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WHAT ELEMENTS OF GAME DESIGN PROVIDE 'EMERGENT GAMEPLAY'?

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Abstract

This paper seeks to understand how industry professionals define the concept of emergent gameplay, and why they consider it to be such a desirable element of game design. Several successful titles are then examined to establish which design features that promote emergent gameplay they have in common. One such feature is then implemented into a game that was created as part of this research, which uses a logging technique to analyse how well that feature contributes to emergent gameplay.

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Preface

The moment I saw Sonic the Hedgehog, my life changed forever. The thrill of playing computer games absorbed me completely, and I knew at that moment that I wanted to make my own games and share that experience with others. It wasn't until much later that I learned that creating games to a high standard is no simple feat, however; programming them requires enormous technical skills, and designing them is both a meticulous and arduous art. This project embodied my desire to understand games, and what aspects of them provide such enjoyable experiences.

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1.1 Introduction

The purpose of this research paper is to establish how effective a given game design feature is at providing emergent gameplay. The Literature Review justifies the value of pursuing this task by examining how industry professionals define emergent gameplay and the reasons why they consider it to be such an important ingredient to making successful games. Several popular market titles are then reviewed to construct a comprehensive view of what design elements they have in common, and how those elements have been leveraged in order to encourage emergent gameplay.

Having identified what design components the aforementioned titles share, the feature that provides the simplest approach to facilitating emergent gameplay is then implemented into a game that has been specifically developed to supplement this research. The game uses a log-file system to record the player's actions, providing a basis for analysis of whether or not the selected design technique was successful in enabling emergent gameplay to occur. The game also has an alternative mode from which the emergent gameplay feature is absent, for comparison purposes.

2.1 Literature Review

Game developers seek ever more effective techniques of immersing players into their games in order to make them better and therefore sell more; and the term 'emergent gameplay' has become a trending buzzword throughout the games industry in recent years as a method of achieving greater immersion (Madigan, The Psychology of Immersion in Video Games, 2010).

There are many definitions of what emergent gameplay actually means, and several key works that reconnoitre the concept in great detail. In order to discuss them in clarity however, the terminology of the games industry should be explained to remove ambiguities in the reader's understanding.

2.2 Gameplay

"If we desire to understand games and game design, we must first clearly establish our fundamental orientation. We must define what we mean by the word 'game'." (Crawford, The Art of Computer Game Design, 1984)

In *The Art of Computer Game* Design, Chris Crawford attempts to define the term 'game' using a series of dichotomies that together can be interpreted to describe a game as "an interactive, goal-oriented activity, with active agents to play against, in which both the players and the agents can interfere with each other". This definition stems from elements that all games appear to have in common. Crawford refers to these respective elements as representation, interaction, conflict and safety.

Representation refers to the subjective and objective emotional reality created by a game, for the purposes of supporting the player's fantasy. This representation is the key to psychologically engaging the player with the game, and is often referred to as 'suspension of disbelief'.

Interaction is perhaps the most important defining aspect of a game, adding the social or interpersonal aspect which makes a game distinct from a simple challenge. For example, a puzzle is passive by nature, since once the solution is found, the puzzle is no longer interesting. This is in contrast to a multi-player game, whereby opponents may employ a wide variety of tactics so that the game is overwhelmingly unlikely to be played the same way twice.

Conflict arises naturally from the interaction within a game, since the player is actively pursuing a goal and obstacles are preventing the goal from being reached, presenting a challenge. It does not necessarily have to be direct or even violent, but conflict is present in games nonetheless. Crawford states that conflict is inevitable if the obstacles are active or dynamic, purposefully responding to the player's actions and actively attempting to hinder the player's attempts to reach their goal.

Safety is an attribute of games because the conflict involved does not actually result in harm to the participants, even though the term 'conflict' implies that there is danger of harm occurring. In other words, games facilitate the psychological experience of conflict and danger without subjecting the players to the physical consequences. This is perhaps one of the most compelling features of games, since there is an important distinction in the separation of the actions and reactions happening within the game from real life, and the consequences of playing the game itself (which remain a reality).

Crawford uses the example of losing to another player in a game, which tends to result in a loss of dignity, as an example consequence of playing a game that permeates reality. This may be a significant deterrent to playing the game in the first place. To combat this, many games are designed so that their risk-versus-reward structure ensures minimal penalty for losing, besides any small investment that was made to enter the game to begin with. Games that involve gambling are exceptions to this rule, however, and therefore use other psychological hooks to draw in players, such as the potential for a large win.

Many computer games that only support a single-player experience often lack enough diversity to fulfil Crawford's criteria for 'interaction', and typically try to compensate for it through some other means; such as complex AI that can react to the player with sufficient richness to keep the game exciting. The most common approach is to leverage a game's advantage in narrative over linear storytelling like books or film, in that the player is free to act out the story for themselves in a story-driven game. This is another method of making single-player games stimulating, and some modern games take this to entirely new levels by allowing the whole course of the story to be changed by the player's actions; though limitations are usually in place, since the key choices and branches in the story are usually explicitly designed in order to maintain coherency in the story path as it progresses.

With the presence of an intelligent agent, such as a sophisticated AI or human opponent, a game satisfies the requirement for an element of 'conflict'. This is in contrast with situations where the obstacles to the player reaching their goal are merely passive or static, in which case the conflict is simply analogous to a puzzle or athletic challenge. Since there are no adequate examples of games that do not contain any conflict, Crawford concludes that conflict is fundamental to making an enjoyable game. To eliminate conflict from a game that does not emphasize cooperative efforts alone, the game would not be able to respond to the player's actions, and therefore the interactive aspect of would be destroyed.

Other variations arise in the definition of a game because some consider them as an unreserved form of art, since they are an expression of ideas (Costikyan, 1994). Also, games are made distinct from work as an activity since gaming is undertaken for enjoyment, whereas work is carried out for remuneration. This makes it difficult to categorise professional game players, like athletes and sportspeople.

"A game is a form of art in which participants, termed 'players', make decisions in order to manage resources through game tokens in the pursuit of a goal." (Costikyan, 1994)

Crawford acknowledges this difference of opinion in his second book, *Chris Crawford on Game Design*, and presents a 'taxonomy of creative expression', stating that the point of contention can be shown with either the presence or absence of the first-most layer in the following diagram:

Figure 1: Taxonomy of Creative Expression

Here we see that a creative expression is art if only made for its own beauty; whereas if it is made for money, it is entertainment. A piece of entertainment is a 'plaything' if it is interactive. Non-interactive entertainment pieces include movies, books and music. If the plaything has no rules or goals associated with it, it is simply a toy; otherwise it is a challenge (Crawford, 2003).

If the challenge has no active competitor (AI or human), it is a puzzle, otherwise the presence of competitors provokes conflict. Crawford admits that this is subjective, since purely algorithmic AI may not qualify as a competitor. If the player can legally interfere with the performance of their opponents, or legally be hindered maliciously by the opposition, then the conflict is a game. If it is against the rules to interfere with the performance of other competitors, the conflict is simply a competition instead. Racing is a common example of a competition.

Ben Betts, Managing Director of HT2, creators of innovative Learning Technologies, supported this taxonomy in every respect other than one: not all creative expressions are created for money, and are not necessarily art either (Betts, 2010). In particular, he is referring to 'e-learning' games, which are often created purely for educational purposes and not for profit; though there are other examples of non-profit games in existence that are not educational, such as Zoë Mode's music puzzle, *Chime* (Ivan, 2009) (Zoë Mode, 2010).

Eric Zimmerman and Katie Salen provide a definition of a game that is broader but more concurrent with that of Crawford's; "a game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome." (Zimmerman & Salen, 2003). They explicitly mention the state of conflict and the presence of rules in a game, but do not mention art.

2.1.1 Ambiguities of Gameplay

"The world of game design has been swamped in a madcap array of terminology. We've got videogames, computer games, and just plain old games. We've got sims, shooters, and RPGs. Even the basic terminology is difficult to make sense of." [Sic] (Crawford, Chris Crawford on Game Design, 2003)

Crawford argues that gaming terminology has saturated day-to-day language usage to such an extent that our understanding of what constitutes interacting with a game activity has been diluted. For example, one might say "I'm game" to indicate willingness to participate in something, or "I'll play along" to state tolerance of a distasteful activity. The issue is perpetuated by people whom ignore the complexities of game design, leaving others that do not without a means of clearly discussing those concepts (Crawford, 1984).

The ambiguity surrounding games is problematic, because while it is true to say that we play games; we also play with toys, which are distinct because a toy lacks any associated goals (Crawford, 2003). It is these goals that transform play into the structured activity of gaming. Because widespread use of gaming terminology has led to this distinction becoming vague, there are numerous titles which are generally considered to be games, but by Crawford's definition they are actually toys. Such titles include Maxis' *The Sims* series (Maxis, 2010; Maxis, 2011) and *SimCity* series (Maxis, 2009).

While both such examples are simulation-type games, this does not mean to say that all simulation-type games should be discounted, however. Many simulators fall under the gaming umbrella because they provide scenarios and contexts that provide the goals, rules and challenges necessary to qualify as games. Such games include Bohemia Interactive's *Operation Flashpoint: Cold War Crisis* (Bohemia Interactive Studios, 2001), and Maddox Games' *IL-2 Sturmovik* (Maddox Games, 2001). These games attempt to simulate highly realistic physics, but gameplay revolves around either fictional or reconstructed scenarios within which the player can participate. Crawford argues that games need only simulate as much is necessary to satisfy the needs of the gameplay, using a coin-

operated arcade game about dogfighting planes as an example – the game featured flying, but was not a flight simulator; it was a game about shooting down other planes and avoiding being shot, therefore it did not need to accurately simulate all of the aspects of flying a plane in order to fulfil its purpose (Crawford, 1984).

The ostensible reason for the ambiguities in the definition of 'games' and 'play' stems from their fundamental role in life. In both of his books, Crawford states that 'play' originates as an educational tool that has been around for so long that it predates mankind altogether, and was therefore not a human invention at all. The evidence for this is apparent throughout nature, where we see juvenile animals play-fighting, for example. The motive for doing this is not to while away the time, but to hone skills of hunting and survival, to learn how to catch prey or evade predators without being injured, and all with the presence of safety and the other game elements previously mentioned (Crawford, 2003).

2.1.2 Gaming Motivation

"Games are a form of entertainment – developers make them for people to play and enjoy. To ignore the role of players in your games, and the importance of their feelings and contribution, is an oversight that I cannot overstate." (Sweetser P. , Emergence in Games, 2007)

While Crawford claims that learning is a fundamental motivation for all gameplay, he recognises that it is not the only motivation, and that in adults these secondary motivations may be of greater importance (Crawford, The Art of Computer Game Design, 1984). They essentially pertain to a desire to experience emotions like excitement and curiosity, which are not often found in everyday life. Games also provide a way of demonstrating prowess, allowing the player to experience a satisfying sense of achievement, and many games are explicitly designed to capitalise on the feedback of this positive stimulus relationship to encourage repeated gaming sessions (Madigan, Phat Loot and Neurotransmitters in World of Warcraft, 2007).

A game player experience research and consulting company, XEODesign®, conducted a study that attempted to shed light on the reasons why we play games (Lazzaro, 2004). The study has a strong focus on emotion, stating that their results revealed that "people play games not for the game itself, but for the experience the game creates: an adrenaline rush, a vicarious adventure, a mental challenge; or the structure games provide, such as a moment of solitude or the company of friends". This revelation fits with Crawford's reasoning behind the motivations to play games in adults, and also with the element of safety that he believes to be a defining aspect of games.

With their results, XEODesign® establishes four key areas to emotion without story that contribute to why we play games, and note that the best-selling games used in their analysis created emotion in at least three of the four key areas, labelled Hard Fun, Easy Fun, Altered States and The People Factor. Crawford disregards 'fun' as a meaninglessly subjective term; however, Lazzaro uses it in each of

these key areas with the implication that it is general motivation for playing a game and experiencing emotion.

Players that like the opportunities for challenge, strategy and problem solving are drawn to Hard Fun. These games typically have a structured approach to achieving a goal, and generate emotions such as frustration or personal pride (upon achieving the goal). Players in this mind-set often play just to challenge themselves, or are 'completionists'; and the games typically include multiple objectives, requiring strategy rather than luck to complete.

Other players may focus on the enjoyment of experiencing the actual game activities, rather than a reward for completing them. These players tend to have a strong sense of curiosity, and the games employ deliberate ambiguity to entice the players into consider options and find out more. This category is referred to as Easy Fun, and provokes emotions like wonder, awe and mystery, and encourages players to become immersed in the game world.

The third key, Altered States, refers to players that describe enjoying changes to their internal feelings during and after play. It focuses on aspects of the game which are external to the player, but create emotions inside the player; this is the result of perception, behaviour and thought being combined into a social context that produces internal sensations similar to excitement or relief. Players drawn to this area play to move from one mental state to another, or to think or feel something different.

Finally, The People Factor refers to many players who centre on the enjoyment of playing with others inside or outside the game, and specifically structure their game experiences to enhance player-to-player interaction, to the point where participants may even play games that they don't like, just to spend time with their friends. These players may desire social bonding, or simply recognition from their peers, and games that demonstrate this key area often promote teamwork, where the pursuit of shared goals yields significant rewards.

These sought-after emotional experiences are often termed 'escapism', whereby a person is attempting to escape from the perceived unpleasant or banal aspects of their daily lift by means of entertainment or recreation (Yee, Rapid Communication, 2006). Although the media layman often portrays this with negative connotations, it is usually only when escapism is taken to an extreme that it becomes a problem. In such cases, it suggests that the person in question is unhappy, with an inability or unwillingness to connect meaningfully with the world (Cagayat, 2011).

Extreme cases aside, there is a link between escapism and immersion (Yee, Method, 2002) (Nacke & Lindley, 2008), in that an immersive game provides an engrossing world for the player to 'escape' in to, leaving behind their day-to-day life in order to experience an entirely new world. Indeed, Crawford says "good games do not simulate physical reality; they mirror emotional reality" (Crawford, 2003). The deeper and richer the interactions in the game world, the easier it is to become immersed within it.

In 2005, Penelope Sweetser and Peta Wyeth presented “A Model for Evaluating Player Enjoyment in Games”, called GameFlow (Sweetser & Wyeth, 2005). The model was developed to draw together various heuristics into a concise model of enjoyment in games that is structured by flow, consisting of eight elements: Concentration, challenge, skills, control, clear goals, feedback, immersion and social interaction. Each element includes set criteria for achieving enjoyment in goals, and the model was validated by conducting expert reviews of two real-time strategy games that had received differing critic ratings – one rated highly, the other poorly. Sweetser et al. state that the model was successful in distinguishing between the games and the reasons that one was more successful than the other. Furthermore, GameFlow is intended to be much better-rounded and generally applicable as a review tool than previous methods of modelling enjoyment in games, which Sweetser regards as too narrowly focussed or specific to particular game genres or social contexts.

Sweetser et al. go on to cite Mihály Csíkszentmihályi’s research into what constitutes an enjoyable experience (Csíkszentmihályi, 1991), upon which Csíkszentmihályi established the Flow model upon which GameFlow is based. Csíkszentmihályi states that the elements of the Flow model combine to cause a “sense of deep enjoyment that is so rewarding that people feel that expending a great deal of energy is worthwhile simple to be able to feel it”, and that Flow is an experience “so gratifying that people are willing to do it for its own sake, with little concern for what they will get out of it, even when it is difficult or dangerous”.

Critically, Sweetser et al. state that “the activity must be intrinsically rewarding and ‘autotelic’. This rings true in games because people play games (computer games and otherwise) for the experience itself, as there is no external reward. Finally, every flow activity provides a sense of discovery, a creative feeling of transporting the person into a new reality, which is a familiar concept for game players”. This statement fits with the description of escapism, coupling it with the motivation to play games that was previously mentioned.

The eight elements of Csíkszentmihályi’s Flow model are adapted to the context of games for GameFlow as follows: “The first element of Flow, a task that can be completed, is not represented directly in the GameFlow elements as it is the game itself. The remaining elements of GameFlow are all closely interrelated and interdependent. In summary, games need to keep the player’s concentration through a high work load, but the tasks bust be sufficiently challenging to be enjoyable. The player must be skilled enough to undertake the challenging tasks, which should have clear goals, and the player must receive feedback on their progress towards completing them. If these criteria are met, then the player will feel a sense of control over the task. The result is a feeling of total immersion or absorption into the game, which causes the player to lose awareness of everyday life, lose concern for their self, and have an altered sense of time. The final element of player enjoyment, social interaction, does not map to the elements of Flow but is featured highlight in user-experience literature on games. People play games for interaction with other people, regardless of the task, and will even play games they do not like or if they don’t like games at all” (Sweetser & Wyeth, GameFlow: A Model for Evaluating Player Enjoyment in Games, 2005). This further supports the links between

escapism and immersion, and the last point in particular reinforces the findings of XEODesign® in regards to the "People Factor" key to emotion in games (Lazzaro, 2004).

2.3 Immersion

"Immersion relates to drawing the players into the game and affecting their senses and emotions through elements such as audio, graphics and narrative." (Sweetser P. , Emergence in Games, 2007)

Immersion refers to a state of consciousness whereby a person's awareness of their physical self is diminished or lost by being surrounded in an engrossing total environment, which is often artificial (for example, game worlds). This mental state is frequently accompanied by spatial excess, intense focus, a distorted sense of time, and effortless action (Varney, 2006). The term is acknowledged as being subjective, and in some cases, ambiguous (Nacke & Lindley, 2008); but studies that have been undertaken have identified progressive 'stages' of immersion, referred to as 'engagement', 'engrossment', and 'total immersion' (Brown & Cairns, 2004); and have categorised the forms of immersion, into 'sensory', 'challenge' and 'imaginative' (Ermi & Mäyrä, 2005) sources.

Sensory immersion results from the use of more detailed and realistic graphical effects and audio by the game, which may also be affected by the quality of the hardware upon which the game is played (Nacke & Lindley, 2008). Challenge based immersion ties in with Csíkszentmihályi's model of Flow, in that the difficulty of the challenge presented by the game needs to be balanced against the skills of the player in order for them to find it enjoyable (Csíkszentmihályi, 1991). Imaginative immersion refers to the absorption into the narrative of a game or identification with a character – synonymous with emotions like empathy and atmosphere, which in turn may be influenced by sensory immersion (Nacke & Lindley, 2008).

One way to gauge whether or not a game is immersive is to see whether or not it can evoke an emotional response (Sweetser P. , Emergence in Games, 2007, pp. 48-49), such as fear or happiness, which fits well with Csíkszentmihályi's model of Flow and with XEODesign's keys to emotion in games. Audio is very effective at stimulating emotions, and has been used to great effect in films for quite some time; such as music that builds suspense or fear in a horror movie (Sweetser P. , 2007). Games have had some difficulty capturing this in the past because of the unpredictability of the player, however, modern games are sophisticated enough to use dynamic music that changes based on the current situation. In recent strategy games it has been common to see dramatic changes in the pace of the music when units engage in combat, such as in Gas Powered Games' *Supreme Commander* (Gas Powered Games, 2007), or even fully procedural music like in Maxis' *Spore* (Maxis, 2008).

Jamie Madigan explains that many psychologists refer to the phenomenon of immersion as 'spatial presence' (Madigan, The Psychology of Immersion in Video Games, 2010), and that it is defined as when "media contents are perceived as 'real' in the sense that media users experience a sensation of

being spatially located in the mediated environment" (Wissmath, Weibel, & Groner, 2009); in other words, games, books, movies or any other media create spatial presence when the user beings to feel like they are 'there', inside the world portrayed by the media. Madigan simplifies the theory behind why this happens; firstly, players form a representation of the space or world which the game is presenting to them in their minds, and secondly, they begin to favour this media-based space as the point of reference for where they 'are' (the location of their 'primary ego reference frame') (Madigan, 2010).

Madigan goes on to say that the two most important characteristics of games that facilitate immersion are the creation of a rich mental model of the game environment and the creation of consistency between the things in that environment. To enrich the game environment, multiple channels of detailed sensory information should be used in conjunction with a strong and interesting narrative, plot or story. Multiple channels of sensory information refer to the provision of input to multiple senses at the same time in complementary ways. Many forms of media, including games, are restricted in the number of senses they can affect, usually to audible and visual stimulus. In particular, it is rare to see a game that involves taste or smell, which is especially true of computer games; although some use movement as an input or force-feedback peripherals for touch, such as *Kinect for Xbox 360* (Microsoft Corporation, 2010) or *PlayStation Move* (Sony Computer Entertainment, 2010) – which were developed to be more natural methods of controlling a game, mapping real-life actions more closely than most other input devices. Also, 3D games and films have been growing in popularity as they provide an enhanced visual experience; and likewise, surround-sound systems enrich the audio that we can get from media.

The detail and completeness of those channels of sensory information fill in the blanks in our mental model of the game world. This contributes to the second of the aforementioned categories, consistency; because it is important that the player spends as little time as possible forming subconscious explanations for absent information. This is dangerous to immersion because those assumptions may be incorrect, meaning that when the game does present that information, it may not meet the player's expectations and damage their 'suspension of disbelief'. It's also important for the environment to be cognitively demanding; meaning that the player should be focussed on what they are doing; if they are busy exploring and navigating the world, they are less likely to notice shortcomings in the game that would break their immersion (Madigan, 2010).

Madigan provided an expanded version of his article on The Psychology of Immersion for GamePro (Madigan, 2011), which discussed the fact that there is some resilience in a player's 'suspension of disbelief' that is not properly understood, in that some incongruous elements of the game like the heads-up-display or loading screens may be accepted and ignored by the player. The same can be said of films and television, which are riddled with artificial jumps in time or cuts between different camera angles, or special effects that don't actually make any sense (like hearing explosions in space), which are just accepted for the sake of having a good time. Tolerance of these things varies

from person to person, with some being more readily absorbed into media-based worlds than others, based on a variety of reasons such as past experiences.

Sweetser refers to consistency, immersion, intuitiveness, freedom and physics as separate ingredients to the interaction within a game, which when combined, help to transition the player into the game world (Sweetser & Johnson, Player-Centered Game Environments: Assessing Player Opinions, Experiences and Issues, 2004). However, each of these components appears to relate to the others.

Intuitive interactions meet the player's expectations about how they can interact with objects in the world; expectations that are formed by the player's past experiences, and by the appearance of objects, which should suggest what the possible interactions are, as described by Donald Norman in *The Design of Everyday Things* in regards to object affordances (Norman, 2002, pp. 9-11). In relation to this, games that are more intuitive are easier for new players to learn because they are easier to relate to with real-world familiarity; but more experienced game players have come to expect games to behave in particular ways, which can make it difficult to design a successful game that goes against the grain (Sweetser P. , 2007, pp. 49-51). The important consideration is to make the options for basic interactions in the game world obvious in order to achieve intuitive gameplay.

There are similarities in Madigan and Sweetser's views on 'consistency' in games, because of the logical conclusion that objects which behave in a consistent manner allow players to learn the rules of the game more easily, which leads to less confusion and frustration. Game worlds that behave consistently in ways that the players can understand allow them to become immersed easily, whereas inconsistencies remind them that they are playing a game, destroying the immersion. Sweetser states that it is important that objects with similar behaviour are also visually similar, whereas objects that have different behaviour are clearly different in appearance as well (Sweetser P. , 2007, pp. 46-48).

Freedom refers to the ability of players to express their creativity and intentions within the game, allowing them to play it in the way they want, rather than how the designer wanted them to play it. Many games limit the number of choices that the player can make because it is easier to develop. Unfortunately, the linear path that results from this restricted freedom may be unintuitive to many players because they are unable to match the designer's conceptual model of how to solve the problem, something also discussed in a non-game specific context by Norman (Norman, 2002, pp. 12-17). Games that define global possibilities for player actions grant them more freedom to express their creativity, forming a conduit for emergent gameplay as the player may choose to do something unanticipated by the designers as they explore the game's possibility space (Sweetser P. , 2007, pp. 51-52).

The physics category refers to the fact that games only simulate a sub-set of what is applicable in the real world in order to focus on what contributes to the value of gameplay, as described by Crawford (Crawford, 1984), cited in 2.1.1 Ambiguities of Gameplay. This means that inexperienced players may

be puzzled by game physics that might not accurately simulate breakable windows or fluid dynamics, meaning that they must 'relearn' the physics of the game world (Sweetser P. , 2007, pp. 52-53); but the more accurately the game does simulate physics, the more intuitive it will be (Sweetser & Johnson, 2004).

2.4 Emergence

"Emergent gameplay is made possible by defining simple, global rules, behaviour, and properties for game objects and their interaction in the game world and with the player. Emergent gameplay occurs when interactions between objects in the game world or the player's actions result in a second order of consequence that was not planned, or perhaps even predicted, by the game developers, yet the game behaves in a rational and acceptable way." (Sweetser P. , Emergence in Games, 2007)

In her book, *Emergence in Games*, Penny Sweetser introduces the topic as one that has garnered much debate in recent years. Developers and players agree that open and natural gameplay would be a good thing, where players can choose their own strategies, and games feature conduits for unbridled imagination and creativity. However, to achieve this, the developers must reach a compromise between the level of control that they have over the unfolding events in the game and the control that they place in the hands of the player.

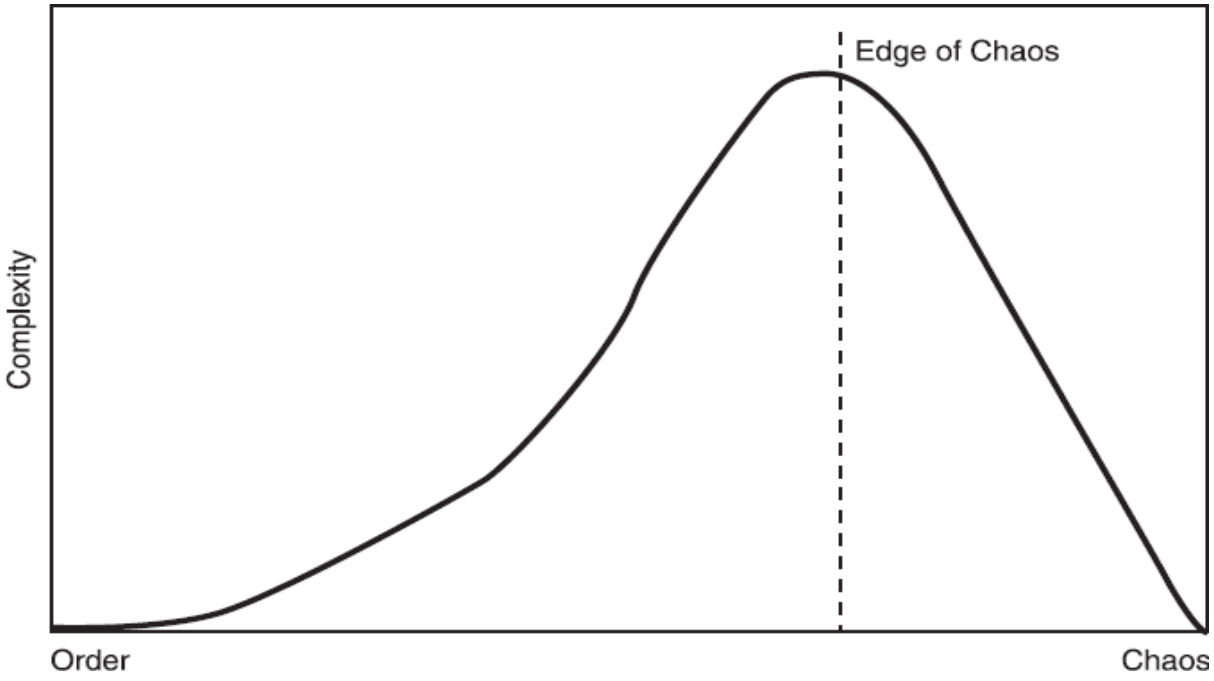
"The interaction of the parts is so fundamental to the system as a whole that the system cannot be described without describing the parts, and the parts cannot be described without describing how they relate to each other." (Sweetser P. , Emergence in Games, 2007)

Emergence occurs in complex biological, physical and social systems throughout life; those systems are collections of other complex systems, which in turn are other systems, and so on. This means that there is potential for something new to be created from simple entities interacting with their local environment and each other. Sweetser describes the result of this as "when these entities come together to form the whole, the whole is not merely a collection of these entities, it is something else entirely", and uses the biological example of a humans to illustrate this; "a brain is not a collection of neurons; it is a thinking machine. A human is not several connected systems; it is a sentient being. A society is not a group of co-located people; it is a powerful network capable of phenomenal behaviour. The whole that is created from the collection is something new, with new properties, behaviour, structure, and potential" (Sweetser P. , 2007).

This hierarchy of interacting systems is related to Chaos Theory – tiny fluctuations in the initial conditions of an emergent system result in vastly different outcomes in the higher levels, as the differences in conditions are amplified at each higher level in the system (Wolfram, 2002). This is popularly referred to as 'the butterfly effect', which presents the notion that a butterfly flapping its wings could trigger a chain of events that result in the formation of a tornado on the other side of the Earth (Bar-Yam, 2000) (Dizikes, 2008). For the optimum possibility of creating emergence, there must

be a compromise between order and chaos. In a perfectly ordered system, the outcome of any input is entirely deterministic, whereas in a purely chaotic system, the outcome is entirely random. Between these extremes lies an ideal point at which the behaviour of a system is balanced between being locked into an ordered pattern and dissolving into chaos. This point is referred to as 'the edge of chaos'; and Sweetser describes it as such: "At the edge of chaos, the system has enough stability to sustain itself, but enough randomness to evolve and adapt" (Sweetser P. , 2007).

Figure 2: Order vs. Complexity



Sweetser states that most complex systems have a common set of properties, which include elements, interactions, formation, diversity, environment and activities, and gives contextual examples of several different systems such as the human brain. An example emergent behaviour that has been successfully implemented into games is an approximation of the flocking behaviour exhibited by birds, herd animals, insects and fish, based on the work of Craig W. Reynolds' steering behaviours (Reynolds, 1999).

In a simplistic flocking simulation, individual members of the flock (termed 'boids' by Reynolds) move around based on a desire to satisfy several needs; to stay close to, but avoid colliding with, other members of the flock. To achieve this, each boid makes assessments of the direction and proximity of other nearby boids, and decide on which direction to move based on this, and then attempt to move there. Because each boid's behaviour is so dependent on what the rest of the flock is doing, highly emergent behaviour is created. The model can also be extended to include more stimuli to the boids (like fleeing from a predator), to yield even more realistic and desirable results.

The collective behaviour that appears within small, localised parts of a system are termed ‘local emergence’, whereas the behaviour of the system as a whole, with the interactions of those smaller systems taken into account, is called ‘global emergence’. Sweetser uses this distinction to categorise emergent behaviour occurring at different levels and to varying degrees. She also states that emergent systems exhibit common elements and adhere to common rules; and provides a distinction between ‘complex’ and ‘complicated’ in that a complex system provides the possibility of emergence because the entities in a complex system do not merely co-exist, they are interconnected and interdependent.

“The concept of ‘emergence’ describes the properties, behaviours, and structure that occur at higher levels of a system, which are not present or predictable at lower levels.” (Sweetser P. , Emergence in Games, 2007)

Sweetser goes on to say that the levels of emergence that have been possible in past games were quite limited, and groups these levels into three ‘orders of emergence’, referred to as ‘first-order’, ‘second-order’ and ‘third-order’, respectively: First-order emergence is the most common and the most basic form of emergent behaviour, and pertains to events or local interactions in the game world have knock-on consequences. This is usually provided by something simple such as movable objects and a physics engine that allows them to bump into each other. Second-order emergence occurs when players use basic elements of a game environment to form their own strategies in new ways, which is still a local effect. Examples of second-order emergence include using combinations of basic actions or abilities to achieve new behaviours or strategies. Third-order emergence affects the game as a whole, and exists where the boundaries of the game are flexible enough for the player to create new and unique paths through the game, resulting in entirely new gameplay that the game is still able to cater for with divergence in narrative, flow, character interactions or social systems.

The degree to which the components of a complex system are interdependent and interact is counterintuitive to many programming paradigms such as encapsulation, inheritance and polymorphism. This problem can make it difficult for developers to implement emergent behaviour into their games. Sweetser mentions that a property based system alleviates this issue – the game world defines the rules of how objects within it can interact, and the objects or entities in the world are given properties which are used to determine what interactions can take place between the objects.

To keep these interactions consistent, as defined as an important part of immersion, the rules and properties of objects should be defined globally. It becomes easy to introduce a bug or error into the game if the possibilities for interaction are defined locally for each individual object, since there may be a particular interaction that gets overlooked. For example, if the players learn that in once instance they can kick a barrel to break it, they can become confused and frustrated if in another instance they come across a barrel that they cannot break by kicking it (Sweetser P. , 2007, pp. 47-48).

Another of Sweetser's models, called 'Active Game Worlds', was developed to combine influence maps and cellular automata to create more reactive AI in games, creating a greater challenge with AI that behaved in a more convincing way (Sweetser & Wiles, 2005). Besides having static objects in the game environment with which the player can interact, this model was developed to enrich the interactions of the AI so that it could respond more appropriately to a dynamic situation. Influence maps are not a particularly new technique for achieving this in Real-Time Strategy (RTS) games, having been used to great effect in the *Age of Empires* series (Ensemble Studios, 1998) (Pottinger, 2000); it involves dividing up the game world into a grid of cells, each containing multiple layers of game world information that the AI can use to make decisions, such as which cell is the best place to put defensive units and so on (Sweetser & Wiles, 2005). 'Cellular automata' refers to the use of rules that govern how the cells in the influence map can exchange information, based on simulating natural phenomenon like the dissipation of heat in thermodynamics, to create the effect of propagation of the information in each cell to its neighbours.

2.4.1 Developing Emergence

The book *Game Development Essentials: Gameplay Mechanics* provides a good example of an emergent scenario from the developer standpoint; "From a game design perspective, you do not necessarily code every relationship into an emergent game, but you provide a series of abilities and interrelationships among features that the player can exploit in a variety of ways. An example of emergent gameplay would involve the following: a flamethrower, objects that burn, the ability to throw items, and NPCs that can be burned by fire. A player might use the flamethrower on an enemy, light an object on fire and throw it at someone or roll it down a hill – or perform some other combination with these available features. Another example is throwing a rock to make noise to distract an opponent in *Far Cry*, where the ability to distract a guard was not designed explicitly by the designer but came about because a guard investigates noises and the player can pick up and throw items." (Dunniway & Novak, 2008) (Crytek, 2004).

In these situations, the game's AI, the level design and physics engine all contribute to the emergent possibilities. Sweetser describes the game's world as its possibility space: "The space, terrain, objects, physics, and environment effects dictate the possibilities for actions and interactions that compose and constrain the gameplay. The elements of the game world (for example, the weapons, chairs, walls, and enemies) are the basic elements of gameplay, similar to the board and pieces in chess. The laws of physics and rules of interaction are the game rules, which constrain the possibility space. Within this space are the allowable actions and interactions of the players. Creating emergent game worlds involves designing types of objects, interactions, and rules, rather than specific, localised gameplay." (Sweetser P. , 2007)

Will Wright, co-founder of Maxis Software, gave his view on the concept of possibility space in a development forum speech in 2003 (Wright, 2003). He described how the possibility space of a game could be represented by a three-dimensional map, where success was characterised by hills or

peaks, and failure could be signified by troughs or valleys. Wright gave several examples of how this possibility space landscape would look when the model was applied to a wide variety of games. He acknowledged that there was no specific goal in *The Sims* (Maxis, 2000) by which 'success' could be measured, however. Instead, 'progress' in the game could be measured in two areas; social and financial success. This resulted in a simplistic possibility space map of *The Sims*, where the lack of either material or social achievement equated to the lowest point on the map, but a combination of both resulted in the highest point. Wright believed that this was realistic, as it showed that players who pursued their careers had plenty of financial success, but consequently they also lacked free time to spend with friends, and vice versa; so that a balance was required.

Wright goes on to say that developers are striving to create large possibility spaces in their games with simple rules. Games that fulfil this aesthetic are easier to create, and also to pick up and play, opening the game up to a larger demographic. Wright presents a simple 'war game' as an example of how simple rules combine to make varied gameplay, which basically uses similar mechanics to rock-paper-scissors; but instead uses tanks, factories and turrets. Factories cost the most, but produce tanks and turrets. Tanks are offensive units that can move, whereas turrets are for defence and remain stationary. Both tanks and turrets can destroy the factories, but have a fifty-fifty chance of one destroying the other in combat – the difference is that tanks cost more than turrets. This is the entirety of the 'war game' rule set, but it allows for the minimum number of strategies to permit emergent gameplay: any given strategy has a counter strategy, and there is a counter-counter strategy to that as well. This means that there is no optimum strategy – it depends entirely on what the opponent is doing. If the opponent builds tanks, the best option is to build turrets, if the opponent builds factories, it would be best to attack with tanks and halt their production; but if the opponent goes for defensive turrets then building more factories would be the best choice. With this number of strategies, the game tends to go one way or the other depending on whether or not one player outguesses the other, otherwise it tends to stabilise over time. Ultimately, in a game like this, player decisions fall into a simple structure of short term gain versus long time gain, high risk strategies versus low risk strategies, and allocation or prioritisation decisions.

2.4.2 Quantifying Emergence

In *The Art of Game Design: A Book of Lenses* by Jesse Schell, Schell points out that the number of actions that a player can perform is usually quite limited in comparison to what characters are seen doing in films or books; which is a natural side effect of games, since the consequences of any actions must be simulated on the fly, rather than worked out ahead of time (Schell, 2008). Many games feature similar actions because of this limitation, whereas games that are considered innovative tend to be the ones that feature new actions that have not really been seen before in past games. This results in the possible actions within a game being a crucial defining aspect of how a game plays.

Consequently, Schell proposes that the amount of potential emergent behaviour that a game features can be measured by the number of 'verbs' that are present. The more operative actions that the player can perform that result in meaningful reactions, the more emergent behaviour is likely to occur. For example, a game where you can run, jump, shoot, buy, sell, drive and build will have more potential for emergence than a game where you can only run and jump. Schell goes on to say that adding too many actions, particularly those that do not interact well, bloat the game, making it feel inelegant.

Schell states that it is important for those verbs to have an effect on many objects, alluding to a similar system design proposed by Sweetser – using the properties of those objects to decide how they can interact, based on the rules of the game world. Having verbs and objects upon which they can act is not enough by itself to make the game interesting; of particular importance are goals that can be achieved in more than one way. When the player can choose different methods of completing goals, which may go on to use the properties of objects they come across, gameplay is likely to be dynamic and enriched.

2.4.3 Role-playing Games

Role-playing is a broad term that can refer to a person acting out the role of a character, whether it is in theatre, games, or life itself (Rilstone, 1994). In the context of a game genre, role-playing games (often abbreviated to RPGs) outdate the advent of computer games, with the 'pen-and-paper' style *Dungeons & Dragons* (*D&D*) achieving widespread popularity since its invention by Gary Gygax and Dave Arneson in 1974 (Wizards of the Coast, Undated) (Edwards, 2003). Other types of RPG include 'live-action' (LARPs), whereby players physically act out the roles of their characters in a mock environment (Anders Tychsen, 2006) according to the guidance of a 'game master' (also known as a 'GM', who like in pen-and-paper RPGs, acts as a referee); and electronic media-based RGPs that may be single-player, such as BioWare's *Dragon Age: Origins*, or multi-player such as Blizzard Entertainment's *World of Warcraft* (BioWare Edmonton, 2009) (Blizzard Entertainment, 2005).

Pen-and-paper style RPGs in particular map well to Sweeter's discussion of emergent narrative (Sweetser P. , Emergence in Games, 2007, pp. 94-102), since the GM in such a game will have an idea in their minds of how they would like scenarios in the game to play out, but the players may choose to do something entirely unexpected, in which case the GM must think quickly and adapt to the new situation, expanding their mental model of how the current situation has been designed in a way that makes sure it is still fun (Pulsipher, 1981). Crawford discusses how computer games improved every aspect of RPGs (mainly by speeding up the events of combat), except for the storytelling (Crawford, 2003). However there are other interesting aspects to computer game RGPs: Massively-multiplayer online RPGs (MMORPGs) such as *World of Warcraft* are directly cited by Sweetser as being prime examples of social emergence (Sweetser P. , 2007, pp. 102-108), since players are free to form groups, trade, fight and embark on quests.

The social emergence in large scale games such as *World of Warcraft* is so large diverse that it has led to the creation of entirely new models of research to understand its dynamics. One such event that sparked models of epidemic (Eric T. Lofgren, 2007) and terrorism (Angela S. M. Irwin, 2010) research was infamously known as the 'Corrupted Blood incident' (Orland, 2008), whereby Blizzard introduced a new boss creature to the game that could attack players with a 'debuff' ability (something that negatively impacted their stats), called Corrupted Blood. The ability dealt damage over time to the player's character, but was also contagious like a disease; in other words, it was able to spread to nearby players that it did not hit directly; and did not disappear until some time had passed or the character died. Low level characters that contracted the symptoms would be killed quickly, but higher level players could survive longer. Though a combination of inadvertence and intention, the disease was taken out of the immediate area due to a programming error that allowed the symptoms to persist even when the players 'teleported' to other locations, causing the infection to spread.

Besides these individual emergent events, role-playing computer games like *World of Warcraft* are often host to a more subtle and ambient form of social emergent behaviour, whereby some players find enjoyment in extending the persona of their characters beyond the requirements of the game to include mannerisms and speech. These players aim to immerse themselves deeper into the game world by acting and speaking in the way that they feel their character would, rather than how they would themselves or how the aesthetics of the game suggest (such as the class or race of their character), with other players that share that enthusiasm. Many MMORPGs have dedicated servers to cater for these players which have specific guidelines, as acting out of character is frowned upon (Blizzard Entertainment, Undated).

2.4.4 Machinima

Machinima, a deliberately misspelled contraction of 'machine cinema', was a term coined by Hugh Hancock to refer to the use of a game's 3D graphics rendering engine to create a cinematic production (Machinima, Inc., 2009). This has various advantages in terms of production costs, since the physics engine, AI and art assets are readily available content in the game. The practice of creating videos from games which involved a plot that was not related to the game's storyline first began to occur in the 1990s with first person shooter games (Lowood, High-Performance Play: The Making of Machinima, 2006), such as id Software's *Doom* (id Software, 1993) and *Quake* (id Software, 1996), which used the game engine itself to record and replay events at that time, rather than the use of video capture techniques more commonly seen today. Since then, machinima has spread into the mainstream media.

Importantly, machinima productions were not something that game developers explicitly catered for; in fact, many considered machinima to be a violation of copyright law, and would take legal action against machinima creators (Au, 2009) or otherwise seek to protect their games (Lowood, Found Technology: Players as Innovators in the Making of Machinima, 2007). Since it essentially involves

the use of game mechanics in ways that were not intended or expected, the production of machinima is often considered being a form of emergent gameplay (Lee, 2006).

Despite various legal battles taking place, the popularity of machinima grew thanks to websites like YouTube.com and Hancock's Machinima.com, with games that offered prospective machinima authors the most flexibility in terms of camera control and character expressiveness being recognised as the most suitable, such as the entirely scriptable *Second Life*, by Linden Research Inc. (Linden Research Inc., 2003). Other games were targeted for their graphics or physics capabilities (Strickland, 2007), such as Valve's *Team Fortress 2* (Valve Corporation, 2007) and Digital Illusions CE's *Battlefield* series (Digital Illusions CE, 2002) or for the size of their fan-base, like Bungie/343 Industries' *Halo* series (Bungie, 2001), Infinity Ward/Treyarch's *Call of Duty* series (Infinity Ward, 2003), or Blizzard Entertainment's *World of Warcraft* (Blizzard Entertainment, 2005).

In particular, a *Half-Life 2* (Valve Corporation, 2004) sandbox modification called '*Garry's Mod*' (Newman, 2006) became a very popular machinima tool; this was because *Garry's Mod* (also known as *GMod*) allowed players to experiment with the Havok Physics engine used in many Valve games, so that 'props' (characters or objects) from any installed Source engine game could be placed and posed in a scene however they wished (Facepunch Studios, 2008). *GMod* itself is inherently emergent; players have a variety of tools with which they can manipulate the props in order to construct various contraptions or whatever else takes their interest – there is no real objective involved.

Some machinima formed series that were growing so large that developers began to consider leveraging their potential for perpetuating the lifespan of their games. For the example, the success of *Red vs. Blue* (Rooster Teeth, Undated), made with the *Halo* series, led to Bungie contacting the creators and granting them permission to continue using the game's properties free of charge (Thompson, 2005). Early episodes of *Red vs. Blue* were letterboxed to hide the character's weapon and heads-up-display from being visible on the screen, but the crosshair was still visible; however, as another indication of the developer's support for machinima in *Halo 2*, the designers added the ability to make a soldier lower their weapon as a special button function, specifically so that Rooster Teeth would have an easier time adding dialogue. Later, *Red vs. Blue* would become available for purchase on DVD (Rooster Teeth, Undated), or for download from the Xbox LIVE Marketplace (Microsoft Corporation, 2005).

Since then, some games have appeared that revolved entirely around the concept of producing machinima, such as Lionhead Studio's *The Movies* (Lionhead Studios, 2005) (Musgrove, 2005); other games followed Bungie's lead of providing their communities with machinima tools, such as the FacePoser tool from Valve for *Half-Life 2* (Valve Corporation, 2009). Valve has even gone so far as creating their own machinima for *Team Fortress 2* (Valve Corporation, 2010) to encourage the community to flourish (Machinima, 2007). Other companies such as Epic Games and Blizzard Entertainment have sponsored machinima contests (Epic Games, 2004) (Maragos, 2005).

2.4.5 Examples of Emergent Games

Gaming history is filled with examples of emergent gameplay to varying degrees, but some titles stand out as something truly special. As gaming hardware has become more powerful and the art of game design has been refined, some games take emergent gameplay from a feature to a core concept. Though there are many games that provide suitable examples of emergent gameplay, the following titles were selected because they are all critically acclaimed, and also because they are very different from one another in nature.

2.4.5.1 Deus Ex

"Future games will employ deeper simulation in order to achieve far greater levels of interaction and complexity, while simultaneously simplifying the learning curve for new players. Most game environments of the past have been based on crude abstractions of reality, limiting player expression and requiring users to learn a completely new vernacular in order to play. The games of the future will rely heavily on much more complex, high fidelity world representations that will allow for more emergent behaviour and unforeseen player interactions." – Harvey Smith [Lead Designer of Deus Ex, Project Director of Deus Ex: Invisible War] (Smith, 2001)

Ion Storm Inc.'s *Deus Ex* (Ion Storm Inc., 2000) is heralded as one of the first games to bring about widespread recognition of emergent gameplay and its value to game design. Harvey Smith, lead designer of *Deus Ex*, states in an IGDA article (Smith, 2001) that they achieved gameplay that allowed the player a great degree of freedom by providing the player with a variety of expressive tools and letting them loose in an immersive and atmospheric environment. The game's levels and gameplay mechanics were designed to not limit the player to a few predefined choices, but instead allowing them to come up with their own strategies within the flexible rules of the environment.

Being a ground-breaking game of its type, *Deus Ex* was not without flaws; and Smith regrets the parts of its design which were heavily scripted or were too restrictive in player choice. Some situations in the game only catered for particular play styles, or required the player to perform a specific action, which conflicted with how the rest of the game played. Smith describes the way in which players that did not fit the catered play style felt 'completely robbed' of an enjoyable experience in these cases. On the other hand, *Deus Ex* shone when its flexible sub-systems could interact in ways that allowed the player to do whatever they wanted, rather than what the designer wanted.

Smith goes on to describe how this enabled players to do things within the game that genuinely surprised the developers: "For instance, some clever players figured out that they could attach a proximity mine to the wall and hop up onto it (because it was physically solid and therefore became a small ledge, essentially). So then these players would attach a second mine a bit higher, hop up onto the prox mine [sic], reach back and remove the first proximity mine, replace it higher on the wall, hop up one step higher, and then repeat, thus climbing any wall in the game, escaping our carefully predefined boundaries.". This is considered an 'undesirable' example of emergent behaviour by

Smith, and he points out that if they had known beforehand about the ways in which strategies like this could be exploited, he would have done something about it.

Regarding simulation of various aspects of real life in games, Smith points out that games offered branched paths in the past, whereby a number of outcomes or interactions were all predefined by a designer. A dialogue tree is a typical example of this. However, Smith believes that game design is slowly moving towards the implementation of systems that accept an input stimulus and decide on an appropriate output behaviour based on internal considerations, leading to high fidelity simulations, wider ranges of expression, and ultimately, more emergent behaviour.

Smith offers multiple reasons as to why this is a good thing; firstly, "simulation allows for more emergent behaviour on the part of the game's systems and more emergent strategy on the part of the player. New gameplay is possible and a larger/deeper possibility space is created. Basically, this means that the player will have more than a 'a few canned options', which provides the game with a greater potential to be perceived by players as interesting". Not only is this view concurrent with those of Will Wright, but it supports the notion that emergent gameplay leads to a more enjoyable game.

The second reason that Smith presents is that "games typically have more consistency when response to player stimulus springs from the interaction (according to rules about relationships) of the elements of a simulated system (as opposed to when response to player stimulus is derived from a bunch of special case, designer-driven instances)". This suggests that the player's 'suspension of disbelief' is maintained by objects in the game behaving in ways that are consistent with the properties that they possess, and that when those properties are directly manipulated by a designer or scripted event, it is noticeable and breaks the player's sense of immersion.

Finally, Smith suggests that "as a labour-cast benefit, a better-simulated game environment requires less time to create content. This saves money, but it also allows designers more time to focus on tuning the gameplay." This describes how it becomes easy to add new entities to an emergent system once the rules of that system are defined. For instance, in a game where the properties of wood, fire and combustible objects are already present and the rules of how they interact are defined, it would be trivial to add a 'barrel of gunpowder' entity; it would simply require setting the appropriate properties and it would behave exactly as you would expect – it would be made of wood, and therefore be flammable, and if it caught fire it would explode.

"In games, realism is not necessarily the goal. But if the world seems to behave consistently and in ways that the player understands, it seems that the player has less difficulty immersing himself in the environment, suspending his disbelief. This this way, realism in games is related to intuitiveness and player expectation." [Sic] – Harvey Smith [Lead Designer of Deus Ex, Project Director of Deus Ex: Invisible War] (Smith, 2001)

At several points in the article, Smith talks about the ramifications of implementing emergence into games as well; the main caveat is that in a flexible system in which the designers have not provided an explicit relationship for every element in the system, uncertainty is introduced. This often leads to interesting implicit consequences – players can formulate plans that spring from indirect interactions of the rules system. Unfortunately, that uncertainty can result in exploits that break the game, which go unaccounted for until it is too late to do anything about them.

Another problem that the development team encountered was providing sufficient feedback to avoid confusing the player when the more flexible rules of the system and more complex simulation resulted in a more granular range of player expression. Smith cites Looking Glass Studios' 1998 title, *Thief: The Dark Project* (Looking Glass Studios, 1998) as a good example of providing a solution to this. In *Thief: The Dark Project*, the game's engine simulated noise, light and dark in great detail so that the player character could hide in shadow; and an indicator was added to the screen to show the player how well hidden from the enemy guards they were.

Smith states that this advanced lighting model, along with extra information being provided to help the player to understand it, allowed for a realistic context that players could relate to, allowing the game to be more intuitive. *Thief: The Dark Project* also used advanced AI that simulates 'sensory honesty' to make AI agents in the game behave more believably. For example, even though the player's position is stored in the game's data, guards are prevented from using this information to detect the player unless they are actually looking straight at them (Leonard, 2003).

For the sequel to *Deus Ex*, *Deus Ex: Invisible War* (also known as *Deus Ex 2*), Smith took on the role of project director (Ion Storm Inc., 2004). The game features much more sophisticated systems in comparison to both the original *Deus Ex* and *Thief: The Dark Project*; for example, when sounds are broadcast in the game, echoes and bounces off surfaces are simulated before determining whether or not AI agents can 'hear' them. The simulation takes into account the types of material that it bounces off, so that carpets muffle the sound for example (Smith, 2001).

In the original *Deus Ex*, no such simulation was performed – sounds simply radiated out in a sphere as if it were empty space with a volume falloff based on distance. This made it difficult to predict whether an entity in the game (like a guard) would hear the player when they were trying to be quiet, which led to some "really unsatisfying occurrences": Either a guard would hear the player, or the player would make a sound that he assumed the guard should hear but didn't, making the game's awareness system feel 'broken'.

In contrast with this, the advanced audio effects in *Deus Ex 2* allowed for more intuitive gameplay because the player could assume that what the enemies could hear was based on their own perception of sounds in the environment. This also promotes sensory honesty like in *Thief: The Dark Project*, since the player can make strategic decisions such as shutting doors to obscure loud noises like gunshots from being heard by the enemy.

"In Deus Ex, we found that players (initially just in QA, but later among the game's fans) were using an emergent strategy that had never occurred to us. One of the unit types (an MJ12 soldier character) exploded upon death. Our idea was that this would cause the player to react strategically, switching away from a pointblank weapon when fighting this unit. In a more traditional game systems model, we would have created an explosion entity with an explicit relationship to the player, damaging the player if he was within range of the explosion. However, in our more flexible system, we simply spawned a generic explosion with properties related to concussive/ballistic damage. Players figured out that they should lead this unit near a locked container before delivering the final blow. When the explosive unit blew up, it inflicted damage on the locked container, opening it up. (We did not plan this or even foresee it - it just worked.) In this way, players were exploiting the system in order to open locked doors and safes (without spending any lock picking resources). We were delighted." [Sic] – Harvey Smith [Lead Designer of Deus Ex, Project Director of Deus Ex: Invisible War] (Smith, 2001)

Smith puts it down to hardware limitations and the nascent state of interactive entertainment that games have by necessity relied on cruder models of simulating aspects of real life like physics in the past, and speculates that the technology of the future will proffer even more interaction between complex systems that are beneficial to expressive gameplay.

2.4.5.2 Scribblenauts

"As far as emergent gaming goes, I mean, Scribblenauts definitely does it very well. I mean, it's one of the games where we literally give people [a] massive amount of toolsets, and [they can] just do whatever they want; and from that point, you know, we have no idea how they're going to solve the levels. That kind of 'is' the definition of emergent gameplay." – Jeremiah Slackza (Slackza, 2009)

Scribblenauts was proclaimed to be a part of the 'action-emergent-puzzle game' genre by Jeremiah Slackza (Slackza, 2009), co-founder and creative director of 5th Cell (5th Cell, 2009). The game is a 2D side-scrolling platformer on the Nintendo DS, with many levels for the player to progress though. The objective is always to simply collect the 'starite' (an object that represents the goal), but to do this the player must solve a puzzle or defeat a challenge by creating objects in the level to help them.

To create these objects, the player types or writes (using the Nintendo DS' touchscreen) the name of any object that they wish to place in the level (Bozon, 2008). The game then searches a massive database of words for an approximate match to whatever the player entered; if a match is found, the player can then place that object. Because the art style of the game is so simple, the developers have included almost everything imaginable, from fruit, to people, to buildings, to dinosaurs, and even things that don't exist in real life, such as time machines, teleport devices and mythical beings. The only things not allowed are proper nouns and copyrighted or vulgar words.

"There's this one level where there's a dog and a cat and you have to get them across, but obviously they're going to attack each other and fight each other. So, people were writing like, 'helicopter' and

trying to transport it over, and 'wall' to make it go around, and all this crazy stuff. And so one person wrote out 'shrink-ray' and then shrunk the dog; and then they wrote like, 'satchel' and put the dog in the satchel and just carried it across. I was like "You can do that?!" I guess you can! I didn't even know. I mean, I made the game and I didn't even know you could do that!" [Sic] – Jeremiah Slackza [Creative Director, 5th Cell] (Slackza, 2009)

The truly remarkable thing about *Scribblenauts* however, is that all of these objects behave in ways you might expect, which is often the key to solving the puzzles. The game also encourages use of imagination by rewarding players for completing the same levels in a variety of different ways. As an example of both these things, one such level requires retrieving the starite from the top of a tree; the player might create a saw to chop it down, a ladder to climb the tree, or a jetpack to fly to the top of it.

Slackza speculates that other games sometimes include emergent elements just for the sake of it, since the technology has come about to make it easier to develop. Like Schell (Schell, 2008), he suggests that this can end up being counterintuitive when it comes to making the game more fun to play. He concludes that there is still a place for straightforward narrative and multiplayer based games, but that emergent games are going to become a very large part of the games industry in the future.

2.4.5.3 Minecraft

"Minecraft is an exploration and a great building game. It's a toy, I would say. You can build almost anything you can imagine." [Sic] – Jens Bergensten [Developer, Mojang] (Mojang, 2011)

Minecraft is an indie game that has become a cultural phenomenon in less than the space of a year. It was originally created by Markus "Notch" Persson alone, but as the popularity of *Minecraft* exploded across the internet, he decided to found his company, Mojang, and work on the game full time (Mojang, 2011). *Minecraft* has been available to purchase throughout its development, which is not common practice in the games industry outside the indie market. It reached the 'beta' phase of its development on December 20th, 2010, meaning it is not a complete game, and yet its popularity is so large that less than one month later, it had already passed one million unit sales (Persson, Exclamation mark., 2011) (WebCite, 2011).

Minecraft features 'sandbox' construction-type gameplay, where the world is procedurally generated at random from different blocks like soil, stone and sand. The player starts out by collecting wood and other resources, and then manufactures tools with which to collect more resources to make better tools or items, and so on. All the while the player must shelter at night from monsters that attack them. The appeal of the game is not in its simple graphics or physics, but the freedom of gameplay to cultivate the land and construct anything that the player desires.

"It encourages people to use their own imagination; it's not linear at all. It's not, you know, "go to this point, do this, and then go to this…" you know? Use your imagination, go wild, and see what you can create. I personally love that in games, and I've seen a lot of positive comments just about that fact in Minecraft; like, "for the first time in ages I got to use my imagination again!"." [Sic] – Jakob Porsér [Co-founder, Mojang] (Mojang, 2011)

The game also has a strong emphasis on multiplayer, where players can work together to build truly impressive structures, or fight one another for resources. Exploration to gather new resources is continually encouraged by the fact that any tools that the players produce have a finite number of uses before they must be replaced. Because the world is generated as the player explores it, something new and interesting can always be found – the game even makes use of different 'biomes', so that as the player wanders they may encounter deserts, forests, swamps, tundra, grassy plains or snow-covered mountains.

"I remember the first time I sort of stumbled across an underground cavern as I was mining, and just as I sort of cracked through the wall and came out into this… was a kind of underground river thing going on, and there were zombies and stuff, and the music kicked in just then. It was like, you couldn't have scripted a better moment, I think, in a game. And this happened by random, really. And that makes it more powerful, I guess, because it's your own." [Sic] – Markus "Junkboy" Toivonen [Art Director, Mojang] (Mojang, 2011)

Complex systems can be built in *Minecraft* since it also includes the ability to construct primitive electrical circuits and logic gates. This was implemented with the intention of creating simple mechanisms like pressing a button to open a door, but some players have taken it to the extreme and have created working Algorithmic Logic Units (as used in CPUs), among other complicated systems (Holwerda, 2010) (Tito, 2010).

Minecraft draws inspiration from Perrson's previous game, *Wurm Online* (OneTooFree AB, 2011) and other games such as Tarn Adams' *Dwarf Fortress* (Adams, 2006), Zachtronics Industries' *Infiniminer* (Zachtronics Industries, 2009), and Bullfrog Productions' *Dungeon Keeper* (Bullfrog Productions, 1997). All of these games exhibit emergent behaviour, which fits with Persson's development philosophy of making *Minecraft* a "huge melting pot of emergent gameplay" (Persson, About, 2009).

2.5 Summary

In the Gameplay section of the Literature Review, the views of several recognised industry professionals on what constitutes as a game and the reasons why we play games are provided. These reasons identify that emotional experience are a strong motivation for playing games in the Gaming Motivation section. In the Immersion section, we see that games are said to be immersive when they engross and absorb players into their worlds full of rich, intuitive interactions that are both interesting and exciting, but also believable; allowing them to experience emotions that they would not

otherwise encounter in every-day life. The Emergence section explores how developing systems that borrow from the concepts of Chaos Theory and cellular automata (that in turn borrow from principles seen in nature), can lead to interaction between interdependent systems that behave according to many layers of simple rules, perhaps using an object property-based system to define how those interactions can be carried out within the confines of the game world. The result is a highly modular and easily extensible system, whereby objects within it can interact in ways that cannot be predicted at the higher-levels, resulting in divergent and immersive gameplay.

The Quantifying Emergence section reviews literature that shows the presence or absence of emergent gameplay is not a binary value, but an analogue range of values, quantifiable by measuring the number of interactions that can take place in a game. This supports the relevance of the Ambiguities of Gameplay section, since a game that offers nothing but a perfectly linear experience is more akin to a film or book than a game. Other forms of emergent behaviour are also examined, such as Machinima and Role-Playing Games, along with the design features of several notable games, with the aim of identifying a common feature in this project's Methodology & Research.

3.1 Methodology & Research

From the titles listed in the Examples of Emergent Games of the Literature Review, in the Emergence section, the most fundamental feature that was both shared amongst the games and cited as an aspect of emergent gameplay was that of player choice. In *Deus Ex*, the player can choose a wide variety of tactics, such as stealth or full on assault, in order to complete their objectives. *Scribblenauts* allows players to place whatever objects they can think of in to the level in order to solve puzzles and reach the goal. *Minecraft* gives players the freedom to build whatever they like in a sandbox environment. Implementing the other emergent features exhibited by these games, such as emergent narrative or sophisticated physics engines, are beyond the scope of this project.

Using the Microsoft XNA Platformer Starter Kit as a leverage point, a simple platformer-style game that provided the player with choice of how to complete its levels was created. Its purpose was to determine whether or not the inclusion of player choice provided any emergent gameplay; and if it did, to also determine whether or not the presence of emergent gameplay made the game more immersive. Microsoft XNA was chosen as the development language because of its emphasis on facilitating rapid game development. Although XNA games can be written in any .NET compliant language, C# is the most widely supported, being integrated with XNA Game Studio Express and all versions of Microsoft Visual Studio.

To gather the results necessary to perform this analysis, the Starter Kit was heavily stripped-down and modified. Firstly, to provide a better basis of analysis, the game was divided into two modes. The first mode, ‘Mode A’, would be the one which enabled the features of emergent gameplay, whereas ‘Mode B’ would not. This simply allows for a comparison between the results of the two modes.

The input system was altered to provide additional support for an Xbox 360 controller connected via USB, or the game could be played using the PC’s keyboard. Mode A represented the majority of the modifications to the game’s framework; and to implement the two modes, the game required a state manager that would select a mode at random on start-up, though the mode could be changed at will if necessary. In either mode, the goal was ultimately the same – to collect all of the gem items, avoid the monsters, and reach the exit.

In Mode A, the game would enter an ‘editor’ state at the start of each level; using the editor, the player could place blocks into the level in order to build a path for themselves to the exit. In contrast, Mode B already had a pre-made route to the exit provided, and the editor was not accessible. While both modes awarded points for finishing the level quickly, Mode A also rewarded the player for using as few blocks as possible.

Both modes provided three levels, none of which were particularly difficult. After the completion of the final level, the first level would begin again. Players were encouraged to simply continue playing until they got bored. The number of levels was chosen to be three since too many levels would have

diluted the results, but too few would have made the players get bored quicker. The main key design element of the levels was that in Mode A, the level was impossible to complete without placing at least one or more blocks (depending on the current level); and that in Mode B, the pre-placed blocks only offered one route to the goal.

These design considerations meant that a 'reset level' mechanism was necessary in Mode A, although it was present in Mode B as well. If a player made a mistake in the editor and then found that they were unable to complete the level for whatever reason, they would be forced to press the reset level button. In Mode A, this would return all of the placed blocks to the inventory and restart the level with the editor. There was no penalty for doing this, or for getting the player character killed either by touching the monsters or falling off the bottom of the level in either mode. However, having the player's character die would not restart the level; it would just cause them to reappear at the beginning.

The actual collection of results was achieved by modifying the game code so that it created a new log file each time it was started, and then wrote to that file as the game was being played. Though not perfect, the logging system was made to capture a great deal of information, following the idiom that too much was better than too little. From the log files it is possible to almost entirely recreate the level as it was played, step by step. Mode A naturally captures more information, as it records where the player placed blocks, and of what type.

3.2 Initial Design

The following section describes the original design proposal for the game. The development methodology was intended to respond to any problems that arose in an agile fashion; despite this initial design being proposed up-front, the game was expected to change during its development to accommodate new or improved features, which may or may not require some aspects being redesigned. The Final Design section highlights the features that changed significantly in the final version of the game used for the experiment.

3.2.1 Help Screen

At all times during the test, somewhere on the screen will be a button prompt, labelled 'Help'. Pressing that button will put the game into a paused state and bring up an overlay screen that provides instructions and illustrates the game's controls. There will be two versions of the screen, one for each mode of the test: 'Mode A' is the 'emergent mode', whereby the features designed to encourage emergent gameplay are enabled, and 'Mode B' is the opposite. Participants will not be aware that the game has two modes, nor the differences between them. On closing the help screen, gameplay will resume as before.

3.2.1.1 Mode A

In Mode A, the help screen will be split horizontally into two components, 'editor help' and 'gameplay help'. The editor help component will describe how the game pauses before gameplay begins, and gives the player an opportunity to place a limited number of helpful objects into the level. The component will describe the controls for how to do this.

The gameplay component explains the controls for moving the player's character through the level, and that their goal is simply to reach a given location in the level using the helpful objects that they placed in the editor phase. If the player realises that they cannot complete the level with the objects that they placed, or if their character is killed by monsters in the game, it shows how they can restart the level in the editor mode and place more objects, but will forfeit some points by doing so.

3.2.1.2 Mode B

In Mode B, the help screen only has one component that is most similar to the gameplay component of Mode A. The only difference is that some objects will already be placed into the level in a manner that allows the player to complete it without too much difficulty; therefore the help screen will not mention the editor phase, as it cannot be accessed in this game mode.

3.2.2 Logging

The game will automatically write a log file as the participant makes certain actions whilst playing, for example, a complete log entry may read as shown in Table 1.

Table 1: Initial LogFile Design

```
Game Initialised
Mode A
Waiting for consent
Consent received
Launching game
Level 3 selected at random
Level loaded
Starting level editor
Player has: Ladder x2, Platform x2, Gun x2, Ramp x1
Player viewed help screen
Player placed Ladder Lddr1 at X:12 Y:2
Player placed Platform Pltfrm1 at X:40 Y:12
Player viewed help screen
Player placed Gun Gun1 at X:30 Y:12
Closing level editor
Player started level
Player used Lddr1
Player collected Gun1
Player was killed at X:34 Y:11 by Monster1
Starting level editor
Player placed Ramp Rmp1 at X:33 Y:11
Closing level editor
Player started level
Player used Lddr1
Player collected Gun1
Monster1 was killed at X:35 Y:11 by Player
Player viewed help screen
Player used Rmp1
Player used Pltfrm1
Player completed level in 3min42sec
Logged successfully
Shutting down
```

As alluded to in Table 1, in Mode A there are a number of items planned for the game that the player will be able to place a limited quantity of into the level; including ladders to reach areas above them, platforms that may float in the air which they can jump on, weapons to defeat monsters, and ramps that they (or monsters) can walk on. Other important information stored in the log file include the coordinates at which certain events happen, like the placement of objects, the collection of usable objects such as weapons, and changes in the game's state such as the initialisation of the level editor, or the viewing of the help screen. Finally, the log file stores the time taken by the player to complete the level.

3.2.3 Ethical Considerations

This log file will then form the basis of the results. Absolutely no personal or identifiable information about the participant is needed or recorded; the useful information is purely in the actions they performed to complete the test.

3.2.3.1 Consent Request

The Consent Request Screen will be the first screen shown by the game, and it may double as a loading screen if needed. All that the player needs to do to indicate that they agree with the terms and

conditions of the test is press the start button when prompted. If they do not consent to take part then they are free to abort the test and leave.

See Table 2 for the information to be shown on the Consent Request Screen. Its purpose is to explain the terms of the experiment to the participant. They should understand that they are under no obligation to provide personal information or even any test results at all.

Table 2: Consent Request Information

By pressing the Start Button to begin, you are giving your consent to participate in this research test. Your consent applies to the following:	
You understand that:	The author of this game is: Matt Pickering mattpickering@live.co.uk ©2010-2011
This game is part of a focus test. The test does not collect **any** personal information about you that can be used to identify you in any way. The results are completely anonymous.	
The information that is collected simply indicates how you completed the test. This information contributes to research being conducted by the author; the results of which will not be used to take decisions in respect of and living individual, nor will it be used in any way which is likely to cause damage and/or distress to any living individual.	
You are free to abort the test and leave at any time.	
Upon aborting a test in progress, information collected up to that point will be discarded.	
You are free to request a copy of your results after the test; you may use this copy to verify that the test has not collected any personal information about you.	
Even if you complete the test, you may request that your results are discarded and do not contribute to the research for which they are intended.	
The game will provide further instructions on how to play and what to do once it begins. You may review these instructions at any time.	

The test should be conducted with supervision. The supervisor will be able to provide technical assistance if required, but will not be able to help you complete the test. The supervisor will not be conducting observational research.
The test is being conducted within the University of Derby; therefore it complies with University policies and conduct. No responsibility will be taken by the author of the test if your behaviour during the test is in breach of those policies.
Because no personal information is recorded during this test, the research makes no claims to confidentiality or data protection.
No monsters were harmed in the making of this game.
PRESS START TO CONTINUE

3.3 Testing

Since testing and iterative improvements were undertaken throughout the application's development, it is difficult to demonstrate its occurrence. Provided with the game's source code are a batch of log files from early in its development, when the logging system was first implemented, which provide insight into the on-going testing that was taking place. For example, the log file name convention had not been properly established at that point; some log files are not even dated. Later, the files would be numbered according to the quantity of files that already existed in the directory.

The contents of the files also differ widely, reflecting the heavy changes that were taking place. Some of the early logs such as '1b.log' show bugs like the full date being logged twice, others such as '0a.log' illustrate problems such as the mode and state being referred to as the same thing. A later log file, '0b_19022011 (2).log' demonstrates an issue whereby the "Level complete!" log event was triggered on every frame that the player's character was in contact with the goal, flooding the log file with duplicate events.

3.4 Final Design

The final version of the game differed from the original design in some aspects, as was predicted. To begin with, the Consent Request screen was given an appearance that matched the theme of the rest of the game. The actual content of the screen did not change very much beyond that, besides some grammatical corrections. Figure 3 shows a scaled down version of what the screen looked like. A larger, more legible version using landscape orientation can be found in the Appendix.

Figure 3: Consent Request Screen

One of the larger changes was that of the Help screen. The difference in help content based on the currently active mode was removed in favour of producing an alternative input method in the event that an Xbox 360 controller was not available. As such, one version of the Help screen for each input method was created instead – one for the Xbox 360 controller, the other for PC keyboard input.

The on-screen button prompt to access help was implemented as originally designed, and is always present in the bottom-right corner of the screen, indicating either the 'X' button on the Xbox 360 controller or the 'F1' key on the keyboard can be pressed. The version of the help screen that is displayed depends on, and is relevant to, whichever device the input comes from. Although the PC version appears to have more controls at first glance, it really just duplicates the buttons on either side to cater for both left-handed and right-handed players.

Lastly, the designs for the six levels were finalised; three levels for Mode A, which have no conceivable route to the exit and require intervention on the part of the player in order to construct a path for themselves; and three levels for Mode B which offer one (and only one) route to the exit, which the player cannot change. These files are defined using a simple text-file format, whereby different characters in the text file translate to corresponding tiles in the level.

Figure 4: Help Screen (Xbox 360)

Figure 5: Help Screen (PC)

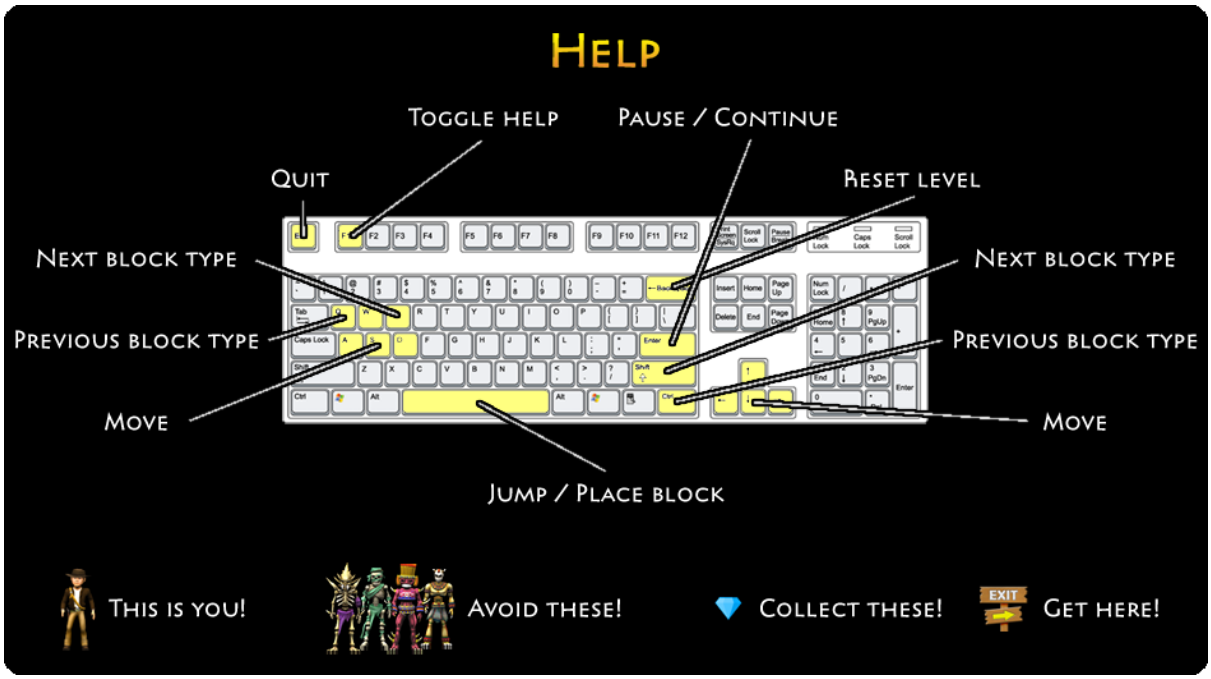


Table 3: Level Format

0a.txt	1a.txt	2a.txt
....CX......... ....######....... .... .1............GGG. ########....########	.... .1..............X. ###............### #::............::# #::............::# #::............::# #::.GG...A....GG.::# ####################	....GG......... ....##......... ....##......... ....##......... ....##......... ....##......... .1....GG.##.GG....X. ####################
0b.txt	**1b.txt**	**2b.txt**
....DX......... ....######....... ..--.............. ....---.......... ....--......... ....---..... ....--.. .1............GGG. ########....########	.... .1.....--..--.....X. ###............### #::............::# #::...--....--...::# #::............::# #::.GG...B....GG.::# ####################	....GG......... ....--##--....... ....##......... ....--...##...--.... ....##......... ....--##--....... ....##......... .1....GG.##.GG....X. ####################

Figure 6: Level 0a

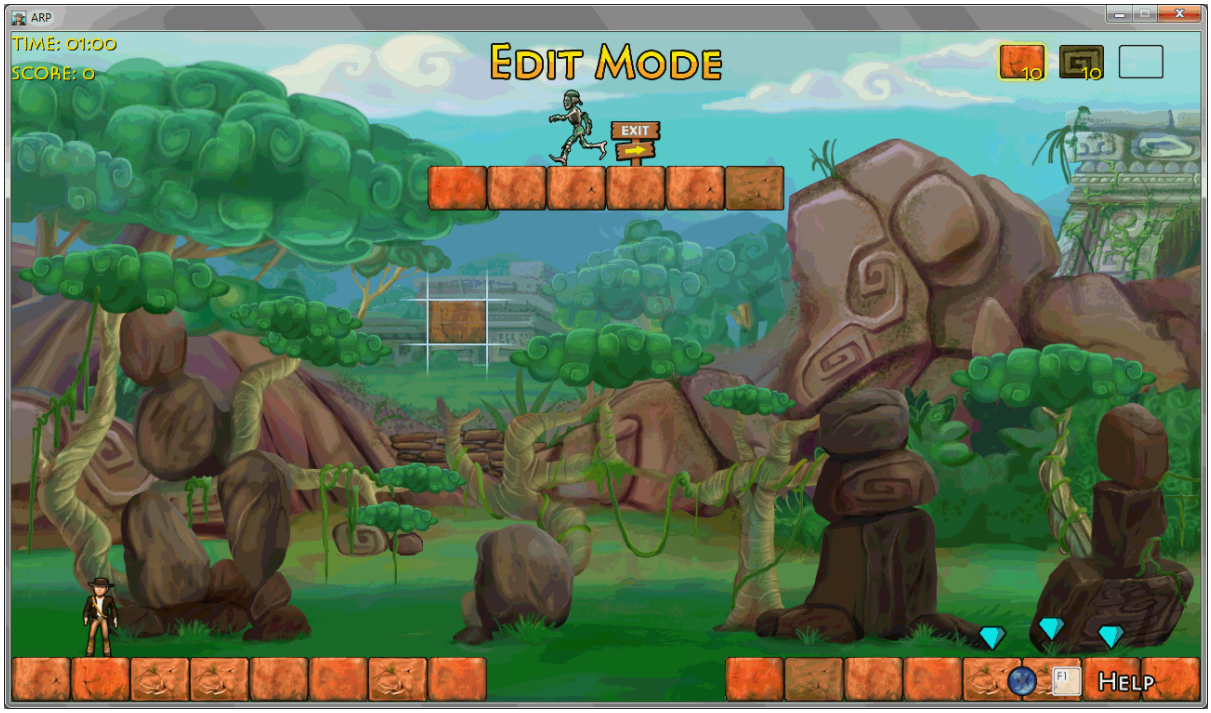


Figure 7: Level 0b

Figure 8: Level 1a

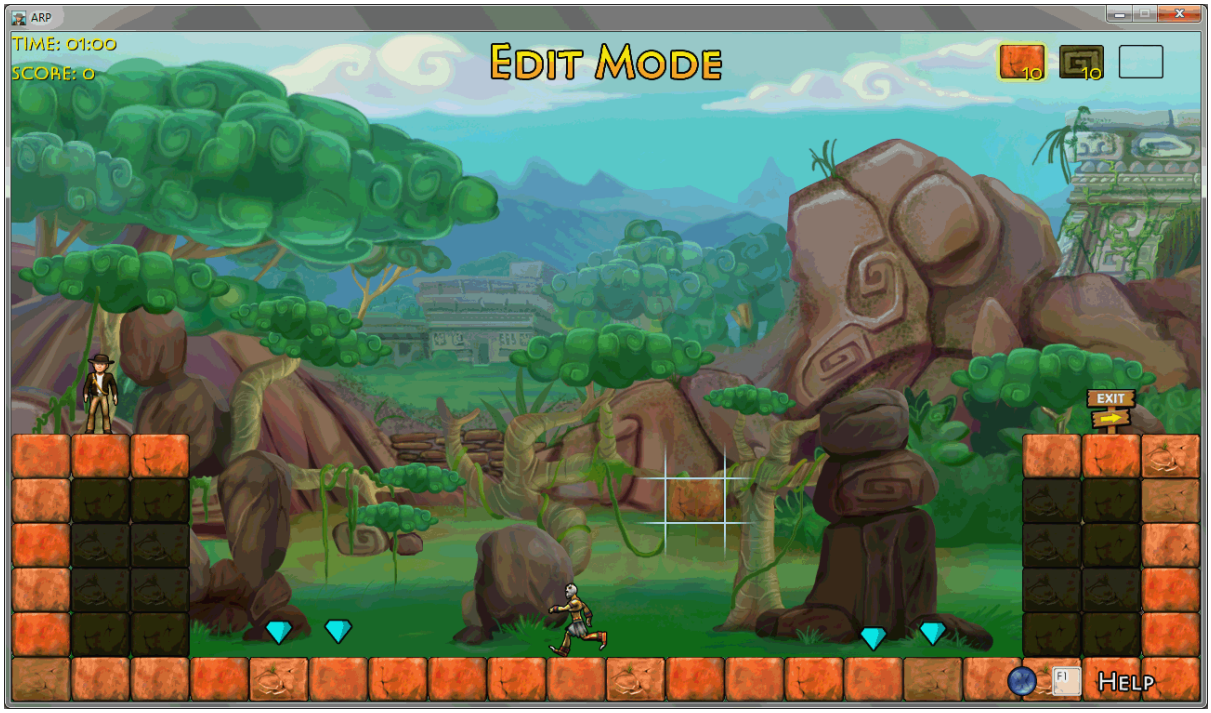


Figure 9: Level 1b

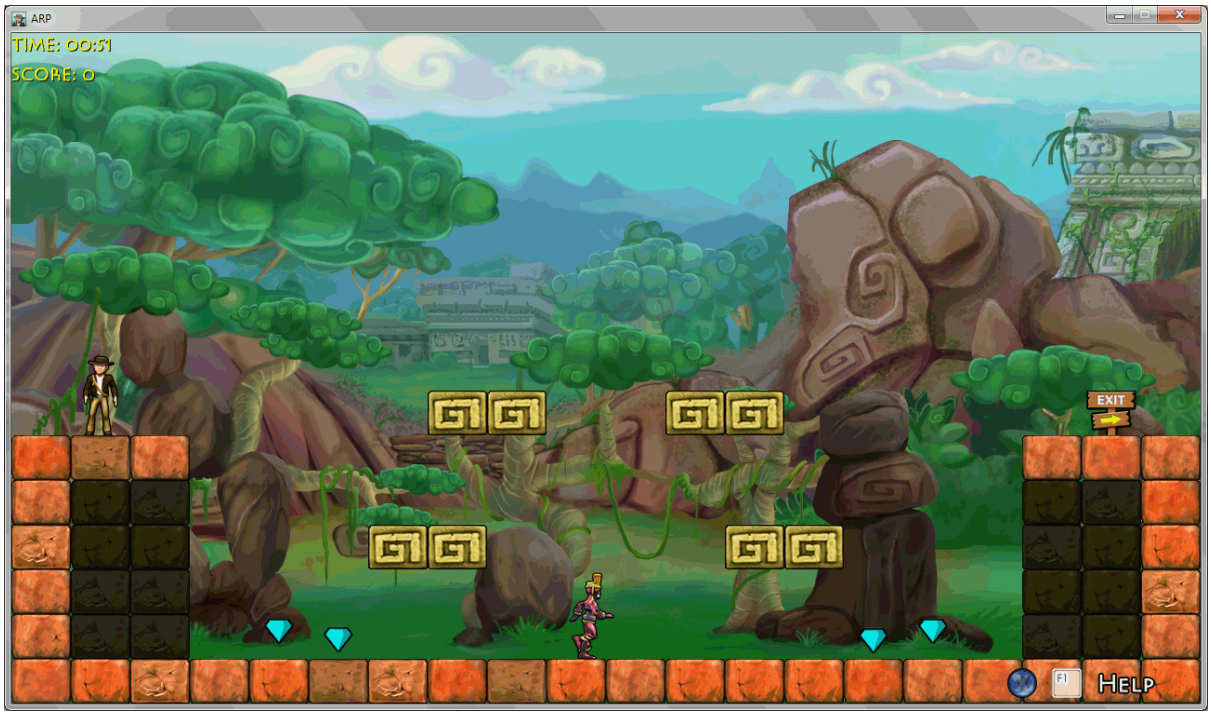


Figure 10: Level 2a

Figure 11: Level 2b

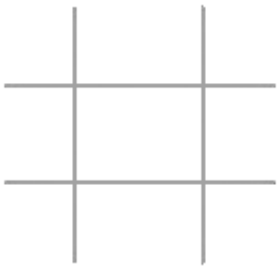
Figure 12: Help Prompt

Notice that in the Mode A images, the level begins in 'Edit Mode', indicated by the text at the top of the screen. The items that can be placed into the level were also changed to simple tile types that could already be found throughout the game; meaning that the player would quickly learn the properties of those tiles. The reason for this was quickly found in play-testing; items like ladders, platforms and ramps would have added nothing of value to the gameplay, since all of them could be substituted for with various arrangements of blocks; and that items like weapons would have made the levels too easy.

As an added benefit, the need to create new art assets for the new items was also removed, circumventing a development bottleneck. Plus, the existing Platformer Starter Kit framework may not have easily accommodated the logic required to support new objects anyway. The limited number of resources was retained, however, so that the level's challenge was not insignificant.

The 'cursor' in the Edit Mode is also visible – a colour-coordinated crosshair that indicates to the player where they are able to place a block. The player moves the cursor around in the level; if the cursor is over a vacant block, it is a pale green colour. If the cursor is over an editable block, it is pale blue; but if it is over a block that cannot be changed (i.e. part of the base level), it changes to a red colour instead.

Figure 13: Edit Mode Cursor



The 'inventory' of remaining blocks that the player can place into the level is displayed at the top-right of the screen. The currently selected block type is highlighted in yellow in the inventory, and the cursor shows a semi-transparent preview of that block inside it. Pressing the 'jump' button takes a block of that type from the inventory and places it into the level at the cursor location.

By default, the player has ten of each solid tile type. When the player runs out of any type of block, that type becomes grey in the inventory, and the cursor also changes to grey if the player has that block type currently selected. The player can remove blocks and return them to the inventory by

placing a hollow 'air' tile on top of any other block that they've placed into the level, or exchange one block type for another by placing the new type on top of the old one (the cursor is blue when this is possible).

There are three types of solid tile, passable, non-passable and platforms (collectively referred to as blocks). The player can only place two of these types; non-passable and platforms. Non-passable blocks physically obstruct the player character or monsters from moving through them in all circumstances; whereas passable blocks do not impede movement at all. With platforms, the player or monsters can move through them from the sides or from underneath, but are able to stand on top of them if landing on them from above.

Table 4: Block Types

Air	Passable	Non-passable	Platform
			

Although not explicitly mentioned anywhere, conserving blocks will score the player more points. Players who are attracted to the idea of high-scores are expected to notice it by themselves, and hopefully they will want to repeat levels in order to score the most points possible; whereas players who are more interested in building a creative solutions to solve the level will not feel pressured into using less blocks than they might do otherwise. Solving the levels quickly also yields more points, which means that the platform block is more useful for completing levels in a fast time (the player character can jump through it from underneath, allowing for rapid climbing to higher areas); and as such it is worth slightly more points than the standard non-passable block.

As seen in Table 3, these block types are loaded in based on the characters used in the text files that represent the levels. This allowed for quick and easy configuration of the levels, and was already supported by the Platformer Starter Kit, along with the tile-based level system. In addition to the block types that are easily visible in the level, some types contain meta-information such as gem locations or creature spawn points.

Table 5: Text File Level Protocol

Text File Character	Block Type
(Full stop) .	Air
X	Exit
G	Gem
(Hyphen) -	Platform
A	Monster spawn points
B	
C	
D	
(Tilde) ~	Platform, with Passable block texture – Not used
(Colon) :	Passable
1	Player spawn point
(Hash) #	Non-passable

These meta-information tiles are usually used to spawn entities into the level, like the player, monsters or gems; or they might serve some other purpose like the exit tile. The exit tile can only be used once the player has collected all of the gemstones (which are also worth points), but both the exit and all of the gems are visible right from the beginning of the level so that the player can see how to construct a route through it.

All of the monsters behave in the same way – the only difference is their appearance. They will walk left or right until they encounter an obstacle or a ledge, in which case they will pause momentarily before turning around and heading back the way they came. The obstacle detection will work on any blocks that the player places into the levels, allowing them to construct traps if they wish. Contact with a monster will kill the player instantly, as will falling off the bottom of the level. The player will reappear at the beginning of the level after dying, but no other aspect of the level will be reset (including the time limit), and there is no limit to the number of times the player can die.

Table 6: Other Game Entities

Player	
Monster A	
Monster B	
Monster C	
Monster D	
Gem	
Exit	

4.1 Results

The study sample consisted of twenty people, who produced a total of seventeen viable log files. Although this was a smaller sample size than what was desired, the participants completed a total of one-hundred and eighteen levels, a highly satisfactory number. Incomplete levels were discarded.

4.2 LogParser

To aid in the analysis of the log files, a second application was produced, which would parse the data and draw a graphical representation of it, and was aptly named 'LogParser'. The LogParser source code, log files used for the results, and the source code of the game itself should accompany this report on disc. The LogParser is capable of opening a log file and splitting it up into completed levels. The levels in the log file can then be cycled, and the application draws the final state of each level on the screen (including any blocks that the player placed within it). The LogParser can also trace the path that the player took through the level and draw that as well. Finally, it contains the ability to take a 'snapshot' of the current level, saving an image of it to file. An image of each and every level has already been created and stored alongside the log files.

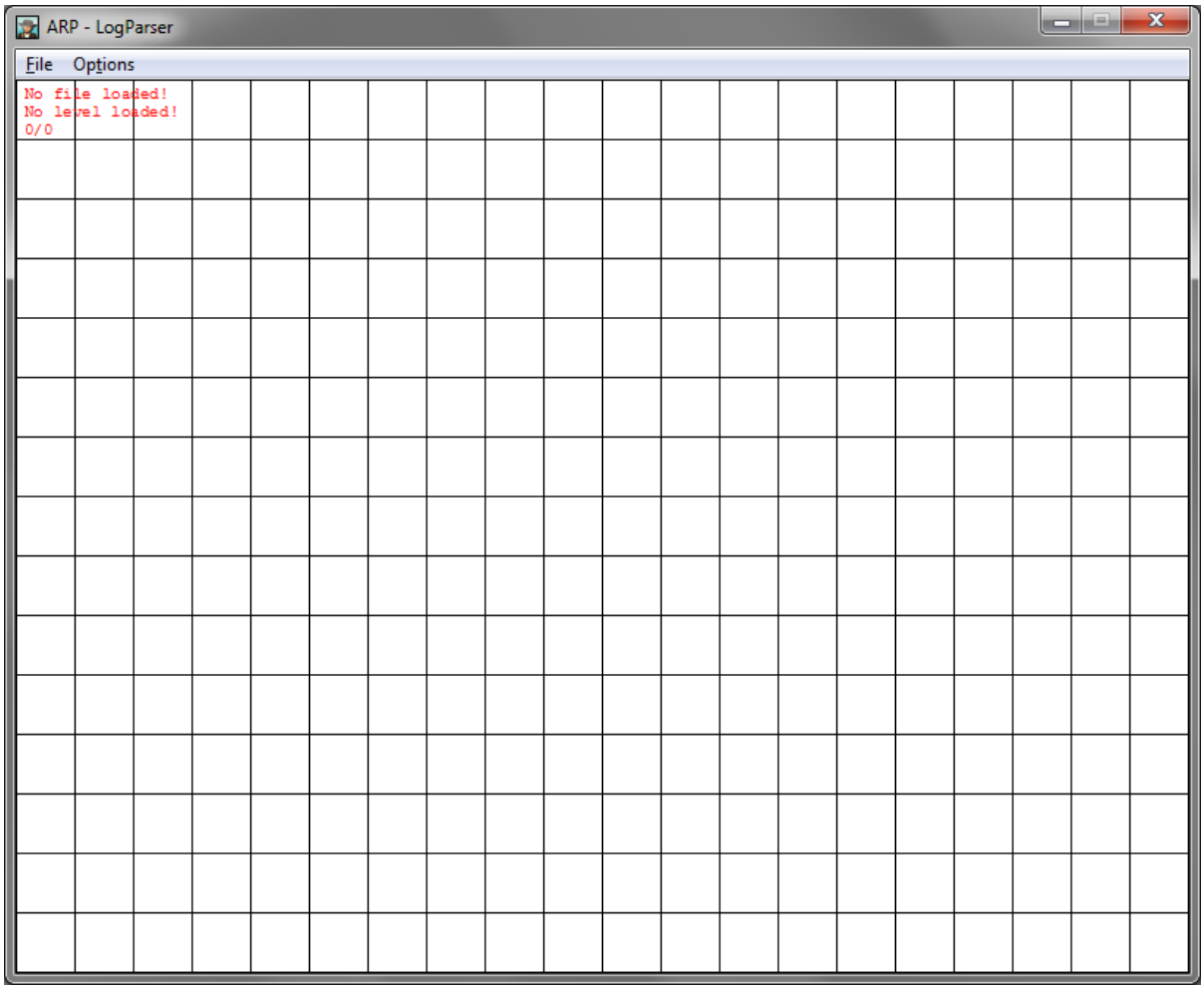
When sorted by file name, the images are grouped by level, then by log file, then by occurrence within that log file. Because the game features the ability to force the mode to be changed, but the log files are created with a name based the initial mode, some log files were later manually renamed later to better reflect the information they contain (such as ba4_11032011.log, which contains data from both Mode B and then Mode A). The filename protocol is: "Mode, Log Number, Underscore, Day, Month, Year, Dot, and Extension"; the "Mode, Log Number" part should not be confused with the level names, which named as such: "Level Number, Mode, Dot, Extension".

Scrolling through the images taken from the LogParser in sequence is the most illuminating method of comparing the results. However, since the effect is difficult to reproduce in a document and the inclusion of all one-hundred and eighteen level images would be impractical, a composite image was made for each of the six levels (three from Mode A, three from Mode B), with all of the individual images of a particular level superimposed on top of each other. The outcome is similar to a 'density map' effect, whereby darker areas show that blocks were placed there more often, and darker paths show that they were paths frequently taken.

In respect to this, the anticipated results for Mode A levels would be an image that showed many divergent paths sprawling all over the level, and many faint blocks placed throughout the level as well. Convergent paths or dense clusters of dark blocks would show that many players made the same decisions about how to tackle and complete the level, indicating weak design, or more critically, a lack of emergent gameplay.

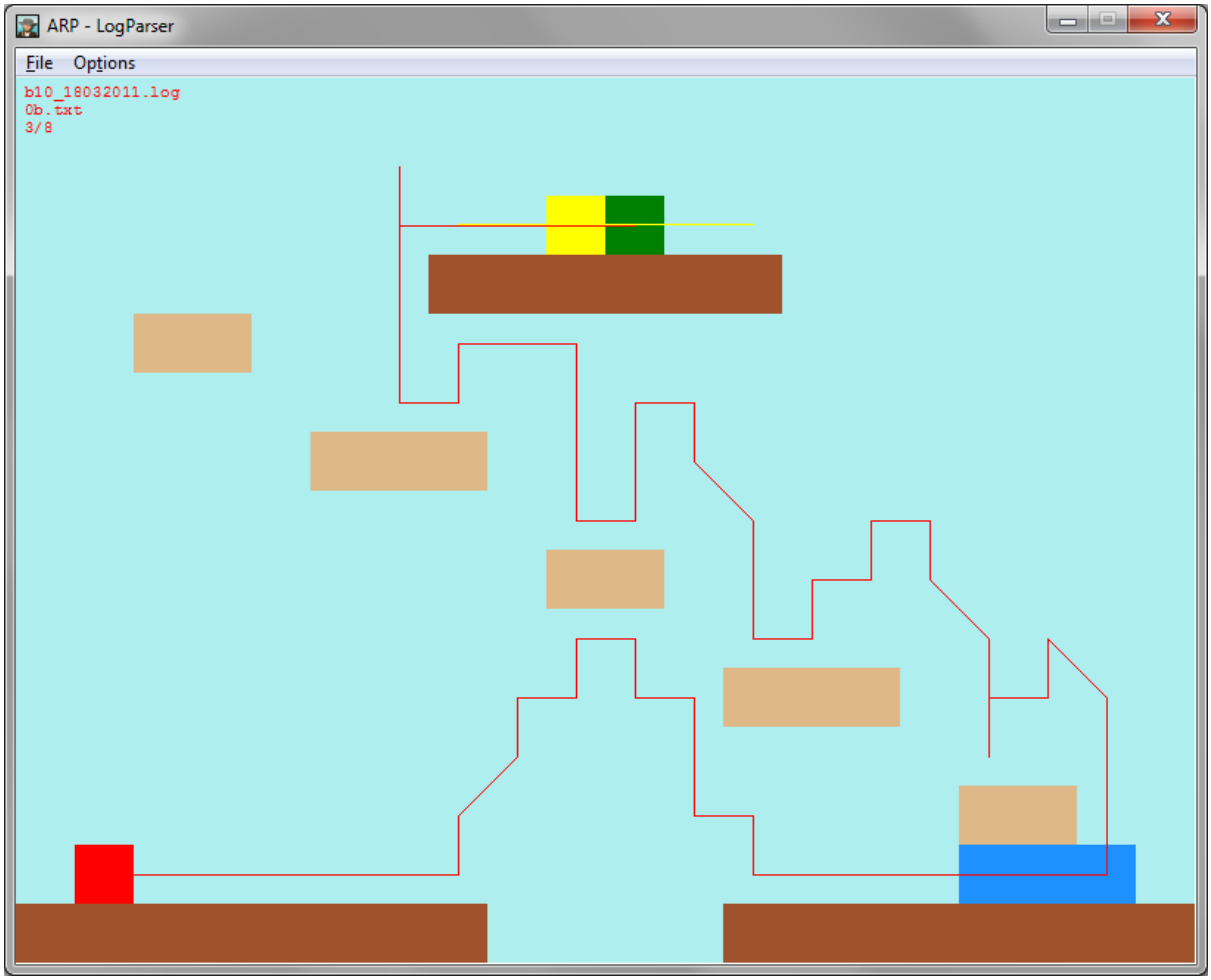
In contrast, the images from Mode B were expected to show the opposite of Mode A – although there is no block placement in Mode B, the one and only route through the level should immediately be obvious, since all paths through the level should take the same route. Finally, to give an indication of whether or not Mode A was more enjoyable to play, the total time that each player spent playing the game was logged at the end of the log files, which can be compared with the total times of Mode B. Although it is not strong evidence, it is logical that players would play a game that they enjoyed for longer than one that they didn't.

Figure 14: LogParser



In Figure 6, we see the LogParser in action. The grid, along with the paths through the level, can be toggled on or off using the 'Options' menu. The red square represents the player's spawn point (i.e. the start of the level), and the red line is the approximate path that the player took through the level. Blue squares are gems, which must be collected in order to complete the level; hence you can see the player's path passes through them en route to the green square, which is the exit or goal. The yellow square represents the spawn point of a monster, which also has a path (indicated in yellow as well). Since the monster AI stops and turns around when it encounters an obstacle or ledge, all that the monster did was pace back and forth on the platform – guarding the exit as it were.

Figure 15: LogParser Example



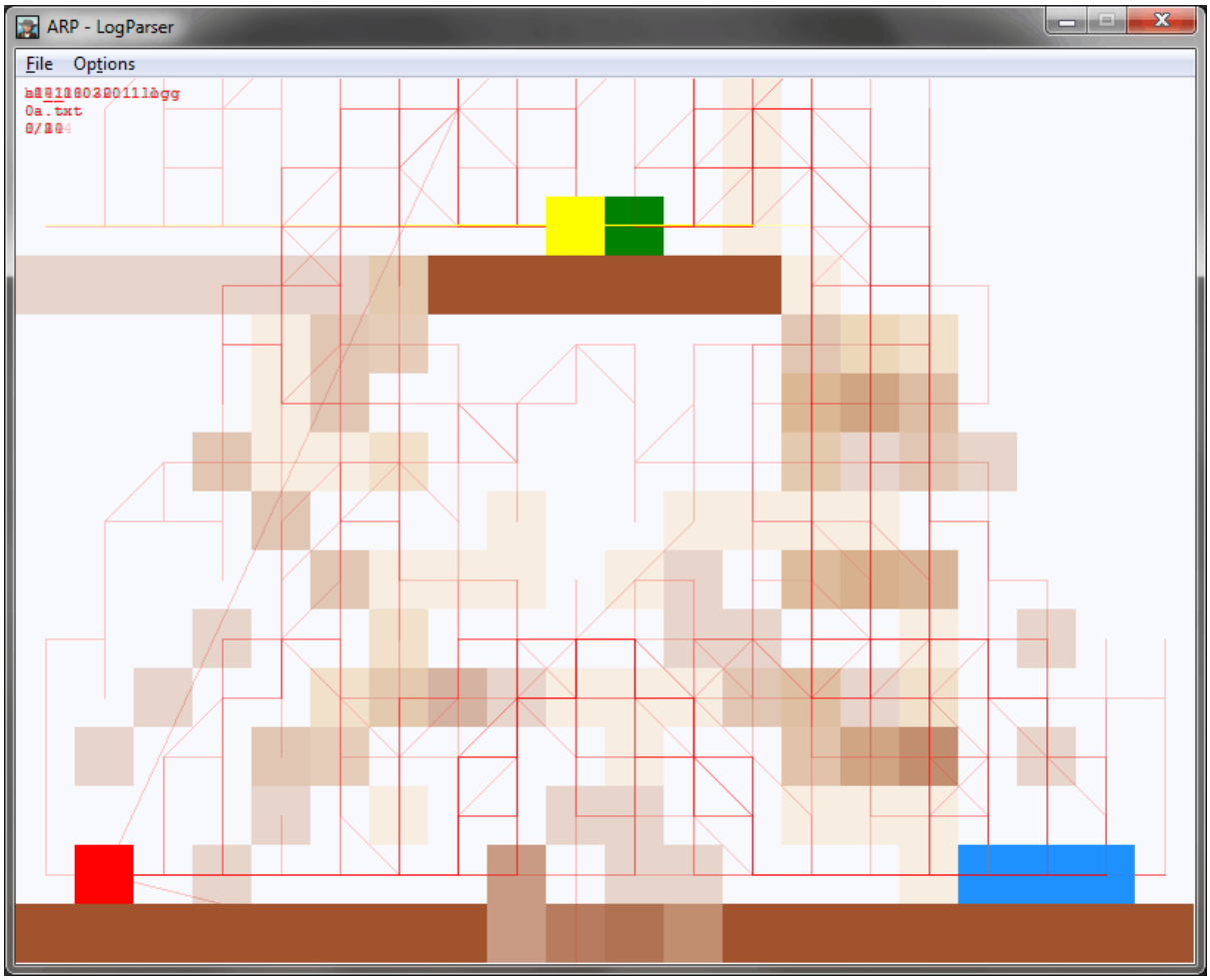
Information about the current level is displayed in the top left-hand corner, including the name of the log file the level came from, the name of the level itself, and the sequence of the level within the number of levels in the log file. Clicking ‘Next’ under the ‘Options’ menu will cycle the current level, displaying whichever one is next in the log. When reaching the last level in the log, clicking ‘Next’ once more will simply display the first level again. The LogParser was designed to be simple in nature, and although it has error handling, it relies on a strict protocol in terms of the log file format – if the game were ever modified, the LogParser would need to be updated as well to solve dependency issues.

The composite images form the basis of the results and the analysis thereof. The images are presented in the subsequent listing, followed by a comparison of the total time played for the two modes. The Analysis section then provides a breakdown summary of the events in each log file. Note that where lines are drawn directly to the red spawn block in the images, it indicates that the player character was killed (and where), before they reappear at the beginning of the level.

4.3 First Level Results

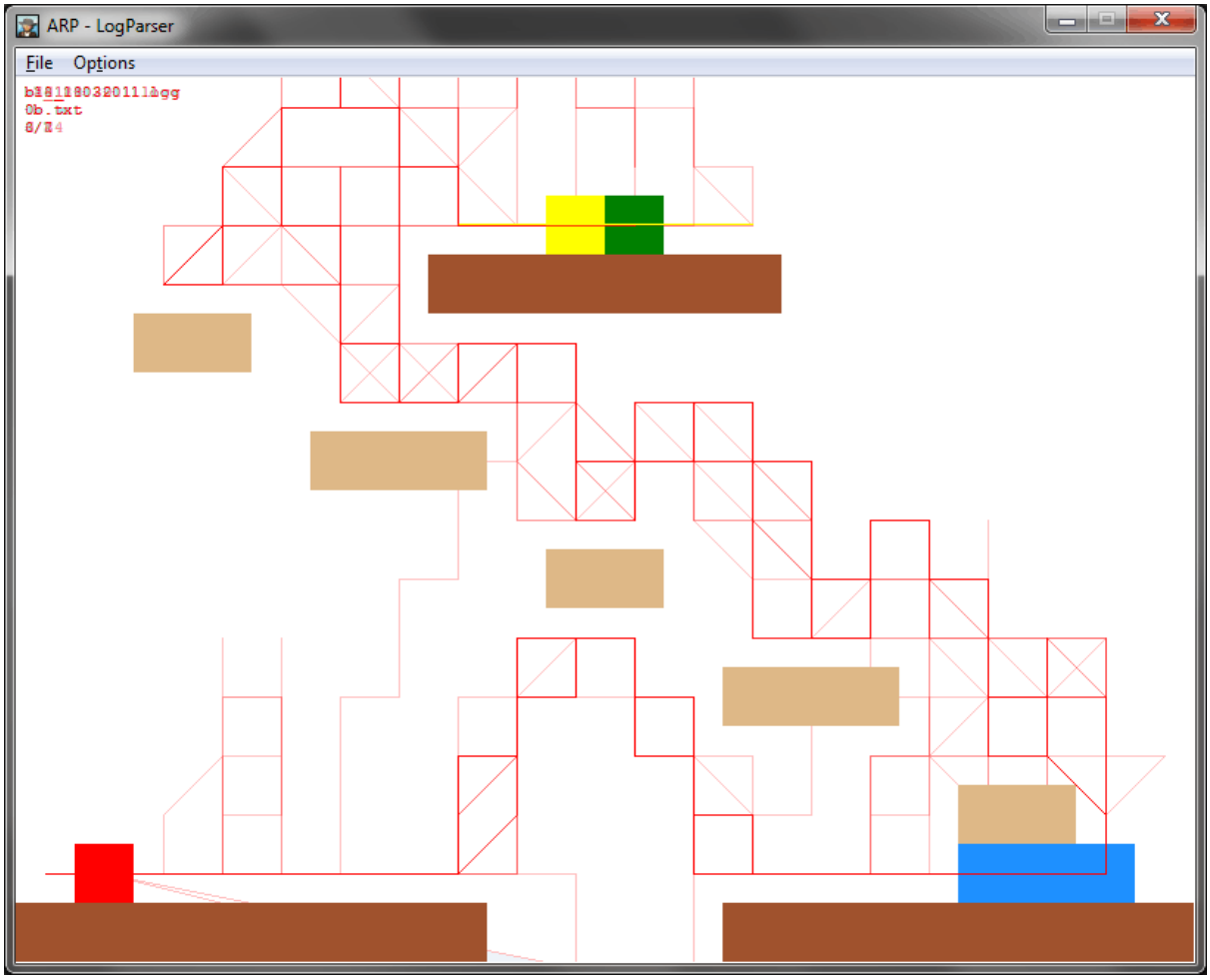
The first level, as shown in the Methodology, was designed to be the most open-ended. It featured two platforms along the bottom of the screen, separated by a fairly large gap; the player started on the leftmost one, and three gems were on the rightmost one. Between the two, high out of reach towards the top of the screen was a platform where the exit was located, guarded by a monster. The level requires the player to construct a series of platforms to jump up to the exit, with an absolute minimum requirement of three blocks.

Figure 16: First Level Results, Mode A



In Mode B, the first level forced the player to jump the gap at the bottom, collect the gems and then climb a series of steps to the opposite side of the screen; from there the exit could be reached. The route was deliberately indirect.

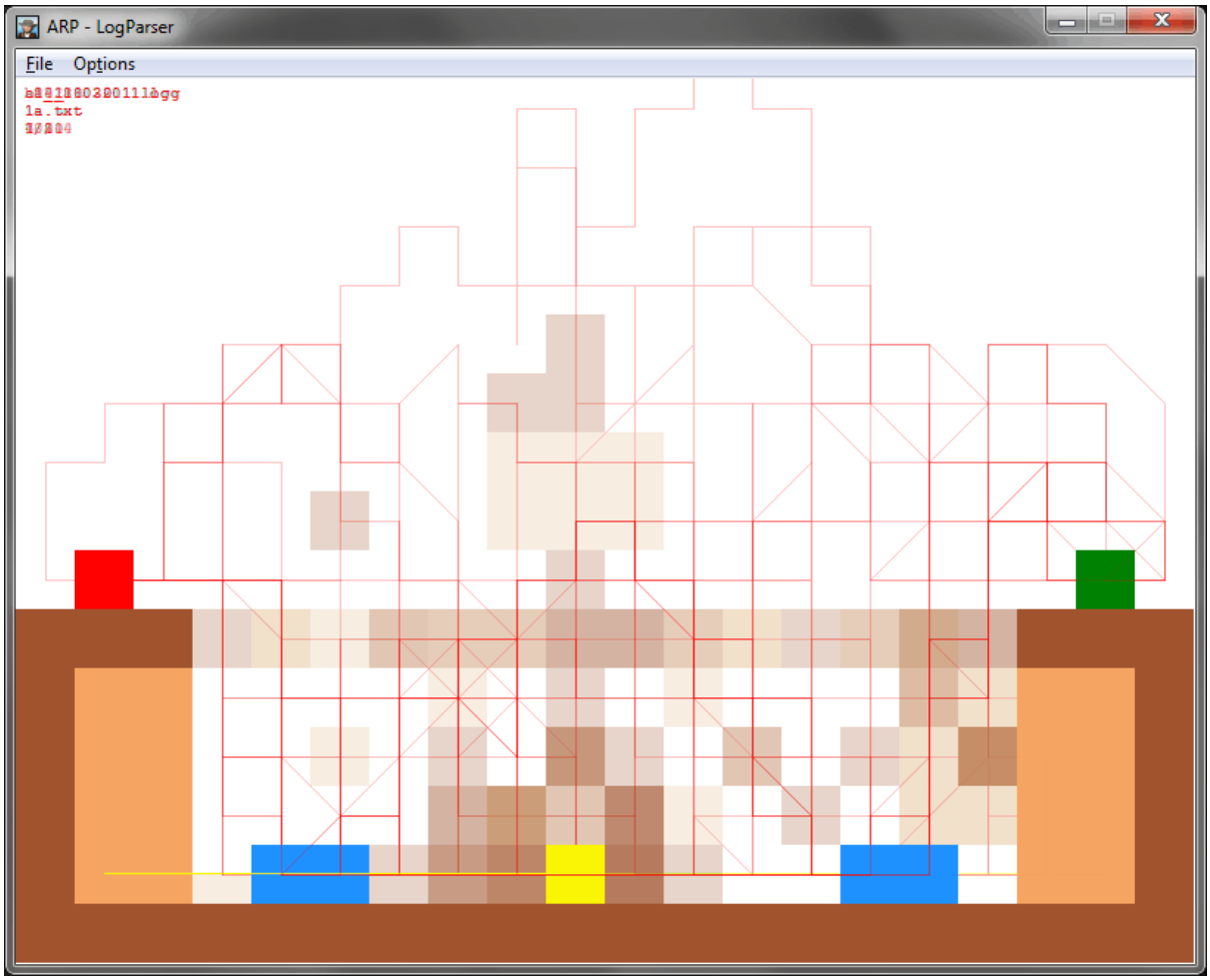
Figure 17: First Level Results, Mode B



4.4 Second Level Results

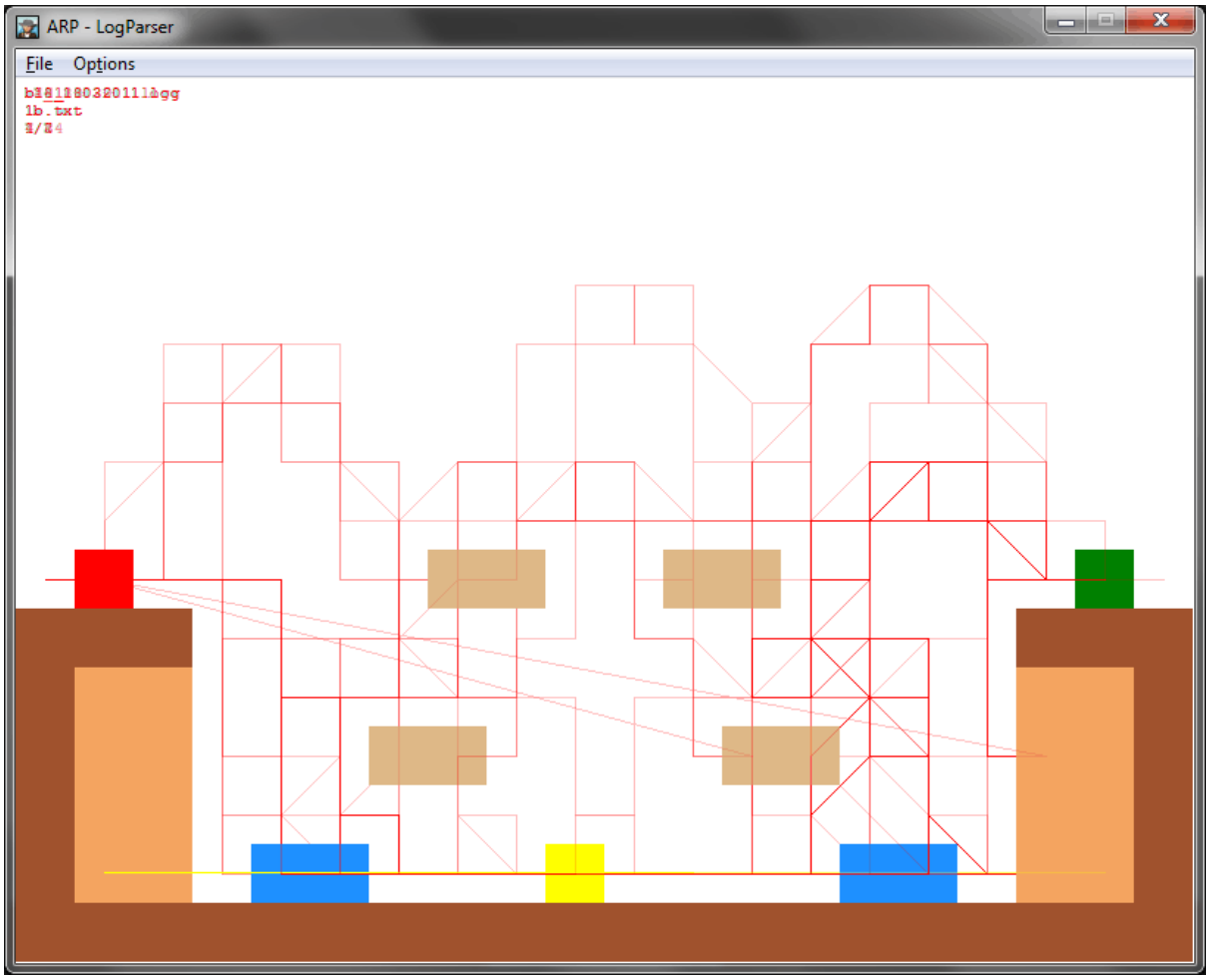
The second level was designed to be somewhat deceptive, but the solution is actually very simple indeed, only one block is actually required, but it must be placed in a very specific place. The level features two overhanging ledges, separated by a wide and deep pit. The player starts on the leftmost ledge, and the exit is on the opposite one. The gems are in the bottom of the pit, and guarded by a monster, meaning that the player must go down into the pit and confront it. The pit is too wide to jump across and too deep to jump out of, so the player is required to build a method of climbing back out.

Figure 18: Second Level Results, Mode A



In Mode B, platforms were already provided for jumping in to or out of the pit. This level offered more flexibility than the first level in terms of the routes available to the player, but it was still not as direct as it could have been.

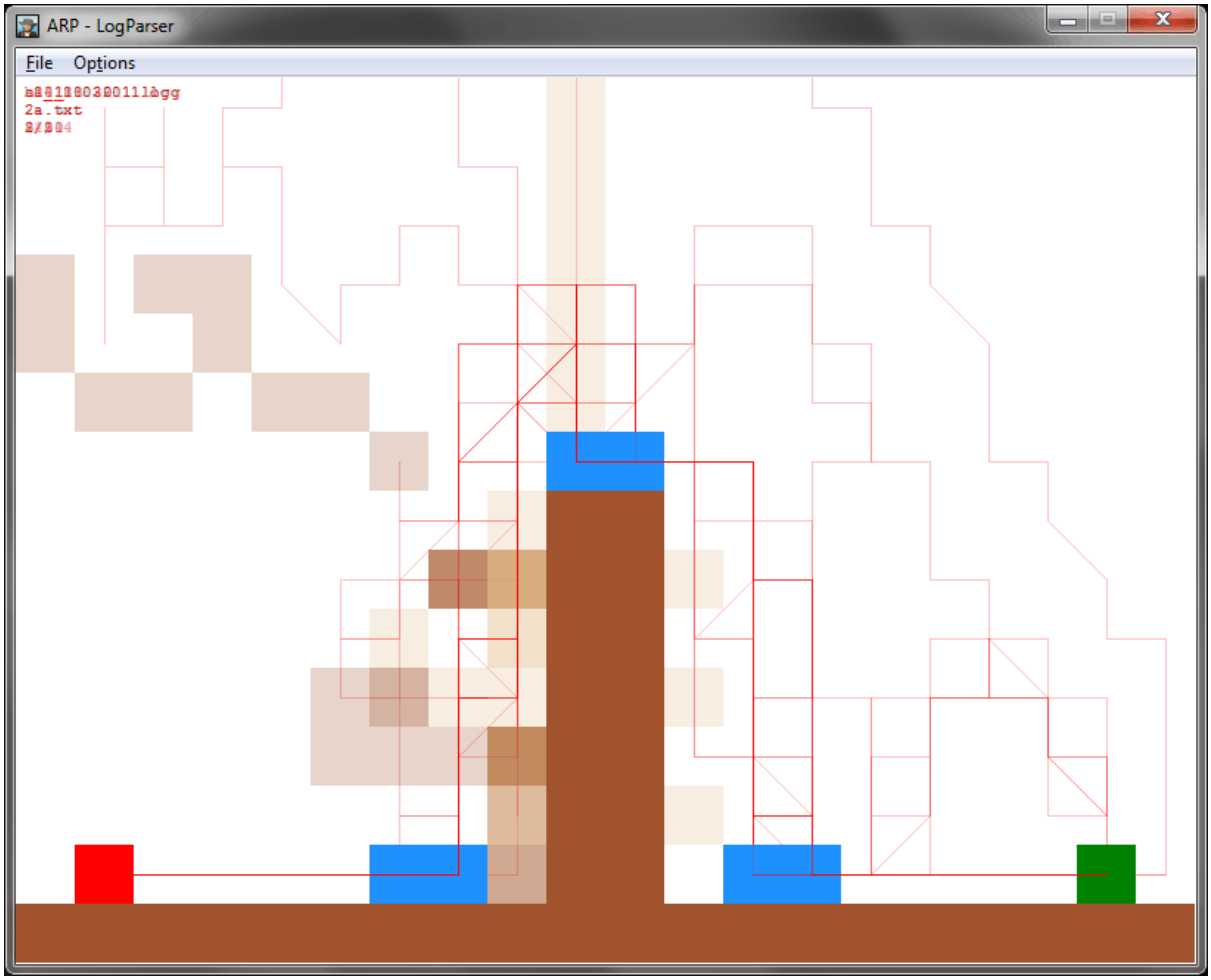
Figure 19: Second Level Results, Mode B



4.5 Third Level Results

The final level in Mode A was designed to be the most straightforward. There are no monsters present, and the minimum number of blocks required is two, in any configuration that allows the player to jump over the pillar blocking the path to the exit.

Figure 20: Third Level Results, Mode A



In Mode B, the level was even more straight forward; platforms to climb over the pillar are already present on both sides. These platforms actually impede access to the gems somewhat, but players made short work of the level all the same.

Figure 21: Third Level Results, Mode B

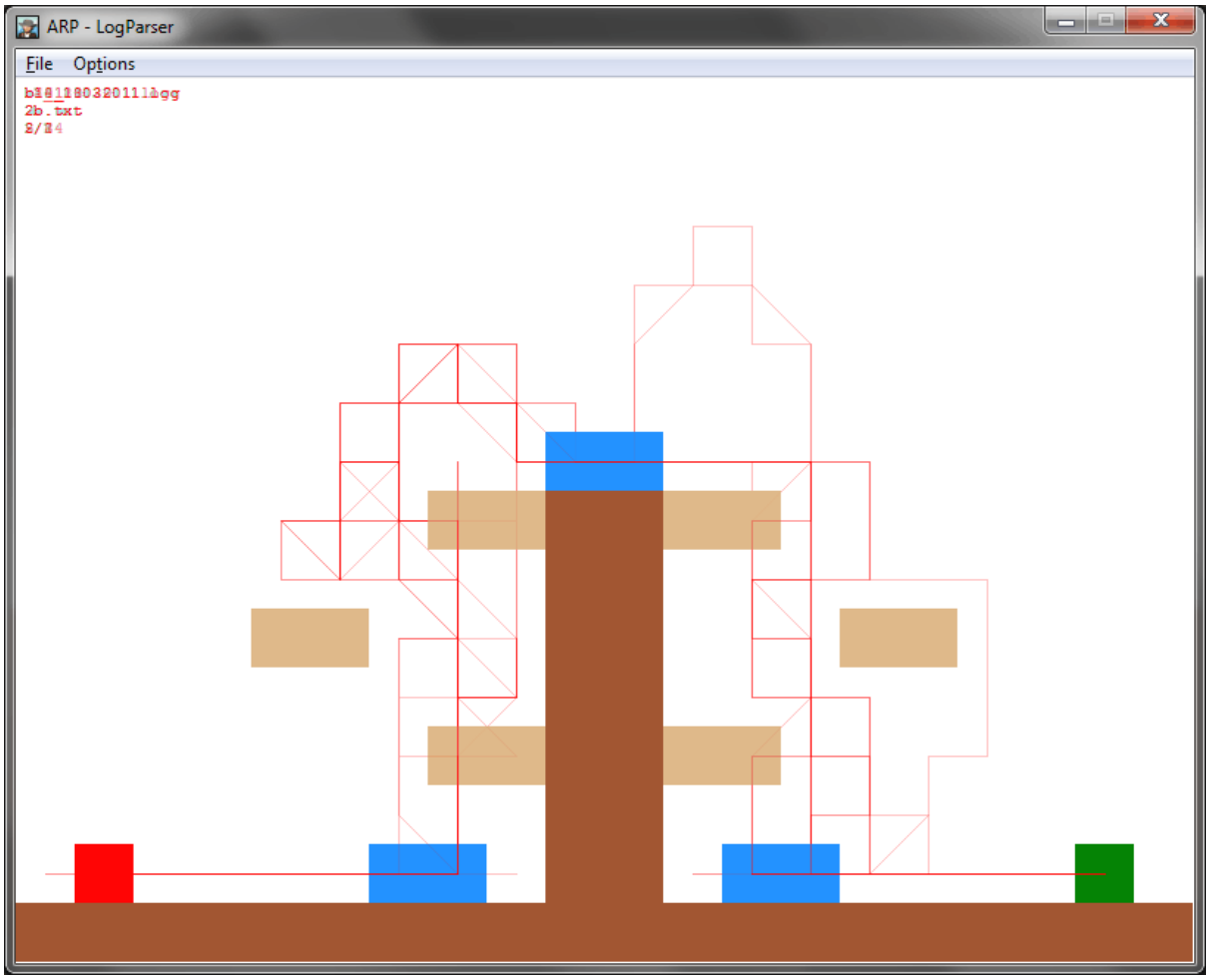


Table 7: Quantity of Results

Level	Results
0a	21
1a	20
2a	19
0b	17
1b	16
2b	13

4.6 Completion Time Results

In Figure 22, the total time spent playing each level is totalled and illustrated by the graph, along with the average time it took each level to be completed. The log files that contained a total run time for one specific game mode are shown in Table 8.

Figure 22: Completion Time Results

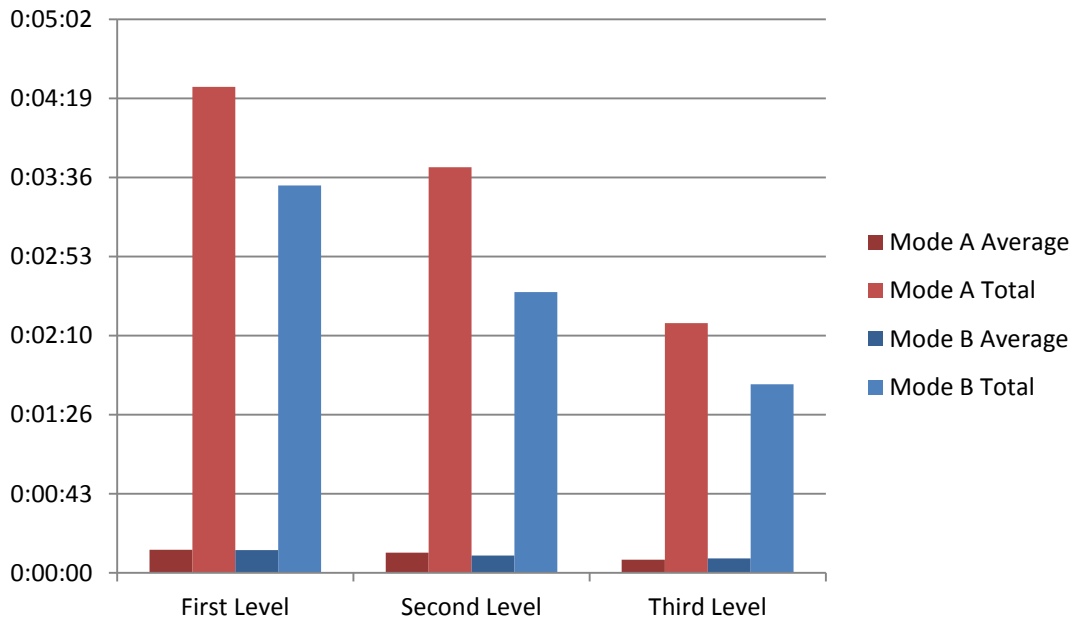
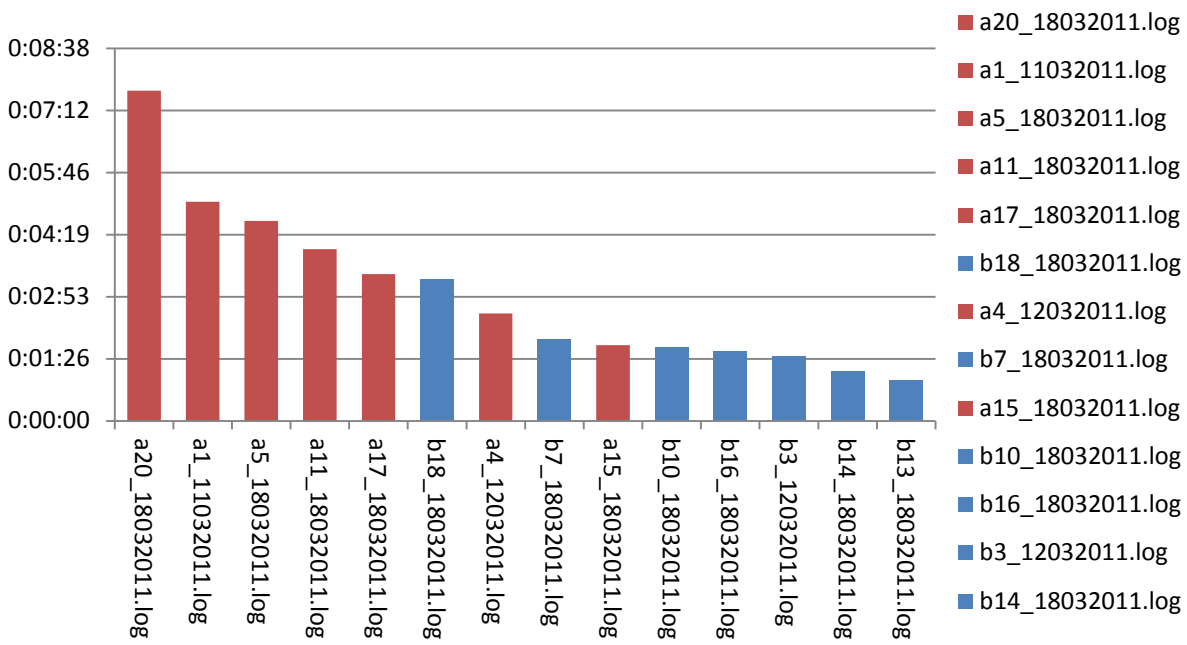


Table 8: Total Run Times

Log	Run Time
a1_11032011.log	0:05:05
a4_12032011.log	0:02:30
a5_18032011.log	0:04:38
a11_18032011.log	0:03:59
a15_18032011.log	0:01:45
a17_18032011.log	0:03:24
a20_18032011.log	0:07:39
b3_12032011.log	0:01:30
b7_18032011.log	0:01:53
b10_18032011.log	0:01:42
b13_18032011.log	0:00:56
b14_18032011.log	0:01:08
b16_18032011.log	0:01:37
b18_18032011.log	0:03:16

Figure 23: Total Play Times



4.7 Analysis

As anticipated in the Methodology section, if the design feature of Mode A was successful at promoting emergent gameplay, the results would show that players took many varied paths through the level and placed blocks in many different places. The results of the first level show this the most clearly, in Mode A, players opted for many different strategies – some would brick up the hole at the bottom of the level, and there were different methods chosen in how to climb up to the exit; although most of them focused on either approaching from the left or the right, and relatively few crossed through the middle as seen in the forced route of Mode B. In Mode B, the one and only route to the exit is very clear as all routes converge on it.

In the second level, we again see a great deal of variety in the tactics chosen by the players, who between them placed tiles that would have bridged the entire pit. Having said that, the one 'optimum' route for this level is visible – a tile on the right-hand side of the level is much darker than any others, showing the solution chosen by players who were interested in efficiency and scoring highly. Despite that, this level also shows the greatest number of creative solutions. One person constructed a 'block man' in the middle of the level, the head of which is visible in the composite image of the results, for no reason other than for exploring the game's possibility space. The discolouration of the yellow monster spawn block is due to some players experimenting with building a trap for the monster, an interesting solution that is certainly impossible in Mode B. This level offered the most flexibility in Mode B, but many players opted to walk along the bottom of the pit to collect the gems, taking the quickest route anyway. Many of the paths seen on the composite image of the second level in Mode B come from the same player, who had some difficulty in getting past the monster.

The final level shows the least diversity in both modes, with only one player in Mode A placing any blocks to the right of the pillar at its centre. A few others built structures on the left-hand side of the level that allowed them to jump from an extreme height; again just for the sake of exploring what was possible in the game. In Mode B, many players tried to complete this level as quickly as possible, which is very obvious in the composite image – none of them really deviate from the optimum path through the level.

Interestingly, the fact that three levels were chosen for the game turned out to be ideal. The game was simple to the point that its entertainment lifespan was short – no more than five to ten minutes. However, three levels seemed to give players just enough time to familiarise themselves with the controls and gameplay mechanics in both modes that by the time the first level game around again, they were keen to have a second attempt and improve their score. The game also exhibits 'second order' emergence by Sweetser's definition (Sweetser P. , 2007) cited in the Literature Review. Also, it was a pity that no player performed any action that was truly unexpected, as an anomalous result would have been remarkable.

The requirement of collecting all gemstones in the level before the goal could be reached was decidedly harmful to the research. This is apparent because each cluster of gems creates a point at which all routes converge, creating nodes along an optimum route, something that Will Wright stated as undesirable (Wright, 2003). This is perhaps why the first level was the most successful as a test-bed, because it features the fewest gemstones and after collecting them the player still has a significant portion of the level left to complete. Instead, it may have been better to have many more gemstones in the level, but remove the need to collect them all, or to have no gemstones at all with the addition of more monsters as an alternative.

While the inequality in the number of results for each level makes the total time played results somewhat biased, it does so in a way that indicates how popular each level was: It is logical that the most popular levels were played the most often. It is important to note that the level completion times do not account for time spent in the editor of Mode A, since the timer only begins counting down when the player starts the level. Due to this, it might be expected that the levels in Mode A were completed quicker, since the player has the ability to construct a much more optimum path to the goal than the routes available in Mode B, and Mode A players also have the opportunity to plan ahead before the timer starts while building the level; this, however, is not the case as seen in Figure 22.

It is speculated that this may be because in Mode A, many players derived enjoyment from building indirect routes to the goal that were creative and interesting, such as the 'block man' construction that was built on the second level, and the diving-board like contraptions in the third level, and therefore spent more time in each level on average; whereas the players of Mode B lacked the opportunity to do these things, and could only aim for goals like achieving a high score by completing the levels quickly. This consideration is interesting because it fits with what Jesse Schell said about how the

number of actions possible in a game is proportional to the amount of emergent gameplay it harbours (Schell, 2008, pp. 140-143).

4.8 Summary

Overall it is felt that although there are correlations in the results that suggest that the presence of player choice as a design feature is a contributor to emergent gameplay, which is what this paper set out to discover, the lack of demographic information about the study sample has weakened the value of the results. Besides that, the game's automated logging system proved a successful technique for gathering results, and combined with a more sophisticated testing application similar to the strategy game used by Sweetser in her Emergent Games Engine Technology system (Sweetser P. , An Emergent Approach to Game Design - Development and Play, 2006), could be used to present and analyse data in a variety of ways. The composite images in particular are effective at displaying the information that was found, which matched expectations that in Mode A, the presence of increased player choice led to varied solutions to each level, whereas in Mode B, the absence of that feature showed clearly convergent routes that left players with few goals to focus on, causing them to lose interest quickly.

5.1 Conclusions

The Literature Review clarified the terminology of the gaming industry, based on the fact that games are a fundamental part of life that we take part in for emotional fulfilment. It established that games allow us to experience emotions and forget about the tedious banalities of day-to-day life by engrossing us in fantastic worlds to explore, but where things behave logically so that we can subconsciously relate to those things easily – so easily, in fact, that our own imagination fills in the blanks for us, creating a 'suspension of disbelief', a delicate phenomenon referred to as 'immersion'. Things that do not behave in ways that their appearance would suggest, or act in ways that are inconsistent with similar objects, frustrate the player and shatter the illusion, because they are reminded that they are just playing a game.

Following that, emergent gameplay was explored as collection of development techniques that can make games more immersive; and ultimately refers to the interaction and interdependency between multiple complex systems. Emergent gameplay can be achieved by using a property based system, whereby our game worlds can be populated with objects that behave both dynamically and intuitively, yet unpredictably at the higher levels; or by allowing the player to feel more immersed because they have more freedom to make the choices they want. The most immersive games distort our very perception of space and time, providing intense experiences of no physical consequence, which lure us back for more – ultimately making the game more successful, and therefore sell more. There is no wonder that game developers wish to unlock the potential of emergent gameplay.

A selection of titles that have already made claims to such success over recent years were then analysed to identify what aspects of their design facilitated emergent gameplay. The simplest common denominator was found to be player choice; in all of the games reviewed, players were given a great deal of control and freedom over the actions that they could choose in order to solve challenges and make progress. With that in mind, a simple platformer game was developed to determine how effective the presence of player choice as a design element was for the promotion of emergent gameplay. To do this, the platformer game consisted of two modes of gameplay, one of which granted the player much more freedom in terms of how they could solve each level, by allowing them to construct their own route through it. The other mode featured much more linear gameplay.

Results were collected from the game in the form of log files that showed where the player had changed the level, and what route they took through it. The log files also recorded how long each version of the game was played for, providing a basis for the conclusion that whichever version was played longer could be considered more enjoyable. However, as identified by the analysis of the results, the participants of the research formed a weak study sample. Despite this, both the results that were collected, and the game itself as a platform for collecting them, show potential for providing much stronger evidence to support the research conducted in this paper, if the experiment were to be repeated with these considerations taken into account with a larger, stronger study sample.

The results were concurrent with expectations, albeit not as clearly as was hoped. There were indications that the game mode that incorporated the design elements to promote emergent gameplay was successful. The levels from the emergent game mode showed that players were able to solve them in a variety of ways and take a number of routes to the goal, whereas the other game mode restricted players to a single route. Also, the former of the two game modes was played for longer, suggesting that players may have found it more enjoyable.

5.2 Recommendations

Ultimately, it is felt that emergent gameplay is such a broad subject that would require a project with resources beyond the scope of what was achievable here in order to investigate properly. It is the breadth of the subject that has made it so difficult for other researchers to define exactly what emergent gameplay is, and so difficult for game developers to successfully leverage despite all of the monetary backing that they have.

However, as already concluded, potential was seen in the results of the research carried out in this paper, to garner a deeper understanding of how emergent gameplay can be achieved through the implementation of game design elements that can then have their influence observed by recording the actions of players for later analysis. Therefore it would be of value to conduct a similar test that used a more sophisticated design principle of emergent gameplay, such as a property-based system, to observe and record how players might use such a feature to solve challenges and complete levels. The purpose of such research would not be to decide what design features would be suitable for a particular part of the game, but to determine whether or not existing features actually contributed anything to the value of gameplay; as Jeremiah Slackza eloquently said while discussing *Scribblenauts*, some games appear to use emergent gameplay just for the sake of it (Slackza, 2009); and Dustin Browder, lead designer of *StarCraft II* at Blizzard Entertainment (Blizzard Entertainment, 2010) also said something of the same disposition: “Just as the NBA doesn’t allow jetpacks in basketball and the Olympic Committee frowns on nuclear-powered luges, sometimes self-imposed restrictions are in place because what might sound like fun – or even actually be fun – could ruin or overcomplicate the design of a game” (Browder, 2011).

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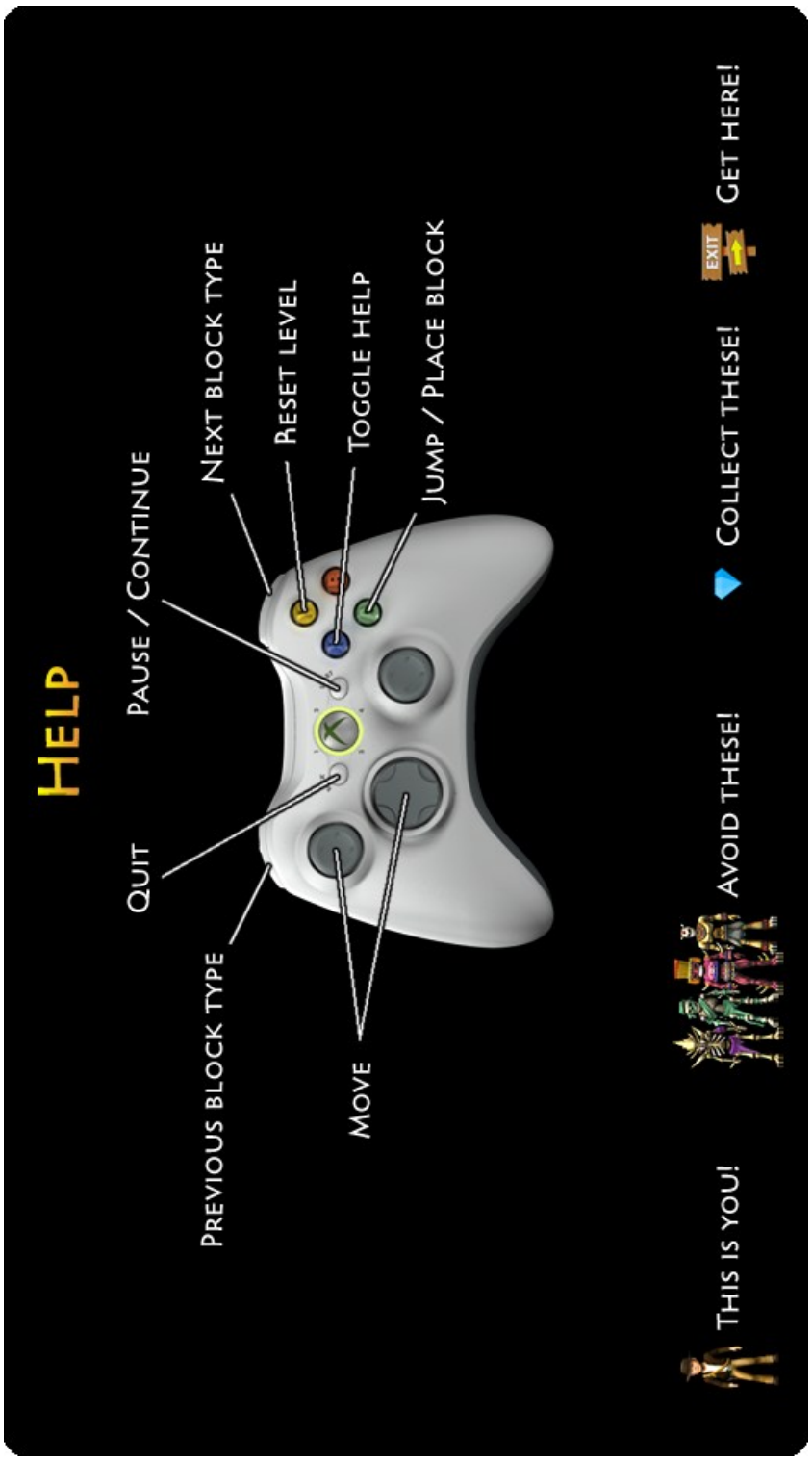
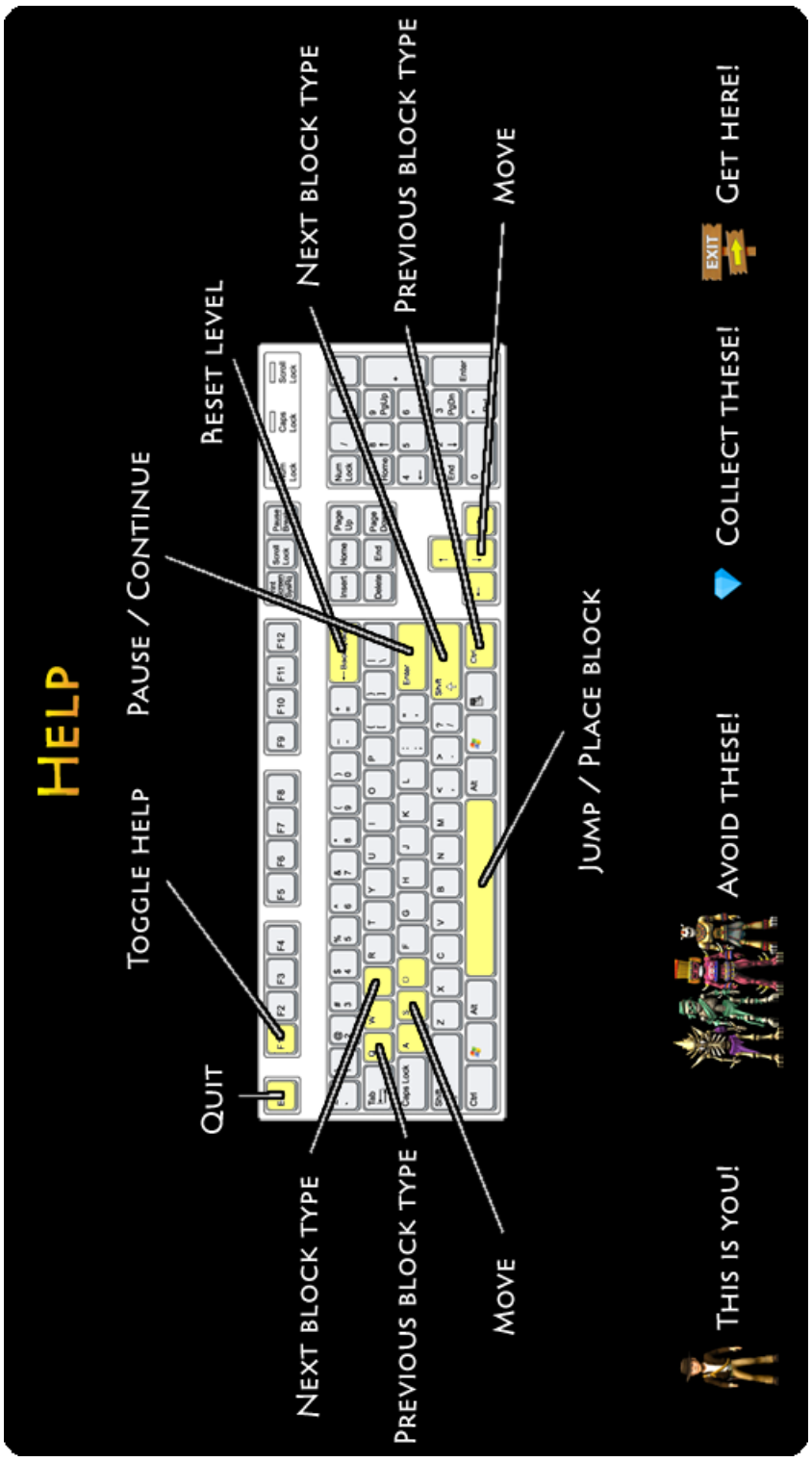
Appendices

Consent Request Screen (Large)

Help Screen – Xbox 360 (Large)



Help Screen – PC (Large)



Ethical Considerations

School of Computing and Mathematics
Faculty of BCL

UNIVERSITY of DERBY

Request for Ethical Approval for Individual Study / Programme of Research by University Students

Students conducting PG Independent Scholarship (PG IS), UG Applied Research Project (UG ARP), UG Maths Projects (UG MP) or Learning-through-Work (LTW) projects must complete this form and submit to their project supervisors for approval. After initial approval, project supervisors need to submit these forms to PG IS, UG ARP, UG MP or LTW coordinator who would then submit these to the Chair of the Computing Ethics Committee (CREC) for further consideration.

Students conducting PG Research projects (eg MPhil, PhD etc) must also complete this form and submit to their research supervisors for approval who would then submit these to the Chair of the CREC for further consideration.

Feedback on your application will be via the Project/Research Supervisor.

1. Your Name:	Matt Pickering	**2a. Programme name and code:** BSc Computer Games Programming (G450) **2b. Your student ID:** 100017537
3. Contact Info	**Email:** mattpickering@live.co.uk **Tel No.** 07717474705 **Address:** 28 School Lane Wadshelf Chesterfield Derbyshire S42 7BY	
4. Module name and code	Applied Research Project (6CC039)	
5. Name of project / research supervisor: Wayne Rippin		
6. Title or topic area of proposed study		
"Do basic sandbox elements of a game design help to encourage emergent gameplay?"		
7. What is the aim and objectives of your study?		
To identify features of existing game designs that encourage emergent gameplay, whether it be intentional or not, and incorporate those features into a design of my own. In order to ascertain those features, I will have to understand exactly what the definition of emergent gameplay is, and also how and why it occurs. I will then create an implementation of my design and perform a focus test with an adequate number of participants in order to establish whether those design techniques have or have not been successful in their encouragement of emergent gameplay.		
8. Brief review of relevant literature and rationale for study (attach on a separate sheet references of approximately 6 key publications, it is not necessary to attach copies of the publications)		
"A Cognative Framework for the Analysis of Game Play: Tasks, Schemas and Attention Theory" Craig A. Lindley and Charlotte C. Sennersten Game Design, Cognition and Artificial Intelligence Research Group, Department of Game Development, Narrative and Time-Based Media, Gotland University College, Cramergatan, SE-621 57, Sweden		

"Flow and Immersion in First-Person Shooters: Measuring the player's gameplay experience"
Lennart Nacke and Craig A. Lindley
Blekinge Institute of Technology
Karlshamn, Sweden

"Scripting Versus Emergence: Issues for Game Developers and Players in Game Environment Design"
Penelope Sweetser and Janet Wiles
School of Information Technology and Electrical Engineering
University of Queensland
St Lucia, Queensland, Australia

"Pervasive Games: Theory and Design"
http://pervasivegames.wordpress.com
Markus Montola, Jaakko Stenros, Annika Waern

"The Psychology of Video Games"
http://www.psychologyofgames.com
Jamie Madigan

"Game Development Essentials – Gameplay Mechanics"
Troy Dunniway & Jeannie Novak
ISBN-13: 978-1-4180-5269-0
ISBN-10: 1-4180-5269-8

"Rules of play: Game Design Fundamentals"
Katie Salen, Eric Zimmerman
ISBN: 0-262-24045-9

9. Outline of study design and methods

After defining the what, how and why of emergent gameplay and identifying features of existing games that encourage its occurrence, I intend to make a simple game of my own that incorporates those features. The game will have two modes: one with the emergent gameplay features enabled, and one with the features disabled. I will then request that volunteers test the game in one of the two modes (no volunteer will play both modes). The mode in use by the game will be selected by me prior to each test, and the players will have no knowledge of which mode the game is running, or the differences between the modes.

I will create a logging system for the game that will store the player's actions in a log file. Their actions are the only thing that I am interested in; I do not need to know any personal details about the players.

By analysing the player's actions, I should be able to tell to what extent my design has been successful. If the players who tested the game in the mode with the emergent gameplay features enabled completed the test in a variety of ways, the design has been a success. This will be reinforced if the players who tested the game in the other mode completed test in the same way each time.

My preliminary literature review has identified that a sandbox game design which has nonlinear gameplay is a suitable design technique to implement for the focus test.

10. Research Ethics

PROPOSALS INVOLVING HUMAN PARTICIPANTS (eg collecting data using questionnaires, interviews etc) MUST ADDRESS QUESTIONS 10 - 14.

Does the proposed study entail ethical considerations (Yes) / No (please circle as appropriate)

If 'No' provide a statement below to support this position and skip Questions 11-14.

If 'Yes' move on to Question 11.

11. Ethical Considerations: Please indicate how you intend to address each of the following in your study. Points a - i relate particularly to projects involving human participants.
Guidance to completing this section of the form is provided at the end of the document.

a. Consent

My game will present a consent screen to the player before anything else, which will explain what they can expect of the test, see attached for a summary of this screen. If they press the start button and launch the game from this screen, they indicate their consent.

b. Deception

The participant will not know that the game that they are testing has different modes, nor will they know the difference in the game modes. All other information collected will be available to the participant at their request. The only reason for this is to ensure purity of the results.

c. Debriefing

Upon completion of the test, the participant will be simply thanked for their contribution to my research, there is nothing else required.

d. Withdrawal from the investigation

I will explain to the participant that they are free to withdraw from the test at any time, and I will destroy the information collected so far (the incomplete results from the test will be useless to me anyway). This information will be included on the consent screen.

e. Confidentiality

Not applicable - personal and biographic information about the participant is not important to my research; there will be absolutely no recording of confidential or identifiable information.

f. Protection of participants

Not applicable.

g. Observation research [complete if applicable]

I will supervise the participant during the test; however, I will not get involved unless there is a technical problem (such as the game crashing). The game itself will generate a log file of the player's actions, the contents of which will be intrinsic to my research.

h. Giving advice

Not applicable – I will not advise the participant on how they could complete the test.

i. Research undertaken in public places [complete if applicable]

The research will take place in the Specialist Computing Labs within the B-Block of the University of Derby.

j. Data protection

Not applicable.

k. Animal Rights [complete if applicable]

Not applicable.

l. Environmental protection [complete if applicable]

Not applicable.

12. Sample: Please provide a detailed description of the study sample, covering selection, number, age, and if appropriate, inclusion and exclusion criteria.

Because the research is taking place within the University itself, the study sample will be students of a similar demographic to myself – young males that are familiar with games.

I aim to collect at least 30 test results.

13. Are payments or rewards/incentives going to be made to the participants? If so, please give details below.

No. Not applicable.

14. What study materials will you use? (Please give full details here of validated scales, bespoke questionnaires, interview schedules, focus group schedules etc and attach all materials to the application)

Because the subject of emergent gameplay is quite broad, I intend to find published peer-reviewed papers on similar or related topics to collect information on the various forms of emergent gameplay. I also expect to find material in talks given at game-related conferences like Game City, Gamescom, Tokyo Game Show or E3, and at non-game-related conferences such as TED.
Furthermore, I hope that by directly analysing the design of some prominent games (that are widely regarded as encouraging emergent gameplay), I can identify what techniques were used in the design to achieve that goal. I can then incorporate those techniques into a design of my own. The developers of these games will most likely have very useful information about their game designs on their websites.
There are also several other blogs and websites that relate directly to the psychology of gaming, and the reasons why and how emergent gameplay occurs. The results of my test should provide a substantial base for a critical analysis when compared to trends in these blogs and websites.
There are also books available that will help me understand how to implement my design.

15. What resources will you require? (e.g. psychometric scales, equipment, such as video camera, specialised software, access to specialist facilities, such as specialist laboratories).

The game itself will produce all the results that I require. To run the game, however, I will require access to the Specialist Gaming Labs on B2 of the University; specifically to the Xbox 360 consoles in B213. My game will be written in C#/XNA, so although it will work on any Xbox 360 console, all of the development tools that I require can be found in those labs; and because of the number of consoles available, I will be able to conduct multiple tests concurrently, allowing me to procure a larger volume of results in a shorter period of time.

16. Have/Do you intend to request ethical approval from any other body/organisation? Yes / (No)
(please circle as appropriate)

If 'Yes' – please give details below.

UNIVERSITY of DERBY

17. Declaration: The information supplied is, to the best of my knowledge and belief, accurate. I clearly understand my obligations and the rights of the participants. I agree to act at all times in accordance with University of Derby Code of Practice on Research Ethics http://www.derby.ac.uk/research/ethics/policy-document

Date of submission……..

Signature of applicant……

Signature of project supervisor ……

Signature of PG IS, UG ARP or UG MP Coordinator (and comments, if any) ……

For CREC Committee Use *Reference Number (Subject area initials/year/ID number)……..*

Date received…… Date approved …… Signed……

Comments

PLEASE ALSO SUBMIT THE FOLLOWING DOCUMENTATION WHERE APPROPRIATE (please tick to indicate the material that has been included or provide information as to why it is not available):

Questionnaires/Interview schedules ☐
Covering letters/Information sheets ☐
Briefing and debriefing material ☐
Consent forms for participants ☐

Advice on completing the ethical considerations aspects of a programme of research

Consent
Informed consent must be obtained for all participants before they take part in your project. The form should clearly state what they will be doing, drawing attention to anything they could conceivably object to subsequently. It should be in language that the person signing it will understand. It should also state that they can withdraw from the study at any time and the measures you are taking to ensure the confidentiality of data. If children are recruited from schools you will require the permission, depending on the school, of the head teacher, and of parents. Children over 14 years should also sign an individual consent form themselves. If conducting research on children you will normally also require Criminal Records Bureau clearance. You will need to check with the school if they require you to obtain one of these. It is usually necessary if working alone with children, however, some schools may request you have CRB clearance for any type of research you want to conduct within the school. Research to be carried out in any institution (prison, hospital, etc.) will require permission from the appropriate authority.

Covert or Deceptive Research
Research involving any form of deception can be particularly problematical, and you should provide a full explanation of why a covert or deceptive approach is necessary, why there are no acceptable alternative approaches not involving deception, and the scientific justification for deception.

Debriefing
How will participants be debriefed (written or oral)? If they will not be debriefed, give reasons. Please attach the written debrief or transcript for the oral debrief. This can be particularly important if covert or deceptive research methods are used.

Withdrawal from investigation
Participants should be told explicitly that they are free to leave the study at any time without jeopardy. It is important that you clarify exactly how and when this will be explained to participants. Participants also have the right to withdraw their data in retrospect, after you have received it. You will need to clarify how they will do this and at what point they will not be able to withdraw (i.e. after the data has been analysed and disseminated).

Protection of participants
Are the participants at risk of physical, psychological or emotional harm greater than encountered ordinary life? If yes, describe the nature of the risk and steps taken to minimise it.

Observational research
If observational research is to be conducted without prior consent, please describe the situations in which observations will take place and say how local cultural values and privacy of individuals and/or institutions will be taken into account.

Giving advice
Students should not put themselves in a position of authority from which to provide advice and should in all cases refer participants to suitably qualified and appropriate professionals.

Research in public places
You should pay particular attention to the implications of research undertaken in public places. The impact on the social environment will be a key issue. You must observe the laws of obscenity and public decency. You should also have due regard to religious and cultural sensitivities.

Confidentiality/Data Protection
You must comply with the Data Protection Act and the University's Good Scientific Practice http://www.derby.ac.uk/research/policy-and-strategy This means:

- It is very important that the Participant Information Sheet includes information on what the research is for, who will conduct the research, how the personal information will be used, who will have access to the information and how long the information will be kept for. This is known as a 'fair processing statement.'
- You must not do anything with the personal information you collect over and above that for which you have consent.
- You can only make audio or visual recordings of participants with their consent (this should be stated on the Participant Information sheet)
- Identifiable personal information should only be conveyed to others within the framework of the act and with the participant's permission.
- You must store data securely. Consent forms and data should be stored separately and securely.
- You should only collect data that is relevant to the study being undertaken.
- Data may be kept indefinitely providing its sole use is for research purposes and meets the following conditions:
- The data is not being used to take decisions in respect of any living individual.
- The data is not being used in any which is, or is likely to, cause damage and/or distress to any living individual.
- You should always protect a participant's anonymity unless they have given their permission to be identified (if they do so, this should be stated on the Informed Consent Form).
- All data should be returned to participants or destroyed if consent is not given after the fact, or if a participant withdraws.

Animal rights.
Research which might involve the study of animals at the University is not likely to involve intrusive or invasive procedures. However, you should avoid animal suffering of any kind and should ensure that proper animal husbandry practices are followed. You should show respect for animals as fellow sentient beings.

Environmental protection
The negative impacts of your research on the natural environment and animal welfare, must be minimised and must be compliant to current legislation. Your research should appropriately weigh longer-term research benefit against short-term environmental harm needed to achieve research goals.

Other Documents

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