the passage of the fire front with its attendant radiant heat and flame may as little as ten minutes.

Important factors that affect house survivability in a bushfire are landscaping, vegetation and house design (Figure 1). In the garden, certain types of garden and plants (especially deciduous trees) will inhibit the spread of fire across a property better than others. Ideally, buildings should have a fuel-reduced area around them. The idea is to minimise chances of direct flame attack or ignition from the effects of radiant heat. It also serves to provide a relatively clear area around a home to allow for ease of access during any fire fighting operations. Shrubs and trees planted close to the buildings are an obvious, and avoidable, fire risk.

Another important factor is house design. The simpler the shape and design of a house, the less chance there is of it catching alight in a bushfire (SCHAUBLE, 2004). In addition, garages and carports can be built as an integral part of the building, thereby avoiding discontinuities and re-entrant corners.

3 Objectives

Our objective was to use a popular computer game engine to create a game-like experience of defending a home during the passage of a bushfire front. Failure to properly prepare, or to become disoriented in the intensity of the fight against embers before and during the
I. Bishop, J. Handmer, A. Winarto and E. McCowan

passage of the front, or failure to adequately watch for fire after passage the front would lead to destruction of the house. We believed that this experience, with sufficient intensity, would create a greater sense of awareness than reading warning and advice documents. A second objective was to test whether the game did successfully recreate the experience and raise awareness. As yet, we have not been able to do this testing.

Fig. 1: Suggested layout for small property to increase fire safety (after SCHAUBLE, 2004)

4 Development Tools and Procedures

Virtual Reality creates three-dimensional spatial objects in order to create an abstraction of the real world. This virtual representation in turn draws on the user natural perception and memory of space and spatial relationship to create a new reality (BOYD DAVIS, 1996). The interactivity and dynamics of Virtual Reality can stimulate the user’s engagement with, and understanding of, the real world (GERMANCHIS et al., 2004). By this reasoning, an appropriate modelling environment, to provide a vicarious experience, would come from a popular form of Virtual Reality, a game, or the driver for games, a gaming engine.

The game Crysis is a first person shooter science-fiction 3D computer game developed by video game developer Crytek and published by Electronic Art. Its first version was released in Europe in November 2007. The gaming mode can be single player or multiple player (up to 32 people can play it at the same time online). Crytek’s CryEngine SandBox Editor 2 was chosen for this research as this game engine is able to:

- Create and model a true 3D environment and landscape
- Be used on a desktop PC or Laptop
- Allow users to interact with model and create interactive scenarios
- Allow real time movement around the virtual environment
- Provide animation and spatialised sound
- Offer powerful graphics quality without diminishing system performance to an unsatisfactory level (list modified from GERMANCHIS et al. (2004)).
The CryEngine Sandbox Editor comes packaged with the Crysis game. The Sandbox is a real time environment building and editing application. Geometry, surface and sound are authored in external applications and accessible via the Sandbox Editor to create the bushfire virtual environment. In addition, it is also affordable, the most stable, easiest to learn and currently one of the most powerful engines around (GERMANCHIS *et al*., 2007, TRENHOLME & SMITH, 2008).

## 4.1 Building the Bushfire Landscape

The CryENGINE2 Sandbox2 editor includes various tools that allow for a high level of customization. First among these tools is the aforementioned terrain editor, which can import or create and manipulate heightmaps. The terrain then needs to be painted with textures, and the game comes with a full library of textures for user selection. The vegetation placement tool allow the user to select from a series of different trees, which can be custom made, and use those to populate an area with it. Groups of these can be made, which in turn creates more realistic-looking areas because trees, small bushes, grass and broken branches can all be grouped and placed randomly in an area, each having characteristics such as size variation, rotation variation and alpha blending. To preserve performance, there is also a brush tool that allow for vegetation to be placed in the same way, only without any physical properties, making it useful for areas in the distance that the player can see but can’t access.

A typical three bedroom house plan was chosen from a database and computerised using the AutoCAD (AHP, 2010). The house plans were imported into 3DS Max where it was modelled. Other 3D static models were created in 3DS Max and some of the interior and landscape objects were found on-line (Figure 2).

![Fig. 2: View of the house in the landscape, and an interior view](image)

## 4.2 Modelling fire elements

Bushfire attack mechanisms are measured in terms of the heat and intensity of both the flame front and the flux of embers (burning debris and windborne debris), before, during and after the fire front. These parameters can be modelled through the particle effects available in CryEngine SandBox. For example, a sprite is a single picture with frames of an animation tiled across it (e.g. flames licking up from the base of a fire). This sprite can then be used in a new particle effect. From there, different colours may be assigned to it, along with extra ‘child’ effects and inherent properties. For example, a large fire in this project...
was formed by modifying a fire animation sprite, adding glow and lighting, sparks, base glow, extra flames (sprites) and noise. These attributes are all saved in an XML file. There were about 7 different types of fires in this project, ranging from small embers (Figure 3) to huge bushfires, all of which were built from different effects. Currently the particles can pass through solids, such as house walls. As well as fire effects, water sprinklers were also designed in such a way that when spraying down, the water only reached the floor and not below it. Extra effects like rising steam and splashes were also added to make the scene more realistic. Particle effects are placed as simple non-geometric entities in Sandbox2, and can be activated by a user event or simply remain static. They can also be linked to objects, so that wherever the object goes the effect stays with it.

Fig. 3: Ember fire activated in the game (left) and becoming beyond control (right)

4.3 Flowgraphs

The flowgraph editor is a feature of Sandbox2 that allows the user to script events in a similar fashion to programming, only that a visual interface is used instead of code. These flowgraphs can link player movement triggers, keystrokes and actions to other objects, missions/objectives and sequences, allowing the player greater immersion in the game. Logic flow is created by connecting various logic boxes to each other with lines between their input and output gates, and defining their properties and state changes (Figure 4). This allows the user to build complex levels without needing to write C++ code or LUA scripts. The entire mission structure, logic, custom events, triggers and effects of this level were all done within a single XML flowgraph, and used hundreds of logic boxes, each with events flowing back and forth to other boxes based on conditions, qualifiers or player triggers.
A potential scenario is that a burning ember could get into the house through gaps, and this could lead to a fire erupting in the living room. This triggers the creation of a small fire. When the owner of the house is not around to protect the house (i.e. extinguish the small fire in time), the fire erupts into a big fire, engulfing the whole living room. This fire would spread to the dining room, and create a huge wave of fire in the dining room and when it reaches the gas-bottle, an explosion happens. Thus the whole house burns down.

Before a level created in Sandbox2 can be played, it must be readied for engine use. After export, the level may be played in ‘pure game mode’, as opposed to the quick gameplay option whilst in the editor. However, a few other steps should be taken to ensure the level is playable by most users. Efficiency is important in level design, as this directly affects the frame rate. Too many things going on like lights or explosions will cause a significant increase in the amount of time it takes the engine to calculate each frame, lowering the fluidity of the game.

5 The Game

The developed game was designed to run over two virtual days. On the first day, the resident/player was made aware that the next day would be one of extreme fire danger - dry fuels, high temperatures, strong winds. They would have game time on that day to make preparations in their virtual home. They had the opportunity to:

- Remove a limb from the overhanging tree
- Clear leaves from the gutters
- Remove wooded furniture and debris from around the house
- Fill the bath and water back pack
- Find fire extinguisher and check torch batteries

The second day begins with the resident waking in their bedroom, the news on the TV says that a fire is in their area, soon the sky is turning red and the noise level is increasing. There is still time to fill the bath and retract the curtains but not much else since soon there is smoke around and fire in the hills (Figure 5).

When the fire front arrives – accompanied by intense noise – ember fires will start around, and in, the house. The worse the preparation the more of these fires will start. These can be put out fairly easily using an extinguisher or a back-pack sprayer, but the process will be tiring and personal energy levels will drop. If the fires cannot be put out quickly enough they will of course become larger and much more difficult to quell. The electricity may fail. The water supply may fail. It will become considerably darker during this period.

If the home is still intact after the front has passed it will still be necessary to again check the interior including roof space (dark) and other locations to ensure that all is safe. If all this is done properly the home will be safe.
6 Discussion

The game as developed to date covers the situation of a single person who is committed to remaining with their home and dealing with a specific house, garden and fire situation. This initial prototype could clearly be extended in a number of ways.

- Development of the initial single player experience into a multi-player experience to develop a team approach
- Development of a set of homes with different physical characteristics in different landscape conditions
- Different fires scenarios – direction of approach, surrounding landscape, intensity, wind speed etc
- Incorporation of an initial decision phase in which people must choose whether to evacuate or stay and fight for their home
- Addition of a contingency plan if the house catches fire uncontrollably.

At this stage also, the fire simulation is not based at all on physical process models of fire behaviour. These models are complex and still not especially accurate, in addition use of a process model could slow to game to the extent that the game becomes unplayable. The events are however based on observations of behaviour and research into building vulnerabilities (LEONARD et al., 2004). To effectively test the influence of different landscape or building conditions this aspect of the fire behaviour and vegetation and building response would need to be much more rigorous.

The game technology will develop further to include better representation of natural processes (see for example fromdustgame.com) and greater use of multisensory stimuli. At the same time, our knowledge of the processes of natural events in the landscape, including those we think of as 'natural disasters' will improve. Consequently, we can expect greater use of tool such as our game to increase awareness and improve decision-making at all stages of landscape planning, design, management and emergency response.
7 References


Acknowledgements

This research was supported by the Cooperative Research Centre for Spatial Information and the Bushfire Cooperative Research Centre. Narelle Irvine assisted with the game development.