Improving Player Choice and the Facilitation of Open Plot Structures in Story Driven Video Game with the Application of Interactive Narrative Theory and Modern Decision Making Techniques

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2012

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AKNOWLEDGEMENTS

Firstly I would like to thank my supervisor David King for his help and advice during the course of the project.

I would also like to thank my partner Kayleigh Ross for her support and understanding through the long nights at the computer.

Finally I would like to thank everyone who took part in the evaluation process for their participation and comments.

ABSTRACT

The aim of the project was to develop an interactive narrative model tailored specifically towards story driven video games implemented using modern decision making techniques. The model was to incorporate a high level of time relative player choice, which was to be represented through a strong user interface and maintained within an open plot structure. During the course of the project the ISGEngine was developed in order to fulfill the aims of the project. The interactive story-game theory was designed in to aid the development process. The ISGEngine was capable of handling a large amount of plot content, processing dialogue decisions, tracking the progress of the plot and maintaining the cohesion and continuity. Using the ISGEngine a demo application was developed in order to evaluate the various features. This demo application consisted of a short role playing game where the player would interact with characters and their actions and inaction would have an effect on the overall plot direction. The results of the evaluation found that it is possible to offer the player a high level of choice and to use and maintain an open plot structure within story driven video games through use of situation generation. It was also found that due to the high level of choice the user interface must be very well designed otherwise the choice is not represented well enough to the player.

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1. INTRODUCTION

1.1 Setting the Scene

Imagine you are playing a typical role playing game, you approach a village that is under attack and a soldier comes to you and asks for your help. You turn and walk away then come back one month later (in game time), the village is still under attack and the soldier still has the exact same scripted response. In this game, the graphics are incredible, the action is intense, the plot is plentiful and there is a massive, open world for you to explore. There is one thing however that keeps you from becoming completely immersed in this fantastic game world. That is the realisation that the decisions you make, no matter how much you want them to, will never have any meaningful effect on the plot of the game or on the game world itself. It is frustrating that after being given all of this free will you are still unable to make a difference. This is the case for many video games today such as The Elder Scrolls IV: Oblivion (Figure 1).

Figure 1: The Elder Scrolls IV: Oblivion

Now picture a perfect game where every choice you make, no matter how insignificant, carried with it cause and effect, even if you are unaware you made the choice. Imagine if, when you chose to walk away from the village, the village burned to the ground and this caused a chain reaction within the plot that was unpredictable. This would inevitably lead you down a different path that is unique to the progress made since the game began; that is what this project aims to achieve.

1.2 Background

With the recent rise of story driven video games it is increasingly desirable for players to be able to interact with the plot and make the story their own. This desire is not being met by current video games; there have been many recent attempts to create the illusion that the player's choices have a deep meaningful impact on the games plot however these techniques are usually transparent and ultimately disappointing (Jubert 2010). This is where interactive narrative can be utilised. Interactive Narrative is the area of study involved in developing meaningful interactive human-computer narratives and dramas (Laurel 1991). With the graphical quality available today, the next logical step for the increasingly popular story driven video game is to fully embrace interactive plot. The lack of development in the field means it is a huge risk for any developer to undertake and not many have tried to do so. There have been many projects involving interactive narrative. These projects are small and primarily developed for research purposes, however if these techniques were to be implemented within a video game successfully it could lead the way for a whole new genre of video game.

1.3 Aim & Research Question

The problem with most modern story driven video games is that they attempt to give the player a sense of free will, however this is met by constant restrictions in both the plot and the game world they inhabit (Jubert 2010). This project aimed to develop an interactive narrative engine tailored specifically towards story driven video games. It was to implement interactive narrative theory using modern decision making techniques. The engine developed was to allow for high levels of multi dimensional player choice which could be represented in an appropriate manner. Additionally the engine was to utilise an open plot structure and be capable of maintain the cohesion and continuity. It was to be designed with RPGs such as Elder Scrolls V: Skyrim (Bethesda Studios 2011) in mind, as this style of game is best suited for representing narrative (Aarseth 2004). Interactive narrative is a very large topic area and there are many different aspects currently under academic research. These aspects include autonomous character behaviour (Si 2011), narrative generation (Barber 2009), and the improvement of plot authorship (McRobbie 2007). This project is primarily concerned with the element of player choice, the subsequent representation and the

required maintenance of plot cohesion and continuity within an open plot structure. The scope of the project will therefore be constrained to this.

1.4 Research Question

The research question for this project was as follows:

> *Can the element of player choice and the subsequent game play experience of story driven video games be improved with the application of interactive narrative theory and modern decision making techniques?*

The research question was then divided into the three main aims:

- *Develop a model with relatively simple plot authorship that is capable of a high level of player choice, whilst maintaining a low content requirement.*
- *Develop a strong user interface capable of representing the player's choice and time relativity within the plot in multiple ways and delivering a unique experience for each player.*
- *Develop a non-invasive plot director capable of maintaining cohesion and continuity within an open plot structure.*

1.5 Dissertation Structure

The dissertation will begin by defining the interactive game play experience and identifying the problems which currently exist in story driven video games. It will then describe interactive narrative theory, which could be applied in order to resolve the problems and the techniques which could be used to implement it. It will go on to describe the theory and the implementation of the ISGEngine, which was developed during the course of the project in order to fulfil the aims. Finally it will describe the evaluation process that was undertaken and the results which were attained and then discuss potential further work for the project.

2. LITERATURE REVIEW

2.1 Modern Story Driven Video Games

2.1.1 Introduction

This section will begin by defining the interactive game play experience, then it will go on to identify the problems with current story driven video games.

2.1.2 The Story Driven Video Game

In recent years story driven video games have grown in popularity, emerging with a dominant place in the video games industry. The games stretch across various genres from first person shooters like Deus Ex: Human Revolution (Eitros Montreal 2011) to survival horrors like Silent Hill 2 (Konami 1999) and from role playing games like Fable 2 (Lionhead Studios 2008) to interactive dramas like Heavy Rain (Quantic Dream 2010) (Figure 2).

Figure 2: Deus Ex: Human Revolution, Fable 2, Silent Hill 2 and Heavy Rain

2.1.3 The Interactive Game Play Experience

Before attempting to improve something it is vital to understand how it works and video games are no exception. Before being able to evaluate modern story driven video games it is important to understand the key components involved in creating an enjoyable interactive game play experience for the player. Video games are, by their very nature, interactive experiences. This can vary greatly depending on the genre and style of game play. Like any interactive experience, game play is one which emerges as a result of the player actively taking part and incorporating their own desires, anticipations and personal perceptions. This means that the experience is subject to

each player's unique interpretation (Ermi and Mayra 2005). To create a powerful hold on the player it is not enough for them to simply watch, the player must become an active participant (Ermi and Mayra 2005, Laurel 1991). It is found that the more choice a player has the more immersive the experience is, however this choice must be relative to the range of possible outcomes (Johnson 2008). An approach to defining the interactive experience was proposed by Janet Murray; by dividing it into the three aesthetic categories, immersion, agency and transformation (Murray 1997). Immersion can be described as the feeling of being psychologically submerged in another reality (Murray 1997). It can be split into three parts; sensory, imagination and challenge-based (Ermi and Mayra 2005). Many believe that agency is the core component of interactive narrative (Murray 1997, Pearce 1997, Laurel 1991); it is the interaction between the player and the reality with which they are presented. Agency is achieved when the player's actions have an appropriate and meaningful impact on the plot or the game world they inhabit. Agency can also be split into two forms; global agency, effecting high level plot direction and local agency, effecting low level characters and objects within the game world (Mateas and Stern 2005a). Transformation is the ability for the player to experience the narrative from different perspectives or directions; this however is generally not considered as important as agency or immersion (Murray 1997).

2.1.4 Giving the Player a Choice

Many have stated that player choice is a very important component of the game play experience (Carless 2009, Hydramyst 2012), additionally it is found that increased choice for the player can improve immersion (Johnson 2008). There are many games which have attempted to introduce an element of choice, although this is generally limited to very specific moments in the game. This choice can be manifested in a number of ways, usually in the form of character dialogue (Bethesda Studios 2011), cut scene responses (Eitros Montreal 2011) or the manner in which the player behaves (Lionhead Studios 2008). The problem with giving the player choice is that all choice must be accompanied by relevant content to represent it. There are many ways to introduce choice to the player however this choice is meaningless if it is not represented appropriately. This is the real underlying problem with delivering choice to the player.

2.1.5 Cause and Effect

Representing the player's choices in an appropriate way is the core concept of developing meaningful agency within a game play experience (Murray 1997). The problem however, is that the representation of a player's choice is generally done on a cosmetic level. Examples of this are the introduction of additional resources for the player (Eitros Montreal 2011) or the selection of possible endings (Konami 1999). Unfortunately this means that these attempts are usually transparent, thus reducing the immersion of the experience and leaving the player disappointed (Jubert 2010, Sola 2012). The most common way of representing player choice is through dialogue with the characters in the game (Eitros Montreal 2011, Bethesda Studios 2011) (Figure 3). In most games these decisions have little significant meaning past the end of the dialogue. The major issue with many story driven video games is that the characters dialogue and behaviours are generally scripted. They very rarely change depending on the current circumstances or game time, therefore the player is left feeling detached and the immersion is lost.

Figure 3: Deus Ex: Human Revolution Dialogue System

To achieve agency the player must always feel as though they are within the reality with which they are presented and that that reality is continuously functioning around them (Murray 1997). If the player makes a choice and the resulting change is inappropriate then the immersion is broken (Johnson 2008). The agency discussed so far has been local, it is also important to have global agency, meaning that the player's choices change the direction of the plot (Mateas and Stern 2005a). The most common way to facilitate change in plot is through a modulated plot structure (McRobbie

2007). This type of structure is however very tightly controlled and does not allow for any great deviation from the authored plot therefore not allowing the player to have a unique experience.

2.2 Interactive Narrative: Theory

2.2.1 Introduction

This section will describe the theories which can be used to aid the development of an interactive narrative model.

2.2.2 A Definition

Since the 1990s interactive narrative has seen an abundance of interest from many different regions of academia involving work in artificial intelligence, computer based story-telling, and more recently, video games, however the ideology is still very young (Szilas 2003). As of yet there are no general techniques for designing and implementing an interactive narrative model. This has led some to the conclusion that interactive narrative is impossible (Szilas 2003). The main reasons it has proven such a difficult task is that interactive narrative is an oxymoron in itself as the term narrative refers to a static story predetermined by an author, while the term interaction refers to a dynamic process (Mateas 1997, Johnson 2008). However this is not to say there has not been a great deal of invaluable research and progress in the field. The most well known example is the Facade Interactive Drama (Mateas and Stern 2005a), although there are many others (Bates 1992), (Szilas 2003), (Aylett, et. al. 2005).

> *"An interactive narrative is a time-based representation of character and action in which a reader can effect, choose and change the plot. The first-, second- and third-person characters may actually be the reader. Opinion and perspective are inherent. Image is not necessary but likely."*
> *(Meadows 2002)*

The above is a definition of interactive narrative presented by Mark Meadows. It brings together the key concepts involved in interactive narrative including; character, action, plot, choice, change, time relativity and perspective.

2.2.3 A Brief History

Interactive narrative inhabits a large area in popular media and was around long before video games established their place as recognized forms of storytelling. Since the 1990s academic research into interactive narrative has rapidly increased, however it has only recently begun to involve video games. The earliest interactive narrative was hypermedia novels and games (Mateas and Stern 2005b), which are still very popular forms of interactive media today. Hypermedia evolved from hypertext and consists of a network of connected nodes; each containing text and possibly images or diagrams, which prompt the user to make choices which would decide the next node (Hutchinson 2003) (Figure 4).

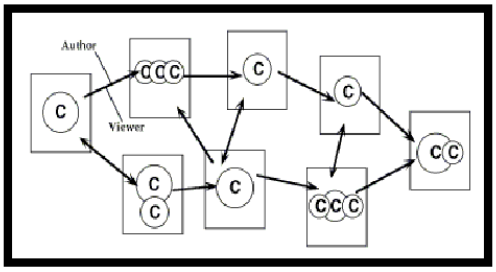


Figure 4: Hypermedia Graph

There have also been attempts to create interactive, although most of these have been unsuccessful (Pearce 2001, Johnson 2008). A good example of this is the interactive movie, 'Last Call' (Vanhemert 2010). In this movie the audience members were able to submit their phone numbers to a database which would randomly call someone during the movie screening and the protagonist would ask them for advice using voice recognition technology.

Figure 5: Last Call Interactive Movie

2.2.4 Narratology and Ludology

Since interactive narrative has become the focus of aesthetic study there have been two viewpoints taken towards it, Narratology and Ludology. Narratology is the view that interactive narrative should be sought through non-computer based media such as theatre and narrative. This is opposed by Ludology which is the view that interactive narrative should instead be sought through video game studies and analysis (Frasca 2003, Aarseth 2004). Many Ludologists often criticise Narratologists for attempting to "colonise" (Eskelinen 2004) these video games as a form of drama or narrative, however most credible scholars are not guilty of this over categorisation (Aarseth 2004). In return many Narratologists criticise Ludologists for their claims that video games are “entirely functional and combinatorial” (Eskelinen 2004), and have no significant values; however this is not the view of all Ludologists (Wardrip-Fruin and Harrington 2004).

2.2.5 Interactive Narrative Theories

Interactive narrative is a very complex and so far non unified subject. The definition, method of modelling and even its achievability are still under dispute. There have been many theories that have been used to aid the design of an interactive narrative model which can be categorised into two approaches; poetics and structuralism both stem from the Narratology point of view. Poetics involves models based upon Aristotle's poetics (Aristotle, 330BC) and are derived from the dramatic requirements of authoring and directing drama. Structuralism involves models based upon the fundamental components of narrative.

2.2.6 Structuralism

As mentioned, structuralism is concerned with the foundational concepts that constitute a narrative. A very popular structuralism theory is the Morphology of Folktales which develops narrative as a logical sequence of actions, derived from a structure of 31 functions introduced by Vladamir Propp for classifying narratives. This approach can be very effective in certain forms of narratives however it can be very limiting as a general narrative structure (Aylett and Louchart 2004). There have been many other structuralism approaches such as the theoretical model of narrative (Szilas 2003) and the post-structuralism model (Aylett et. al. 2005). A good example of a

structuralism based interactive narrative model is IDtension (Szilas 2002), which is based on a hybrid combination of different structuralism theories. The model is comprised of characters, tasks, goals and obstacles. The rules of the system are derived from a complex system of character values and a knowledge database. Structuralism based interactive narrative models such as this are very effective in simulating the overall organization of the plot and can be very useful in generating rules and algorithms for choosing relevant character responses or plot sequences. The downfall to this approach is that it lacks the ability to model dramatic tension, plot coherence and the emotional dimension of the narrative.

2.2.7 Poetics

Poetics is based upon the Aristotelian Interactive Drama Theory, first developed by Brenda Laurel (Laurel 1986, Laurel 1991), and widely accepted to be the best foundation for an interactive narrative model (Aylett and Louchart 2004, Mateas and Stern 2005a, Mateas 1997). The Aristotelian interactive drama theory is derived from a combination of Aristotle's theories of causality and the qualitative structure as well as the Freytag triangle (Laurel 1991). The qualitative structure is made up of six layers; action, character, thought, language, pattern and enactment (Figure 6). The causality relationships between layers of the qualitative structure takes the form of inferred formal cause moving from action to enactment and material cause moving from enactment to action. Each element is both the formal cause of the element below it and the material cause of the element above it. This structure can be used in the aid of drama design.

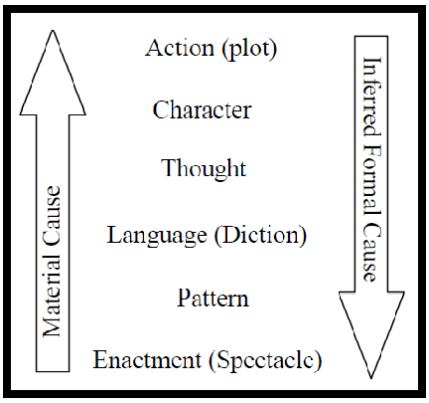


Figure 6: Qualitative Structure

The Freytag triangle is the structure which describes the dramatic tension within a narrative; it starts at the exposition, rises to a climax and then falls to the denouement (Figure 7).

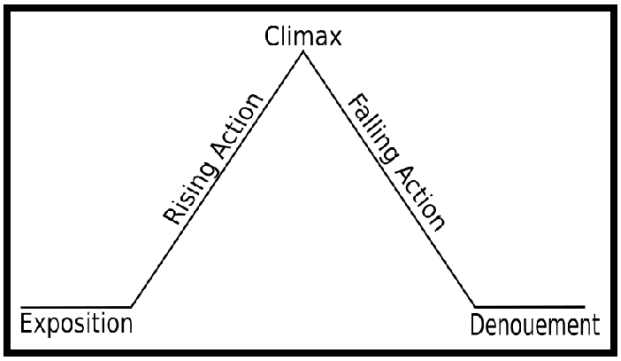


Figure 7: Freytag Triangle

A further development of this theory, the Neo-Aristotelian theory, was proposed by Michael Mateas and Andrew Stern during the development of The Facade Interactive Drama (Mateas 2000).This theory adds an additional two lines of causality to the qualitative structure; user intention which follows the same direction as formal cause and material for action which follows the same direction as material cause. Additionally this model places the user action in the character stage of the structure (Figure 8).

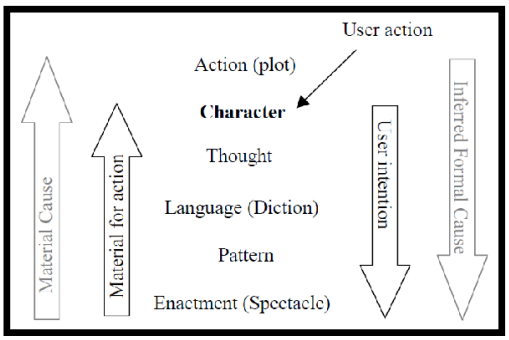


Figure 8: Neo-Aristotelian Qualitative Structure

The characters actions are limited from below by the material constraints created by the material resources available and from above by the formal constraints created by the plot direction; agency is achieved when there is a balance between these constraints.

2.3 Interactive Narrative: Modelling Concepts

2.3.1 Introduction

This section will describe the various concepts involved in developing an interactive narrative model.

2.3.2 Embedded Versus Emergent Plot Structures

Generally there are two ways to structure an interactive narrative model; embedded and emergent. Embedded involves inserting choice points into the narrative where the player can decide the path to follow. Emergent involves creating autonomous characters and a set of rules and allowing the narrative to develop naturally from the player's interaction with autonomous characters (Johnson 2008, Murray 1997, Laurel 1991). For story driven video games embedded plot structures are the most popular as the modular plots can easily be represented and directed with techniques such as decision tress, graph theory and Bayesian networks and are therefore much easier to control (Johnson 2008) (Figure 9).

Emergent plot structures are capable of much higher levels of interaction and agency however this comes at the cost of control over plot cohesion and dramatic probability (Johnson 2008, Murray 1997), they also generally utilise open plot structures (Figure 9).

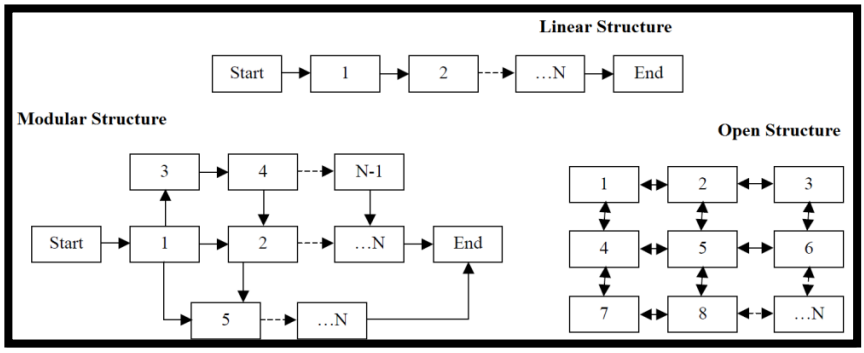


Figure 9: Plot Structures

An interactive narrative can be neither fully embedded nor fully emergent, since if the model favours completely towards plot direction then there is no room for interaction and if the model favours too much towards autonomous characters then there will be no sense of plot direction and the story will fall apart. The importance of these

components in the development of an interactive narrative model was illustrated in a formula expressed by Joseph Bates (Mateas 1997):

Drama = Character + Story + Presentation

2.3.3 Creating Agency

There are many ways in which to create choice, however creating agency is much more difficult. All choice must be meaningfully represented and appropriately constrained. It is impossible to create complete freedom; instead the player should be able to perform actions which are appropriate to the reality which they are within (Murray 1997, Ward 2004). One of the biggest challenges in creating agency is in maintaining the scope of the choice (Johnson 2008). When developing an interactive experience much care must be taken in considering the possible violations that may be created (Ward 2004). The user interface is the point at which the player interacts with the experience therefore it must be seamlessly connected to the plot and the interaction must have clear continuity and cohesion (Johnson 2008). The player must feel in control of their choices (Murray 1997) and all choices must come with a sense of goal or mystery to motivate the player (Johnson2008). Time relativity has also been identified as an important component in interactive narrative (Aarseth 2004, Meadows 2002).

2.3.4 Maintaining Control through Constraints

It would be great if a story driven video game could give the player complete free will; however this is impossible because no author or designer could anticipate everything action a player may wish to perform. Therefore this free will is more of an illusion, a balance of agency and constraints which allow the player to perform all the actions which are appropriate for the current simulation. Therefore the aim is not to limit what the player can do but limit what the player thinks of doing (Laurel 1991). The difficult task is to implement these constraints in a way which does not break the immersive experience. An important aspect of immersion is the use of boundaries to control a player's participation within the represented reality (Murray 1997), all choice comes with constraints but both the choices and the constraints must be represented in a believable manner (Murray 1997, Ward 2004). The direction and potential of a plot can be guided with Aristotle's theory of dramatic probability which

is expressed in the form of a flying wedge. Moving through time the range of possible outcomes starts off completely open and narrows down the probability to one or more specific outcomes (Figure 10).

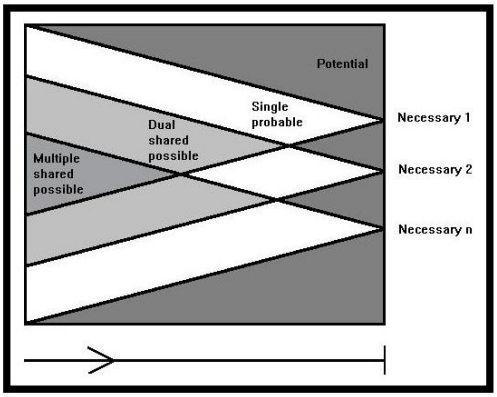


Figure 10: Flying Wedge

Constraints are essential in order to maintain the amount of potential that is introduced to the plot, making sure the plot doesn't spread out of control and at the same time ensure the plot comes to satisfying end (Laurel 1991). Constraints can be anything from a suggestion to a rule and do not have to be invasive to the plot. They can be introduced in the form of natural events which are out of the control of any character, situations such as specific placement of game objects or coincidences such as a chance meeting with another character (Laurel 1991). In order to maintain the dramatic probability and direction of the plot it is common to have a director or drama manager, however this can be problematic if the director forces an inappropriate action within the plot (Mateas 1997, Mateas and Stern 2005a). A director can be used to select the best possible plot segment from a pre-authored list (Mateas and Stern 2005a, Szilas 2004), although this can be very time consuming as it is very difficult to predict all of the players possible choices. An alternative approach is to procedurally generate plot segments from more general forms (Barber 2009, Aylett et. al. 2005), although this requires a very complex generation system.

2.3.5 Rich Believable Characters

To make characters believable they must have a rich structure capable of goals, values, intellect and persona allowing them to make unique and narrative relevant decisions (Mateas and Stern 2005a, Aylett, et. al. 2005). In the Oz Project Joseph Bates defined a set of requirements for creating believable characters; Personality,

Emotion, Self-Motivation, Change, Social Relationships and Illusion of Life (Mateas 1997).

2.4 Implementation Techniques

2.4.1 Introduction

As mentioned previously interactive narrative is an area of development which is currently lacking general implementation techniques, due to this there have been many different approaches taken. In this section the different implementation techniques will be described along with the reason why they were useful and some possible alternatives.

2.4.2 Representing the Database

Due to the fact that an interactive model can require a high level of data, which must be kept track of and easily accessed on a regular basis, a suitable structuring technique must be implemented. Many interactive narrative models use database structures to store the relevant data corresponding to the plot and game, although the implementation of these structures is generally not described. A series of lists were used to represent the different kinds of data and functions were developed to access the data. Additional consideration must be taken in the development of the database to allow the authorship to remain relatively non-complex. In order to store the different plot data the STL deque was chosen as it allows for simple adding of list items and quick access. Possible alternatives could have been hash tables or associative maps (CPlusPlus 2000).

2.4.3 Decision Making

To enhance the decision making process of the character dialogues a series of fuzzy inference systems were adopted. A fuzzy inference system works by taking in a series of crisp input values and uses a series of mapped functions and rules to convert them into a crisp output value (Millington 2009). The reason this technique was useful was because using fuzzy logic results in more varied output values, therefore making each output value unique, even if just by a small amount. An alternative to this would be to use a simple rule based system, however the results from the decision making process would be much more clean cut and scripted. When using fuzzy inference systems the

performance of the systems must be considered, depending on the frequency and the complexity of the fuzzy logic calculations may need to be kept very simple in terms of the rules and functions.

2.4.4 Structuring the Plot Sequences

When developing an interactive narrative model it is important to establish a technique for constructing and manipulating plot sequences. This can be done in different ways depending on the plot structure. Interactive narratives using embedded plot structures commonly utilise techniques such as decision trees, graph theory or Bayesian networks. As emergent plot structures are far less common, there are very few techniques which have been used. As emergent plot structures require procedural or generative algorithms the techniques are generally developed relative to the specific interactive narrative model. In the case of this project the ideal implementation technique would be behaviour trees; as they are very simple to construct, quick to process and can utilise both OR and AND operators (Figure 11).

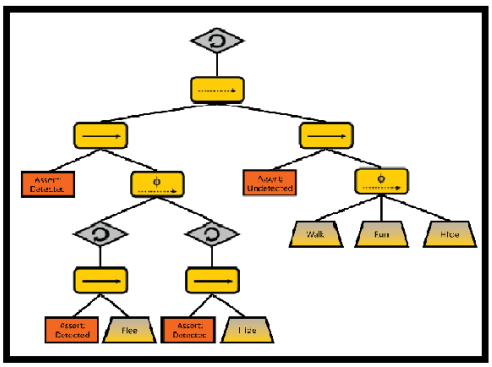


Figure 11: Behaviour Tree

An alternative to this could be Bayesian networks (Figure 12). This technique incorporates probability theory; however this technique can become very complex as the structure increases in size (Bangso 2004).

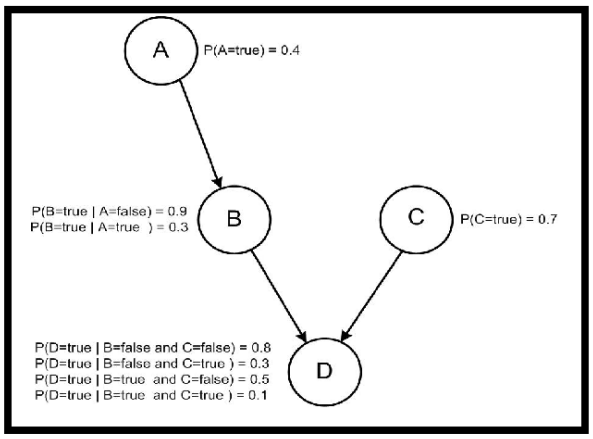


Figure 12: Bayesian Network

Due to the simplicity of behaviour trees performance is not an issue as long as care is taken in the scheduling and processing of the trees (Millington 2009). The behaviour trees can be implemented with a linked list structure utilising any container structure although the STL deque would be most appropriate due to its ease of access (CPlusPlus 2000).

2.4.5 Character Behaviour

Goal oriented behaviour is a form of artificial behaviour which involves the execution of actions depending on various variables (Millington 2009). The reason this is a good technique is that it allows the characters to behave in manner relative to the current game state and plot direction. This allows the characters to act autonomously and therefore give the impression they were not just simply scripted bots waiting for the player to interact with them, making them appear much more believable. If the character behaviour is kept from becoming overly complex there are generally no large performance issues with this technique (Millington 2009). An alternative to this would be to use simple scripted behaviour, although since scripts must be pre-authored this would not be able to represent all plot possibilities.

3. METHODOLOGY

3.1 The Theory

3.1.1 Introduction

The first stage of the project was to create an interactive narrative theory specific to story driven video games in order to aid the development process. The theory developed was the interactive story-game theory; this section will describe how the theory was derived.

3.1.2 Story Versus. Game

Due to the nature of the Naratology and Ludology debate the majority of interactive narrative models developed focus on Narratology theory only. Recently some scholars have attempting to combine the two approaches (Frasca 2003). This is the direction which this project has taken because it is believed that a story driven video game should be modelled on an equal representation of both game and story. Whilst attempting to distinguish the key foundational concepts present in game and story, two concepts were found in both. These were character and time (Figure 13).

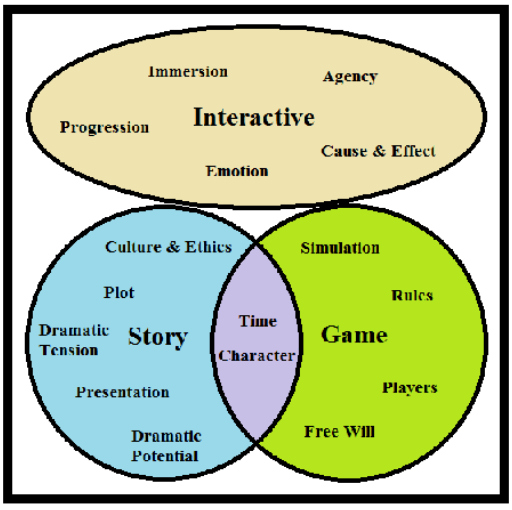


Figure 13: Definition Map

Since character is such a strong component in both games and stories it is generally believed to be the best place to be the centre of the interaction (Laurel 1991). The other common component; time, is also considered very important to an interactive

narrative model (Meadows 2002), although no interaction inherits from it, it is crucial in representing transformation in the plot (Aarseth 2004).

3.1.3 Interactive Story-Game Theory

The interactive story-game theory was adapted from the neo-Aristotelian interactive narrative theory (Figure 14). It was modified to incorporate an equal representation of story and game, therefore allowing development and analysis of an interactive narrative model relevant to all key components which constitute a story driven video game.

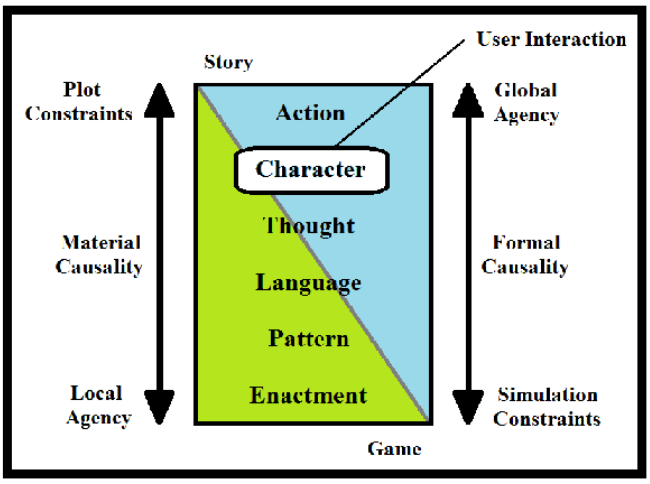


Figure 14: Interactive Story-Game Theory

In this theory both the formal causality and material causality has been broken down into two separate components; global agency and simulation constraints and local agency and plot constraints respectively. Each element in the qualitative structure remains the same and the user interaction is still placed within the character element, however now each element is both the global agency and the plot constraint of the element below and the local agency and the simulation constraint of the element above. Each line of causality works in parallel as the player progresses through the game and time passes, affecting both the story and the game. The four main components (global agency, local agency, simulation constraints and plot constraints) all must be balanced in order to achieve appropriate and meaningful agency and maintain an immersive experience. This means that when the story and game are being designed both the agency and constraints of the story and the game are considered. This model is used in two ways. Firstly as implemented functionality of

the ISGEngine and secondly as a set of heuristics to guide the authoring process. As an example imagine a typical role playing game, the player is exploring and finds an important quest item. When designing this scenario four things must be considered, how the finding of the item will affect the plot (global agency), how the player will go about retrieving the item (local agency), the appropriateness of the item within the game (simulation constraints) and the appropriateness of the item as part of the story (plot constraints).

3.2 ISGEngine

3.2.1 Introduction

This section will describe how the ISGEngine was implemented, how it relates to the interactive story-game theory and the overall aims of the project.

3.2.2 The Rules

Before beginning the development of the ISGEngine, a series of rules was derived from the project aims in order to guide the implementation process (Table 1).

Table 1: Model Rules

Model Rules	
1.	**Multiple methods of choice for the player.**
2.	**Multiple methods of representing the player's choice.**
3.	**Time relative plot content.**
4.	**Relatively simple authorship process.**
5.	**Low content requirement.**
6.	**Open plot structure.**
7.	**Non invasive plot director.**
8.	**Maintained plot cohesion.**
9.	**Maintained plot continuity.**

3.2.3 Model Structure

The main components of the ISGEngine are Game World, Time Handler, Director, Situation Generator, Dialogue System and Database (Figure 15).

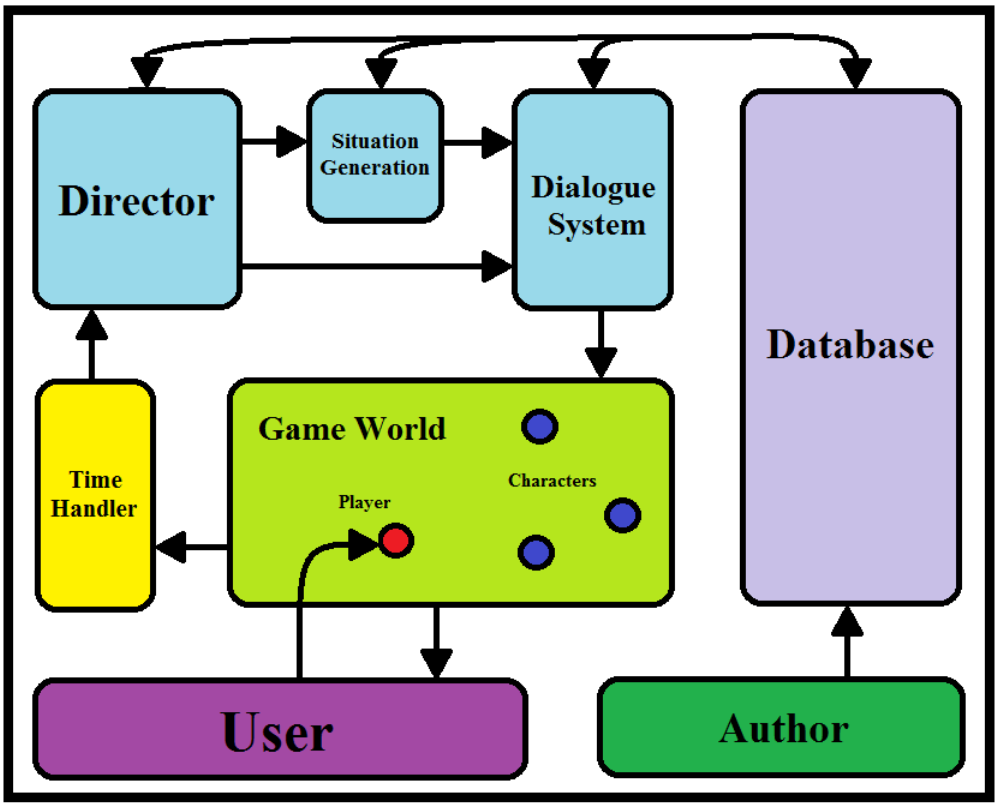


Figure 15: ISGEngine Structure

The Game World is responsible for processing and representing the simulation, this is where the player will interact with the game. The Time Handler is responsible for updating the game time so that time relativity can be used within the plot. The Director is used to check the continuity of the current plot sequences, if a potential problem is detected then it sends a message to the Situation Generator to solve the problem by introducing new content. The Dialogue System is responsible for processing dialogue topics and character traits and then for returning character responses. The Database is responsible for storing all of the data which makes up the game and the plot and contains the authoring functionality.

3.2.4 The Database

All of the content that constitutes the plot and game is compiled into a database structure, in which there are many different sub structures. Each of these sub

structures is implemented as a STL deque storage container which can be added to and accessed through the databases functionality. The largest sub structure is the character's which contain many additional sub structures, the rest are character independent (Figure 16).

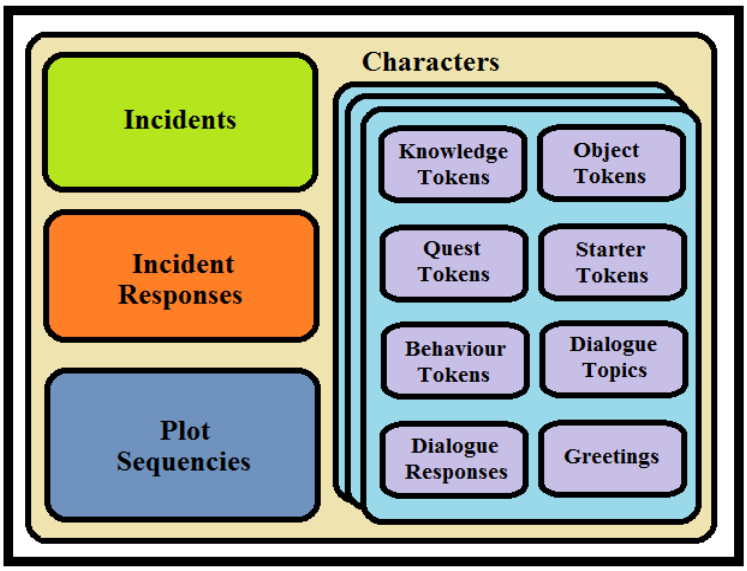


Figure 16: Database Structure

Within the character sub structure the knowledge tokens, object tokens and quest tokens are used to determine a characters relationship with a topic. The dialogue topics are used to determine a characters ability to be engaged in dialogue relating to the topic. The dialogue responses are used to determine the characters positive response to the dialogue and also contain the will values, which are used to determine the characters willingness to give the response. Starter tokens do not require dialogue responses or dialogue topics as they relate to a general dialogue and the responses are included within them. Behaviour tokens are used to represent characters behaviours which can be triggered and greetings are characters initial responses when dialogue begins. When authoring the plot there is a wide range of functionality which compile these sub structures according to a series of parameters.

3.2.5 Incidents

The fundamental component of the ISGEngine is the incident; this represents an action within the plot. There are many different types of incident and they are triggered when the corresponding game event is performed. Incidents are important because they are used to track the player's progress throughout the game and plot and

also to guide the director in its decision making. Below is a table of the different types of incident which can be triggered and a description of them (Table 2).

Table 2: Incident Types

Incident Type	Description
IN_TYPE_KNOWLEDGE_GAINED	Triggered when a piece of knowledge is gained.
IN_TYPE_KNOWLEDGE_GIVEN	Triggered when a piece of knowledge is given.
IN_TYPE_KNOWLEDGE_MISSED	Triggered when the time window on a piece of knowledge is missed.
IN_TYPE_OBJECT_GAINED	Triggered when an object is gained.
IN_TYPE_OBJECT_GIVEN	Triggered when an object is given.
IN_TYPE_OBJECT_MISSED	Triggered when the time window on an object is missed.
IN_TYPE_QUEST_GAINED	Triggered when a quest is accepted.
IN_TYPE_QUEST_COMPLETE	Triggered when a quest is completed.
IN_TYPE_QUEST_MISSED	Triggered when the time window on a quest is missed.
IN_TYPE_QUEST_FAILED	Triggered when a quest is failed.
IN_TYPE_DIALOGUE_STARTED	Triggered when a dialogue starter is performed.
IN_TYPE_DIALOGUE_ENCOUNTERED	Triggered when a dialogue encounter behaviour is performed.
IN_TYPE_PLOT_REVIVE_REQUIRED	Triggered when a plot sequence is in jeopardy.
IN_TYPE_CHARACTER_MET	Triggered when the player meets a character.
IN_TYPE_GAME_STARTED	Triggered when game begins.
IN_TYPE_BEHAVIOUR_COMPLETE	Triggered when character behaviour is completed.

Incidents are coupled with the name of the content it refers to and the character that is involved, which can also be none or any.

3.2.6 Dialogue System

The dialogue system is the heart of the player choice; this is where the majority of the agency is manifested. There are multiple ways in which the player can make choices; some are more subtle than others. The player can choose which topics they discuss with the characters, the manner in which they discuss the topics, which can be neutral, friendly or aggressive, which quests they accept and how they carry out those quests. Additionally the player also makes choices when they miss, fail or ignore a quest or dialogue topic or repetitively discuss the same topics with a character. These choices are manifested in altering the character traits; like, fear and patience which correspond to the characters current relationship with the player. The representation of the player's choices is manifested through character responses, incident responses and character behaviours.

3.2.7 Content Structure

The plot is built in an open structure; this means that there is no direct link between content nodes as there would be in regular modulated structures. The ISGEngine has an independent content structure where each piece of content is made up of a dialogue topic, a content token and a dialogue response. The dialogue topic is dependent on a set of pre-conditions (incidents) and a time window. The dialogue response has post-conditions in the form of change in character traits (Figure 17).

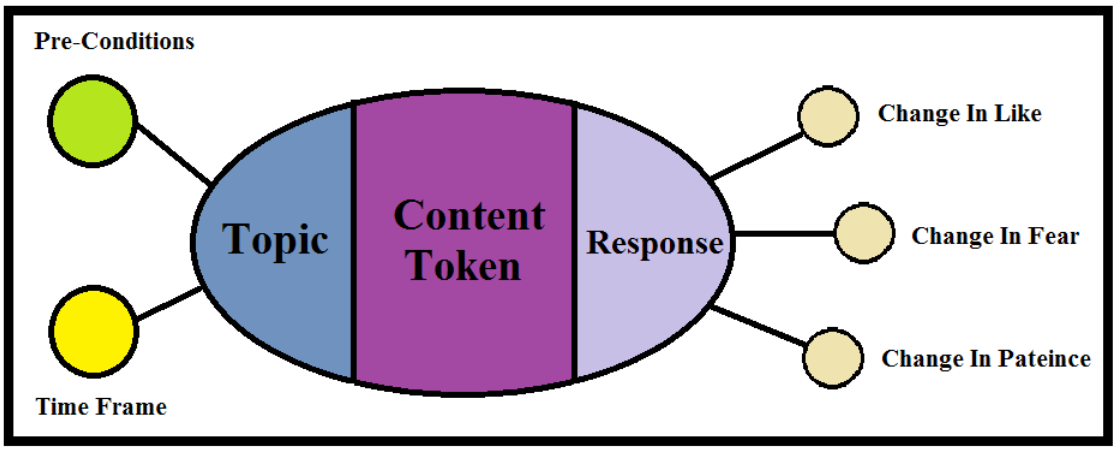


Figure 17: Content Structure

3.2.8 Dialogue Process

The success or failure of a dialogue topic depends on the result of the dialogue process, which is made up of 5 layers. The layers are dialogue type selection, patience test, will test, incident triggering and trait updates. The major decision making is done in the will test layer, this consists of a set a fuzzy inference systems which take in a characters traits, the manner of the dialogue and the will values associated with the positive response. The result determines whether or not the response is positive or negative. The dialogue type selection layer is responsible for identifying the type of dialogue the player is instigating and also in the case of some dialogue topics determining if the character posses the knowledge or object. The patience test layer simply checks to see if the characters patience level is high enough to engage in dialogue with the character. The incident triggering and trait update layers triggers all the appropriate incidents and update the characters traits according to the result of previous layers. The dialogue type selection layer identifies the type of dialogue topic that is being initiated, this is important because some of the subsequent layers differ slightly depending on the type of dialogue topic. For example the will test is ignored for DG_TYPE_KNOWLEDGE_GIVE dialogue types as telling a character something should not rely on the character liking the player or fearing them. Below is a diagram of the dialogue process (Figure 18) and a list of the different dialogue topics which the player can initiate (Table 3).

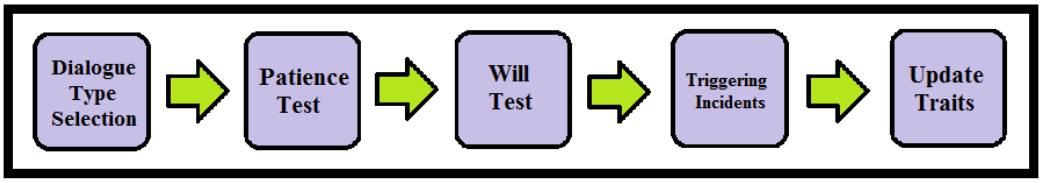


Figure 18: Dialogue Process

Table 3: Dialogue Types

Dialogue Type	Description
DG_TYPE_KNOWLEDGE_REQUEST	Dialogue involves requesting knowledge about a topic from a character.
DG_TYPE_KNOWLEDGE_GIVE	Dialogue involves giving a character knowledge about a topic.
DG_TYPE_OBJECT_REQUEST	Dialogue involves requesting an object from a character.
DG_TYPE_OBJECT_GIVE	Dialogue involves giving a character an object.
DG_QUEST_REQUEST	Dialogue involves taking a quest from a character.
DG_QUEST_COMPLETE	Dialogue involves completing a quest for a character.

The will test as mentioned consists of a two fuzzy inference systems working together. The reason for this is that by using fuzzy calculations the player can receive a much more unique and varied response from the input than if normal rule based scripts were used. This benefits the representation of choice because it allows for the very small differences in character traits to make a big difference to the responses received. The will test layer is described below (Figure 19), further details on the implementation of the fuzzy inference systems see Appendix B: Fuzzy Inference Systems.

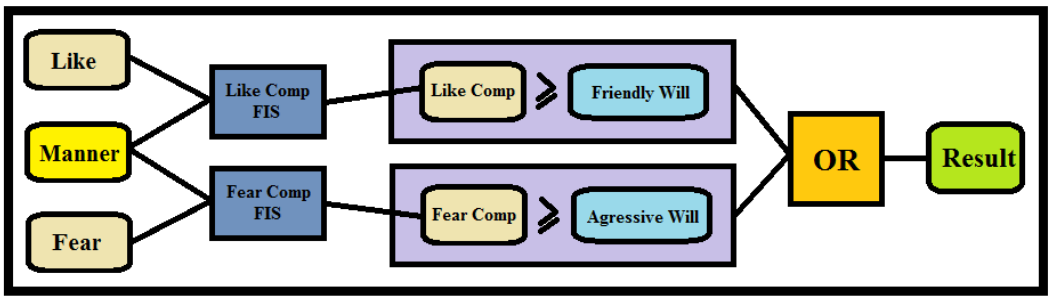


Figure 19: Will Test Algorithm

3.2.9 Incident Responses

In addition to the dialogue system, incident responses are used to add another line of agency. They can be used to alter a characters response, will values and traits. An example of this could be the alteration of a character's like trait or response due to the completion of a quest for another character.

3.2.10 Character Behaviours

Character behaviours are used as physical representation of the player's choices and can be of the following types (Table 4).

Table 4: Behaviour Types

Behaviour Type	Description
BV_TYPE_MOVE	Character moves to a given location.
BV_TYPE_VISIT_CHARACTER	Character moves to a given character.
BV_TYPE_DIALOGUE_ENCOUNTER	Character moves towards the player and engages in dialogue.
BV_TYPE_REMOVE	Character is removed from the game.

An example of this could be if the player delivers a message for one character to another, this knowledge may result in them performing some other action.

3.2.11 Plot Sequencing and Situation Generation

The greatest problem discovered in interactive narrative, especially when developing an emergent model with open plot structures is the maintenance of dramatic potential, i.e. continuity. In order to solve this problem most interactive narrative models use a director to choose the best plot sequence from a list of possibilities however this is generally very disruptive to the immersion. In this project a slightly different approach was taken, rather than a director guiding the direction of the plot, the control is given completely to the player and the plot possibilities are maintained rather than forced. This means that the player can feel in control of their decisions while safe in the knowledge there will always be a conclusion to the plot. This is done using plot sequences; which are defined by the author to contain a collection of incidents. The ISGEngine then compiles a plot sequence tree which represents the content and pre-conditions required to achieve that direction in the plot and monitor its continuity and progress. The author then creates an IN_TYPE__PLOT_REVIVE_REQUIRED incident which can be triggered when a node of the plot sequence tree is broken, i.e. zero continuity. Finally the author defines content with which can be introduced by the situation generator at the right time. The plot sequence tree is built by iteratively

adding nodes based on the conditional incidents, every non leaf node is given a pre-conditions node and a trigger node. The pre-conditions node contains all of the possible paths (of incidents) to reaching the content and trigger node contains all of the incidents which must be triggered in order to complete the content. An example plot sequence tree is shown on (Figure 20) (Table 5) which represents a quest which relies on both character traits and time windows. Previously it was discovered that there are two major connections between story and game are character and time, this is reflected in the plot sequence trees as the final nodes of the trees are PN_TYPE_CHARACTER_TRAITS, PN_TYPE_TIME_WINDOW and PN_TYPE_GAME_STARTED nodes. If a break is found in a PN_TYPE_TIME_WINDOW node then the plot sequence cannot be revived and is left however if the break is found in a PN_TYPE_CHARACTER_TRAITS node then the plot can be revived by introducing additional dialogue starters and character behaviours to get the player back on track.

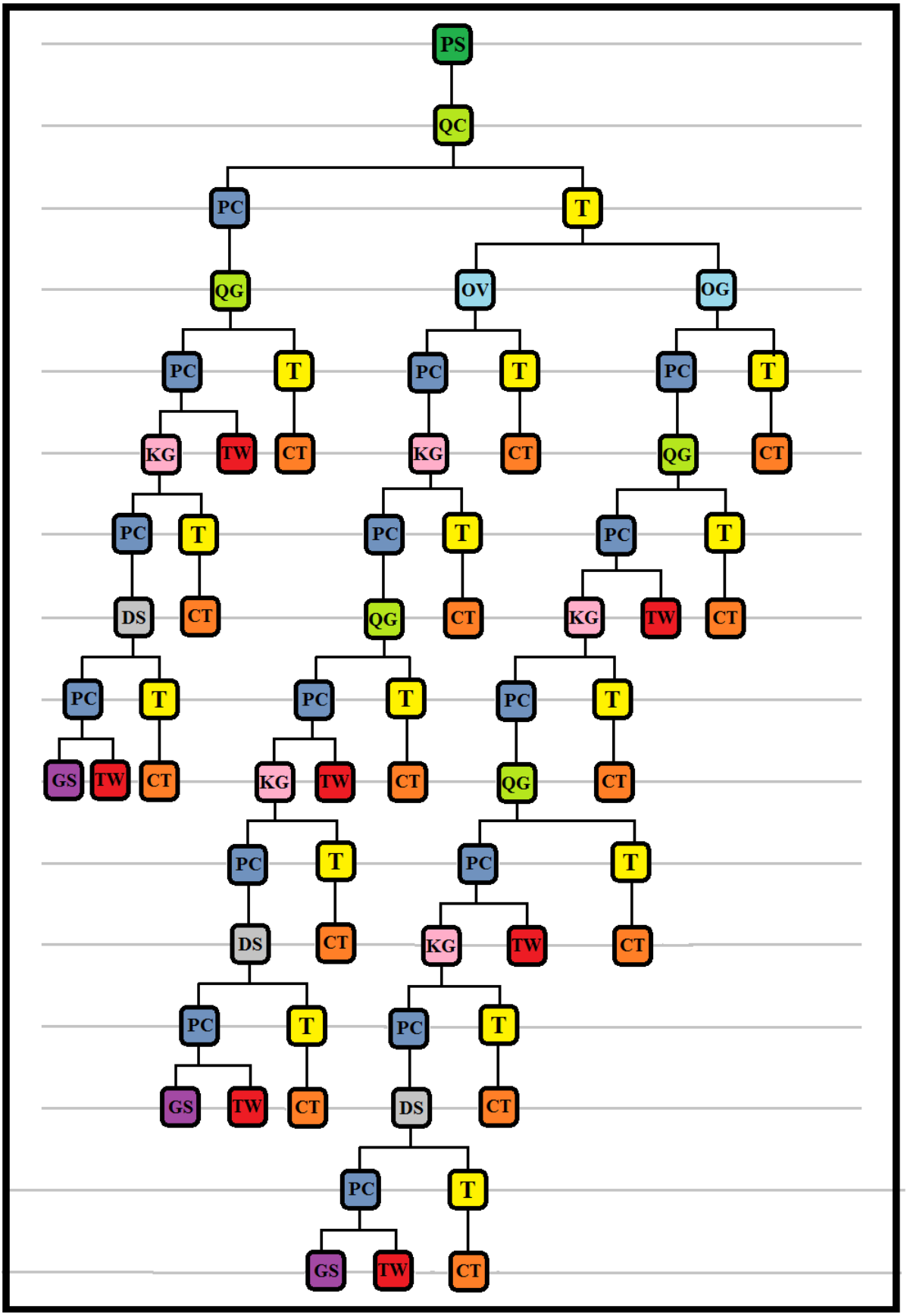


Figure 20: Plot Sequence Tree

Table 5: Plot Node Types

Abr.	Plot Node	Node	Description
PS	PN_TYPE_ROOT	AND	Root node of the tree.
KG	PN_TYPE_KNOWLEDGE_GAINED	AND	Knowledge gained incident.
KV	PN_TYPE_KNOWLEDGE_GIVEN	AND	Knowledge given incident.
KM	PN_TYPE_KNOWLEDGE_MISSED	AND	Knowledge missed incident.
OG	PN_TYPE_OBJECT_GAINED	AND	Object gained incident.
OV	PN_TYPE_OBJECT_GIVEN	AND	Object given incident.
OM	PN_TYPE_OBJECT_MISSED	AND	Object missed incident.
QG	PN_TYPE_QUEST_GAINED	AND	Quest gained incident.
QC	PN_TYPE_QUEST_COMPLETED	AND	Quest complete incident.
QF	PN_TYPE_QUEST_FAILED	AND	Quest failed incident.
QM	PN_TYPE_QUEST_MISSED	AND	Quest missed incident.
DS	PN_TYPE_DIALOGUE_STARTED	AND	Dialogue started incident.
DE	PN_TYPE_DIALOGUE_ENCOUNTERED	AND	Dialogue encountered incident.
BC	PN_TYPE_BEHAVIOUR_COMPLETE	AND	Behaviour complete incident.
PC	PN_TYPE_PRE_CONDITIONS	OR	The pre-conditions for the above incident (any can be triggered).
T	PN_TYPE_TRIGGER	AND	The requirements in order to trigger the above incident (all must be triggered).
CT	PN_TYPE_CHARACTER_TRAITS	LEAF	The node relies one or more character traits being at a certain level.
TW	PN_TYPE_TIME_WINDOW	LEAF	The node relies on being within a certain time window.
GS	PN_TYPE_GAME_STARTED	LEAF	Default node, relies on game starting.

As an example imagine a quest in a role playing game where the player must retrieve an item from another character to continue. If the player relationship with that character is not good enough for this to happen, the continuity is broken. This is where the situation generator introduces new content such as a new quest in order to repair the player's relationship with that character. The downside of this technique is that if the player deliberately attempts to break the plot continuity, they will succeed. Additionally if a character misses a time windows for certain content then the continuity could also be broken. This means that there must always be generic plot sequences authored which do not rely on character traits or time windows to maintain constant continuity. In order to maintain dramatic potential the plot must be bottle necked at certain points this is done by using large quests which involve multiple characters. This means that the player will encounter the relevant quests no matter which plot sequence they are following. The incidents that occur in the plot can be triggered by various different player actions. This adds an additional line of agency into the experience as the incidents can be played out in various different orders and at various different times, giving the player a greater sense of free will and a more unique experience.

3.2.12 Rich Character Behaviour

The main source of agency is derived from the player's interaction with the characters and their content. This means that the immersive experience depends on the non-player characters being intelligent and believable. The way this will be achieved is through a rich decision making process and goal oriented behaviour. Every decision a non-player character makes will is the result of three factors; intellect, traits, behaviours. This means that not only do the characters appear to posses intelligence and reasoning, this also create additional local agency by allowing the non-player characters to also react differently depending on the current plot direction. Each character has personal goals which they aim to achieve throughout the game, some of these they can accomplish on their own and will go about it in their own time; however some goals may require assistance from the player or may need to be triggered by an additional incident.

3.2.13 Time Relativity

The ISGEngine represents time relativity by introducing time windows for all content. These time windows are used to introduce content at specific times or to trigger plot changes or character behaviours. This is represented by using different dialogue responses when a time window is over and by using content missed incidents to allow events to be triggered when content is no longer available.

3.2.14 Maintaining Cohesion

Maintaining plot cohesion is a very difficult task. This is because it is extremely difficult to map or calculate a plot sequence's rate of emotion or drama, especially as this differs from player to player. Therefore instead of attempting to develop a numerical method to control cohesion the ISGEngine employs a series of functions which allow the author to develop a cohesive plot easily. Examples of these functions are:

- Content accessibility (local and global).
- Character's previous awareness of content.
- Additional content pre-conditions.
- Character response changes.
- Dialogue requirements.

Maintaining cohesion is a difficult task and it is one that cannot be achieved by the interactive narrative model alone. A large amount of the onus to create appropriate and cohesive plot structures falls on the author or designer. The ISGEngine simply provides the functionality to allow this to be done with relative simplicity.

3.3 Evaluation

3.3.1 Introduction

This section will describe the demo application developed using the ISGEngine and the methods of evaluation which were performed in order to evaluate it.

3.3.2 Methods of Evaluation

This project combined both improving player choice and maintaining continuity and cohesion in an open plot structure. To reflect this, the evaluation process was

compiled of a combination of quantitative and qualitative methods. This meant that the project could be evaluated accurately in relation to the research question and project aims. There were three methods of evaluation (Table 6) involved:

- Development of Project
- User Questionnaire
- Metric Data

Table 6: Evaluation Methods

Research Aim	Method of Evaluation
Simple Authorship	Development of Project
High Level of Choice	Questionnaire & Metric Data
Low Content Requirement	Development of Project & Metric Data
User Interface	Questionnaire
Representation of Choice	Questionnaire
Unique Experience	Metric Data
Non-Invasive Director	Development of Project & Metric Data
Maintenance of Cohesion	Development of Project & Questionnaire
Maintenance of Continuity	Metric Data

3.3.3 Demo Application

In order to evaluate the project a demo application was developed utilising all the features of the ISGEngine (Figure 21).

Figure 21: Demo Application Screen Shots

The demo application consists of a short game lasting 8 minutes (real time) which contains an authored plot and 7 characters. The authoring process including testing took 2 weeks to complete. The plot is made up of two sections. The first is a series of generic dialogues and quests for each of the seven characters. The second section consists of two main quests which are affected by the player's choices in the first section. The main quests consist of one character Henry Talos attempting to rob the tavern owned by another character Davie Merch. The second quest concerns Davie Merch in turn being suspicious of Henry Talos and wanting to investigate his behaviour. The open structure of the ISGEngine allowed for various different paths which could influence the main quests in the second section. In the first section the player could choose, who they spoke to, whether or not they would accept a quest, whether or not they would complete quests and how they would complete the quests. In the second section the player has to choose whether or not they will help Henry Talos in the robbery and whether they will tell Guard Johnson about his plans. The ending is decided using a simple script (Figure 22) (Table 7); however this is not how the ISGEngine is intended to be used, this is merely for evaluation purposes. If implemented fully the player's choices would be represented through ongoing changes to the plot, dialogue and character behaviours. This technique is simply to demonstrate the difference in plot direction after a series of simple non invasive choices for the player.

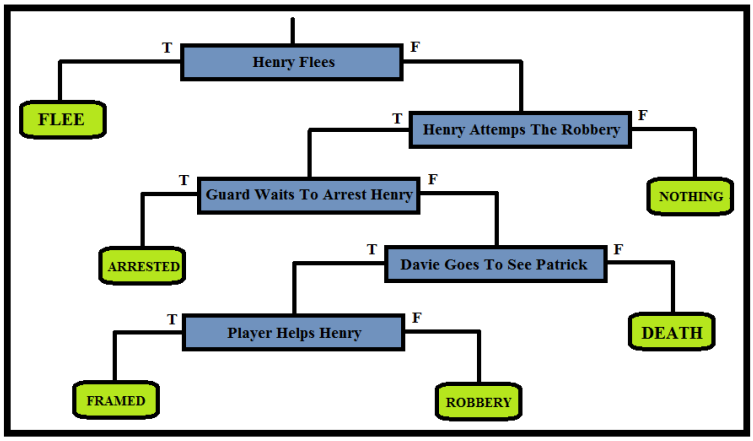


Table 22: Ending Selection Algorithm

Table 7: List of Endings

Ending	Description
NOTHING	Henry Talos does not attempt to rob the tavern.
FLEE	Henry Talos flees from the town.
ARRESTED	Henry Talos gets arrested for the robbery.
DEATH	Davie Merch is killed during the robbery. (Occurs if no player interaction with main story is performed)
FRAMED	The player gets framed for the robbery.
ROBBERY	Henry Talos successfully robs the tavern.

To evaluate the ISGEngine's potential for creating and representing player choice the plot in the demo application was authored using all of its implemented features. To evaluate the plot sequencing and situation generator features, the authored plot contains six plot sequences to track the possible endings and one to enable situation generation. An IN_TYPE_PLOT_REVIVE_REQUIRED incident was created to handle low character traits with Henry Talos. If this was triggered it would initiate a character behaviour for Henry Talos to approach the player and engage in dialogue. In order to evaluate the dialogue system, multiple responses with different levels of will and additional incident responses were authored. In order to evaluate character behaviours, many were used to represent a quest being completed or failed.

3.3.4 Project Development

There are some aims of this project for which there are no way of evaluating the performance specifically. In order to evaluate whether or not the model had a simple authoring process, maintained a low content requirement and contained a non invasive director a third party would have had to be allowed to author a plot using the ISGEngine. Unfortunately the timescale of this project would not allow this therefore these components of the project aim had to be evaluated during the development process.

3.3.5 User Questionnaire

As mentioned earlier the interactive game play experience is one which is unique to each player and therefore must be evaluated by analysing each individual player's

personal opinion of their experience while playing using both quantitative and qualitative methods. The questionnaire created was divided into two sections; the first is a series of questions which ask the player to rate their experience, ranging from very good to very poor. The second is another series of questions which ask the player give short answers detailing what they found was to be good about the experience and what should be improved. The questionnaire which was given to each player can be found in Appendix A: User Test Questionnaire.

3.3.6 Metric Data

There are many different aspects of the ISGEngine which the player would not be aware of and would be unable to comment on. Therefore in order to evaluate these aspects game metric data was recorded from during each user test session. The data recorded the incidents that the player triggered the progress in each plot sequence, the state of each character and activation of any situation generation. This data was then used to determine the level of interaction and uniqueness of each player's experience.

4. CONCLUSION

4.1 Discussion of Results

4.1.1 Introduction

This section will start by presenting the overall results accumulated from the questionnaires and the metric data collected during user testing. It will then go on to analyse the results in order to determine the overall effectiveness of the ISGEngine and to what extent the aims of the project were satisfied.

4.1.2 Results of the Questionnaire

The questionnaire described previously, was given to all user testers after playing the demo application (Table 8).

Table 8: Results from Questionnaire

No.	Question	Average Mark
1.	How well do you feel the game gave you to the opportunity to make your own choices?	Good
2.	How well do you feel the game represented your choices?	Average
3.	How well do you feel the character relationships were represented through dialogue?	Average
4.	How well do you feel the character behaviours aided the representation of your choices?	Good
5.	How well do you feel the direction of the plot reflected your choices?	Good
6.	How well do you feel the immersion was maintained during interaction with the game?	Average
7.	How well do you feel your ending was appropriate to your choices?	Good
8.	Overall how immersive did you find the game play experience?	Good

The results show that the majority felt that the level of choice, change in plot and ending were good, however the representation of choice, especially the user interface was lacking.

4.1.3 Results of the Metric Data

In addition to the questionnaire a series of game metric data was accumulated during the user test sessions (Table 9).

Table 9: Results from Metric Data

Characters Met	Large Change In Character Traits	Ending Encountered	Incidents Triggered	Incidents Triggered (%)	Plot Revival Triggered	Interacted With Main Quests
7	4	Nothing	117	36.1	False	False
4	3	Nothing	96	29.6	False	False
6	5	Nothing	90	27.8	False	True
4	3	Nothing	121	37.3	False	True
7	5	Death	104	32.1	False	False
3	3	Death	83	25.6	False	True
6	5	Death	134	41.4	True	False
5	4	Death	127	39.2	False	True
5	4	Death	103	31.8	False	True
5	3	Death	78	24.1	True	False
5	2	Robbery	90	27.7	True	True
3	1	Robbery	82	25.3	True	True
5	5	Robbery	94	29.0	True	False
7	4	Robbery	84	26.0	True	True
7	5	Flee	137	42.3	False	True
4	2	Arrested	79	24.4	False	True
7	6	Arrested	108	33.3	False	True
6	5	Arrested	120	37.0	False	True
7	6	Framed	142	43.8	False	True
5	5	Framed	113	34.9	True	True
5.4	4.0	NA	100.1	30.9	NA	NA

The results show that there were a wide range of ending encountered and the majority of players interacted with one of the main quests. It also showed that the majority also encountered less than a third of the available content.

4.1.4 Simple Authorship

The plot authored for the demo application was done so relatively easily and took only two weeks to complete. Due to the various functions of the ISGEngine, many aspects of the story could be tailored in great detail. This showed that the ISGEngine is able to facilitate the authoring of game plot simply and easily.

4.1.5 High Level of Choice

The majority of players felt there was a good amount of choice available to them. This was supported by the metric data which showed a large variation in the choices made by each player. This showed that even with a small plot, a large amount of choice can be made available through an open plot structure. The only problem with the level of choice was that due to issues in the user interface there were some choices that players were unaware of. It was found that the plot continuity was generally maintained without the need for situation generation as most players made appropriate choices; this showed that the plot direction does not need to be forced.

> *"There was lots of freedom in interaction and character discussion."*
> *(User Tester)*

4.1.6 Low Content Requirement

The plot which was authored for the demo application used a relatively small amount of function calls, meaning that the content requirement was low. Additionally the metric data collected showed that despite this the average content encountered by players was 30.1%. This was a surprising result as the demo application was not very large or complex however the content developed for it was more than necessary.

4.1.7 User Interface

This is where the project was let down, unfortunately the user interface was not very strongly structured and explained to the player. This was reflected in the questionnaire as many felt they could not perform the actions they wanted to or manoeuvre appropriately, although when designing the demo application these issues were not clear. This prevented certain aspects of the ISGEngine from being evaluated fully, however the development of an interactive narrative model is an iterative process with a limited time frame therefore it is expected that some aspects may be in need of

improvement. Many of the user testers also commented on ways in which the user interface could be improved.

> *"Names above the characters heads would be useful." (User Tester)*

> *"Clearly explaining the game at the start would help." (User Tester)*

> *"Indicate dialogue that has been used to make conversations feel more realistic." (User Tester)*

> *"If I could respond to NPC behaviours for example apologise for being aggressive." (User Tester)*

4.1.8 Representation of Choice

The representation of the player choices was done in various ways; some aspects were successful and some were not. Most players said the direction of plot was very well represented and the ending was appropriate for the choices they had made. The character behaviours were also found to be meaningful to the player choices. Unfortunately the representation of the player's choices through character dialogue was not found to be as good. The cause of this was mainly due to the player's lack of understanding concerning the user interface. The metric data collected supported this as many players did not utilise the manner of dialogue feature.

> *"It was unclear whether Friendly, Neutral or Aggressive would give different results or even what they meant" (User Tester)*

The time relativity feature received mixed responses; some thought that it was a nice addition where as some felt it was disruptive to the experience. From the metric data collected it was clear that the player's choices made a large difference to the character traits and behaviours and the overall direction of the plot. The full extent of this effect however was not being represented to the player significantly enough.

> *"It was clear how the characters related to each other." (User Tester)*

> *"I felt that my choices had an impact on the story." (User Tester)*

4.1.9 Unique Experience

The metric data accumulated showed that there was a variation of the different endings encountered. All 20 players had very different experiences, i.e. the characters they engaged in dialogue with, the incidents they triggered and overall the plot path they followed (Figure 23).

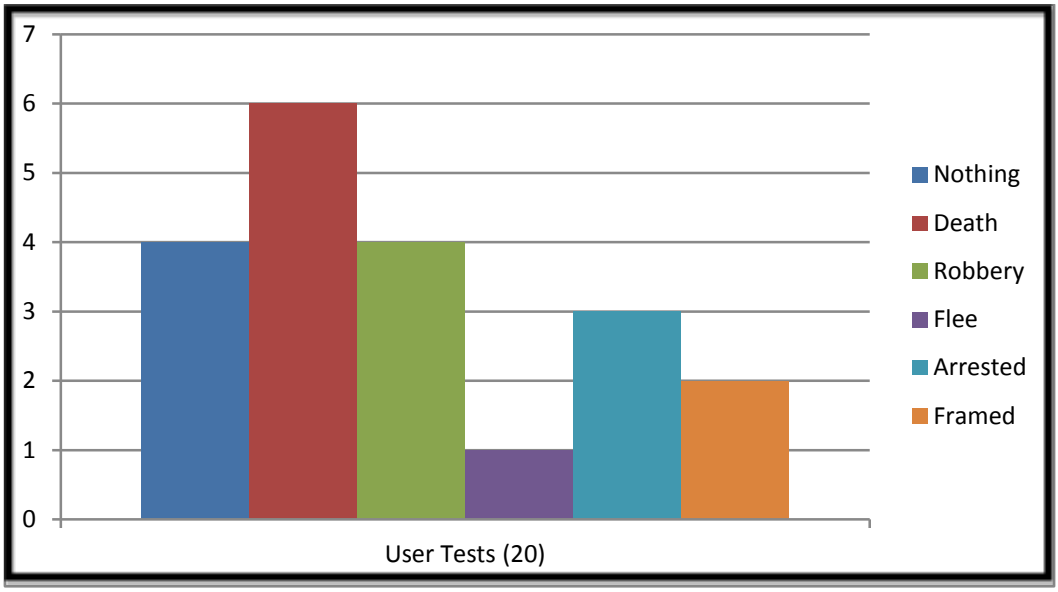


Figure 23: User Test Endings Encountered

The plot paths that each player took varied greatly even when the same ending was encountered. In the diagram below (Figure 24) the three coloured lines represent the different players paths through the plot content.

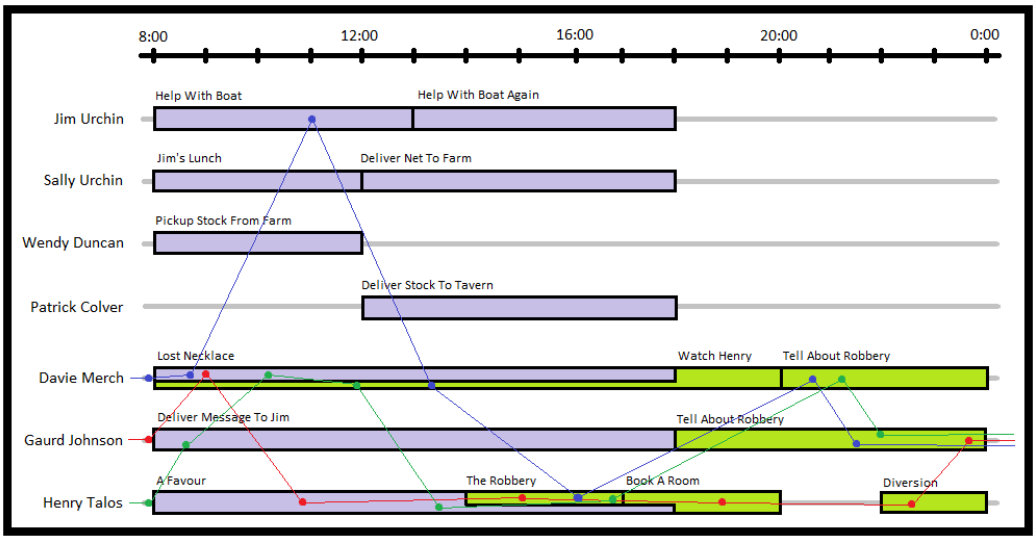


Figure 24: User Test Plot Paths (Arrested)

The number of characters encountered with and number of incidents triggered also vary significantly. This showed that although the player's choice was not represented as well as it could have been, the choices still had a dramatic effect on the experience they encountered compared to other players (Table 10).

Table 10: Results from Metric Data (Arrested)

Characters Met	Large Change In Character Traits	Ending Encountered	Incidents Triggered	Incidents Triggered (%)	Plot Revival Triggered	Interacted With Main Story
4	2	Arrested	79	24.4	False	True
7	6	Arrested	108	33.3	False	True
6	5	Arrested	120	37.0	False	True

4.1.10 Maintaining Plot Cohesion

The overall immersion of the experience was found to be good and most players felt their ending was appropriate. Many felt that the cohesion of the experience was poor as they did not understand their choices or were unable to perform the actions they wanted to; this was 5due to the user interface. Maintaining plot cohesion is a very difficult task and if the authoring process was performed by a professional designer, the plot cohesion could be greatly improved.

4.1.11 Maintaining Plot Continuity

The plot continuity was maintained as intended through situation generation. It maintained that there was a suitable plot sequence available to every player at all times. The majority of players found their way to the main story although some missed the content due to the time windows. Whenever a player did not come across the main story the situation generator was signalled appropriately and content was introduced. This showed that an open plot structure can be implemented within a story driven video game and be controlled without an invasive director.

4.2 Further Work

4.2.1 Introduction

This section will discuss how the ISGEngine could be improved or worked upon. It will then discuss the future of interactive narrative and the story driven video game.

4.2.2 Further Improvements to ISGEngine

From the evaluation it is clear that if a demo application was created with a much stronger user interface then the true potential of the ISGEngine could be more effectively utilised. Developing an interactive narrative model is an iterative process and there are many areas in which it could still be improved. The dialogue system could be extended to involve multiple responses, positive and negative as well as more detailed responses for specific situations such as when the character does not want to talk to the player. One major improvement would be to procedurally generate character responses based on pre authored speech patterns for each character. This would allow for much more variation in responses which are much more specific in regard to the current game state.

4.2.3 Developing the Situation Generation Further

The situation generation technique was very successful in maintaining plot continuity in an open plot structure. One way in which it could be greatly improved would be to introduce randomly generated game content such as quests, a feature which is currently being developed in story driven video games (Bathesda Studios 2011); this would mean that the content introduced would not require authoring and an unlimited amount of content would be available.

4.2.4 Applying to Large Scale Video Games

If the ISGEngine were to be applied to a large scale story driven video game it would probably be best suited for side quest storylines rather than the main story as it is not yet capable of large content such as cut scenes or dramatic events. As a tool for developing story driven video games the ISGEngine has the potential to be very efficient and useful however, there are many areas in which it could be improved, mainly the user interface.

4.2.5 Improving the Performance

The performance of the ISGEngine was never an issue during the project although many of the algorithms, especially the fuzzy logic calculations could have an effect in a much larger project. Additionally the storage and access functionality could be improved to handle large amounts of content without putting strain on the performance of the database.

4.2.6 Improving the Authoring Process

The ISGEngine contains a lot of functionality for controlling the structure of the content however there are many common arrangements of content which could also be implemented into the functionality to assist and avoid mistakes. An example of this would be, in the demo application characters would approach the player it they had failed a quest, this was authored manually using incident responses and character behaviours however it would be much more efficient to add additional parameters to determine whether or not such a content structure should be authored. It would also be useful to incorporate some form of syntactical checker to analyse the cohesion of the authored plot sequences.

4.2.7 Future of Interactive Narrative

Interactive narrative is a rapidly growing area in the video games industry and there will definitely one day be a place on the shelves for the kind of interactive story games discussed throughout this project. This project has discovered that developing interactive narrative requires an open plot structure and a great deal of agency. It was found that representing player choice is a very difficult task and not one that will be solved straight away. In regards to the open plot structure this project was very successful in implemented such a structure and maintaining plot continuity throughout.

APPENDICES

Appendix A: User Test Questionnaire

After playing the application please answer the following questions about your experience.

Section A: Please rate the following features of the application:

	Question	Very Poor	Poor	Average	Good	Very Good
1.	How well do you feel the game gave you to the opportunity to make your own choices?	O	O	O	O	O
2.	How well do you feel the game represented your choices?	O	O	O	O	O
3.	How well do you feel the character relationships were represented through dialogue?	O	O	O	O	O
4.	How well do you feel the character behaviours aided the representation of your choices?	O	O	O	O	O
5.	How well do you feel the direction of the plot reflected your choices?	O	O	O	O	O
6.	How well do you feel the immersion was maintained during interaction with the game?	O	O	O	O	O
7.	How well do you feel your ending was appropriate to your choices?	O	O	O	O	O
8.	Overall how immersive did you find the game play experience?	O	O	O	O	O

Section B: Please answer the following questions about the application:

Expand on any question from section A; giving reason for your choice.

_____

What do you feel would improve your gaming experience in regards to player choice?

_____

Is there anything that you felt was disruptive to the immersion or game play experience?

_____

Do you have any additional comments?

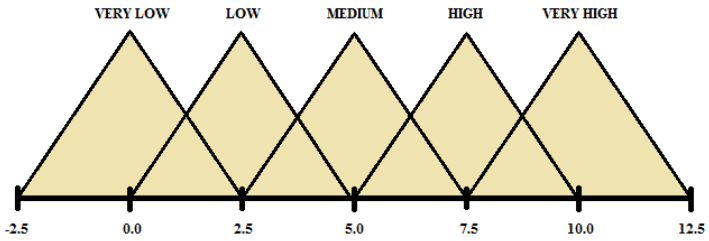
_____

_____

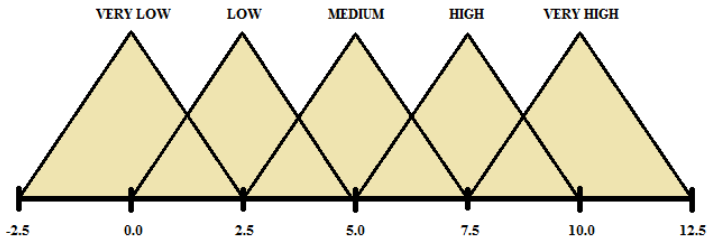
Appendix B: Fuzzy Inference Systems

B.1 Fuzzy Membership Functions

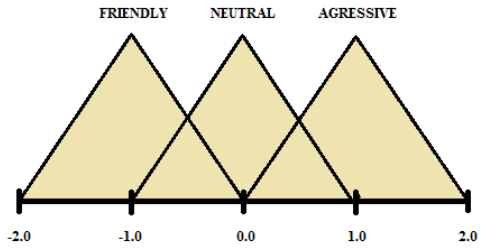
Input: Like



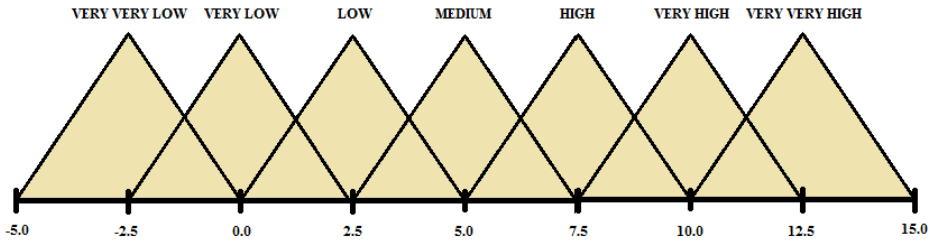
Input: Fear



Input: Manner



Output: Fear / Like Component



B.2 Fuzzy Rule Set (Like Component)

AND	Friendly	Neutral	Aggressive
Very Low	Low	Very Low	Very Very Low
Low	Medium	Low	Very Low
Medium	High	Medium	Low
High	Very High	High	Medium
Very High	Very Very High	Very High	High

B.3 Fuzzy Rule Set (Fear Component)

AND	Friendly	Neutral	Aggressive
Very Low	Very Very Low	Very Low	Low
Low	Very Low	Low	Medium
Medium	Low	Medium	High
High	Medium	High	Very High
Very High	High	Very High	Very Very High

Appendix C: Proposal Document

C.1 Abstract

There has recently been a great deal of research and experimentation in the field concerning interactive narrative however the techniques and models have yet to be seen implemented within a video game. The popularity of story driven video games is on the rise and it is becoming increasingly popular for players to have a genuine influence on the plot through their choices however without the successful implementation of interactive narrative this is not happening. The aim of this study is to develop an interactive narrative model tailored specifically for story driven video games. The model will favour plot direction through rich autonomous characters, and will also introduce the use of relative time and the principle of choice and consequence in the decision making process. This study will analyse current models and the techniques used to implement them as well as investigate into interactive video games. Then from the research found derive a set of rules which the model must adhere to. Then finally design, implement and evaluate the model in terms of the desired interactive narrative characteristics.

C.2. Introduction

C.2.1 Setting the Scene

Imagine you are playing a typical role playing game, you play the protagonist hero, you approach a village that is under attack and a soldier comes to you and asks for your help. You turn and walk away and come back one month later (in game time), the village is still under attack and the same soldier has the exact same scripted message for you. In this game, the graphics are incredible, the action is intense and there is a massive, open world just waiting for you to explore, however there is one thing that keeps dragging you back from becoming completely immersed in this fantastic game world. That is the realisation that the decisions you make, no matter how much you want them to, will never have any real effect on the plot of the game or on the game world itself. It is frustrating that after being given all of this free will to wander as you please and interact with anything or anyone at any time, yet you are still unable to make a difference, and this is the case for many video games today. Now imagine a perfect game world where every decision you make, however small or

large, whether you are aware that you made the decision or not, still carried with it cause and effect. Imagine if when you chose to walk away from the village and chose not to help, the village burned to the ground and this caused a chain reaction within the plot that you could not predict and would inevitably lead you down a different path in the game; that is what this study aims to achieve.

C.2.2 Background

Video games have come a long way since they first arrived on an oscilloscope screen and with the recent rise of story driven video games it is an increasing desire for players to be able to interact with the plot and make the story their own however this is not being met by current video games. There have been many attempts in recent games to create the illusion that the player's choices have a deep meaningful impact on the games plot however these techniques are usually transparent and ultimately disappointing.

C.2.3 Significance

With the graphical quality of games today, the next logical step for the highly demanded story driven video game is to fully embrace interactive narrative, however with the current level of development in the field it is a huge risk for any developer to undertake and not many have tried to do so. There have been many projects involving interactive narrative, although they are small and primarily developed for research purposes they are beginning to reach a very high level and if the techniques were to be implemented within a video game successfully it could lead the way for a whole new genre of video games.

C.2.4 Foreword

Before delving into the topic it is important to mention that many works on this topic although they have focused on the same key principles, have used very different notation such as *interactive narrative*, *interactive drama*, *emergent narrative*, *interactive storytelling*, *interactive fiction* and *cyber drama*, however this study will use the term *interactive narrative* as it is the most commonly used.

C.3. Literature Review

C.3.1 Introduction

Although the topic of interactive narrative has recently seen an abundance of interest from many different regions of academia involving work in artificial intelligence and computer based story-telling, the ideology is still very premature (Szilas 2003). It has yet to be given one universal definition and this has led some to the conclusion that interactive narrative in this form is impossible (Szilas 2003). One of the reasons this has proven such a difficult task is that interactive narrative is an oxymoron in itself as the term narrative refers to a static story predetermined by an author and interaction is the process of manipulation and change (Mateas 1997). However this is not to say there has not been a great deal of invaluable research and progress in the field. The most well known example is the *Facade Interactive Drama* (Mateas and Stern 2000, Mateas and Stern 2005), additionally there is the *Oz Project* (Bates 1992, Mateas 1997), *FearNot!* (Aylett and Louchart 2004, Aylett et. al. 2005) and *IDtension* (Szilas 2003, Szilas 2004). There are also published books by Brenda Laurel (Laurel 1991), Jane Murray (Murray 1997), Celia Pearce (Pearce 1997) and many others. This work has greatly furthered the field and started to refine the development however so far it has not yet been fully integrated within a video game. There have been many titles in the past few years that have begun to bridge the gap from illusion to fully interactive narrative. *Deus EX: Human Revolution* (Eitros Montreal 2011), *Fable 2 (*Lionhead Studios 2008), *Heavy Rain* (Quantic Dream 2010) and *Mass Effect 2* (Bioware 2011) series are good examples of story driven video games that have attempted just that (Figure 1).

Figure 1: Deus Ex: Human Revolution, Heavy Rain, Fable 2 and Mass Effect 2

Although interactive narrative as discussed in this study has only begun to emerge recently there have been many other forms of media that have involved user interaction. In the 1990s there was an attempt to make interactive cinema where the

audience were allowed to choose what happened next, although this was mostly unsuccessful (Pearce 2001). More successful than this were early interactive video games such as *Myst* (Cyan 1993), where the interaction is derived from immersing the player in the process of mystery and discovery (Pearce 2001) and hypertext games, which are text based games where the player is given a description of the game world and chooses an action to perform. There are a few distinctly different theories that can be used in trying to define interactive narrative. The one which attracts the most attention and is widely accepted to be a good foundation (Aylett and Louchart 2004, Mateas and Stern 2005, Mateas 1997) is a theory based upon Aristotelians Poetics; the first person to widely embrace this theory was Brenda Laurel (Laurel 1986, Laurel 1991).

C.3.2 Aristotelian Interactive Drama Theory

The Aristotelian interactive drama theory derives from a combination of Aristotle's theories of causality, the qualitative structure and the dramatic arc (Laurel 1991). The theory of causality is made up of four key components; formal cause, material cause, efficient cause and end cause. When in the perspective of interactive narrative, material cause refers to the low level actions preformed by characters and formal cause refers to the ultimate goals and direction of the narrative. The efficient cause relates to the current place within the narrative (past events, current knowledge and possible actions) and end cause refers to the ending or conclusion that the narrative comes to. The qualitative structure is made up of six layers; Action (Plot), Character, Thought, Language, Pattern and Enactment. The causal relationships between layers of the qualitative structure takes the form of inferred formal cause moving from Action to Enactment and material cause moving from Enactment to Action (Figure 2). The dramatic arc is the theory describing what gives a narrative dramatic tension. The dramatic arc starts at the exposition, rises to a climax and then falls to the denouement (Figure 3).

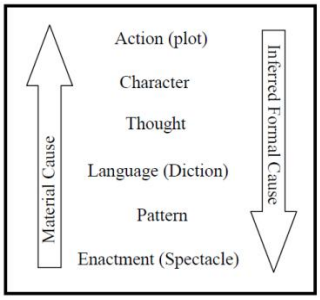


Figure 2: Qualitative Structure

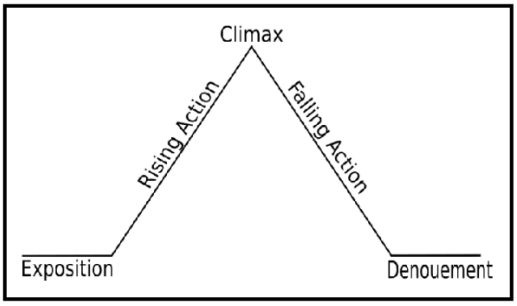


Figure 3: Dramatic Arc

It is also important to maintain the dramatic potential of a narrative, Laurel expresses Aristotle's theory of *dramatic probability* in the form of a *flying wedge*, moving through time the range of possible outcomes starts off completely open and narrows down the probability to one or more specific outcomes at the end (Figure 4).

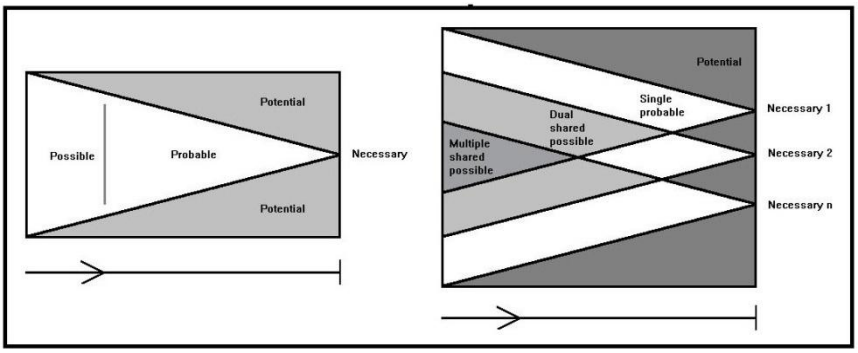


Figure 4: Flying Wedge

However further development from the AI community found that this theory does not allow for sufficient interactivity (Aylett and Louchart 2004).

C.3.3 The Aesthetic Categories

An approach to defining the interactive story experience was proposed by Janet Murray; by dividing it into the three aesthetic categories, *immersion* (the feeling of being psychologically submerged within another reality), *agency* (the ability to make meaningful decisions) and *transformation* (the ability to experience the different aspects of the plot) (Murray 1997).

C.3.4 Neo-Aristotelian Interactive Drama Theory

Due to the lack of interaction capability in the *Aristotelian interactive drama theory* Michael Mateas and Andrew Stern took an approach to combine it with the Murray's

aesthetic categories to create the *Neo-Aristotelian interactive drama theory* (Mateas 2000). This theory added an additional two lines of cause to the *qualitative structure*; *user intention* which follows the same direction as *inferred formal cause* and *material for action* which follows the same direction as *material cause*. Additionally this model places the user action (player) in the *character* stage of the structure (Figure 5).

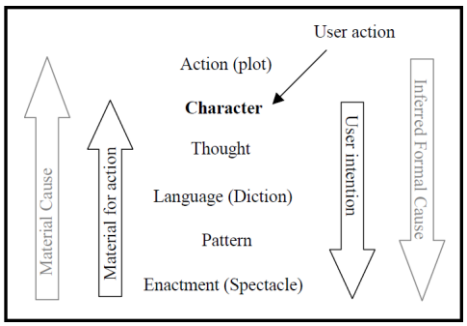


Figure 5: Neo-Aristotelian Qualitative Structure

The characters actions are limited from below by the material constraints created by the material resources available and from above by the formal constraints created by the plot direction; agency is achieved when there is a balance between these constraints.

C.3.5 Additional Theories

Another approach taken is the *theoretical model of narrative* which is made up of three layers, the *discourse layer* (the message), the *story layer* (actions and events) and the *perception layer* (audience perception) (Szilas 2003). Some have also compared interactive narrative to computer based versions of fantasy role playing such as *Dungeons and Dragons* (Laurel 1991, Pearce 2001).

C.3.6 Narratology vs. Ludology

The theories described above follow *Narratology* which is the view that understanding the structure of interactive narrative games should be sought out through literature and non computer bases media. This is opposed by *Ludology*, which is the view that interactive narrative games should be derived from an extension of video games as simulation (Frasca 2003, Aarseth 2004), first introduced by Gonzalo Frasca (Wardrip-Fruin and Harrington 2004).

C.3.7 Interactive Narrative Models

Regardless of the theory used to define interactive narrative the main concepts are ultimately the same. Any interactive narrative model requires a high level of user agency, a good balance between character and plot and believable characters (Mateas 1997, Aarseth2004). A good example of an interactive narrative model was illustrated in the *OZ Project* (Figure 6).

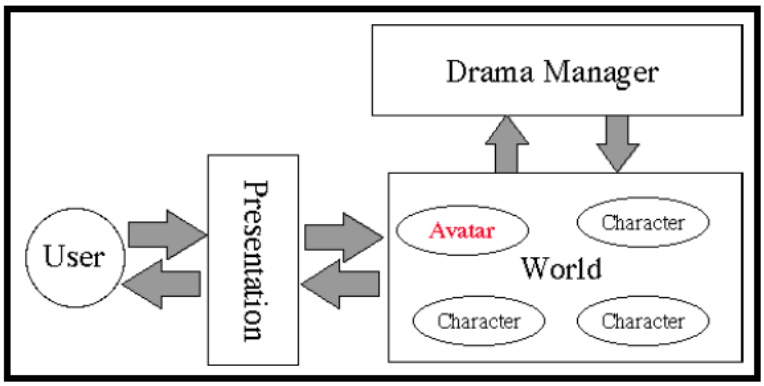


Figure 6: Oz Project Interactive Narrative Model

C.3.8Agency

When a characters' actions have a direct effect on the narrative this is known as *agency*, this can be in the form of *global agency* (high level plot goals and direction) or *local agency* (low level characters and objects).

C.3.9 Balancing Character and Plot

When developing a model for interactive narrative the key components to consider are plot and character, as described in the formula expressed by Joseph Bates (Mateas 1997):

$$Drama = Character + Story + Presentation$$

One of the biggest problems when designing a model for interactive narrative arises from trying to balance the character and plot as to allow for the right amount agency whilst also maintaining the overall direction of the narrative (Mateas and Stern 2005, Bates 1992). If the model completely favours story (plot) then the narrative will be linear allowing for no interaction, however if the model completely favours character then the plot will have no real direction and the narrative will fall apart.

C.3.10 Creating Rich Autonomous Characters

To make characters believable they must have a rich structure capable of goals, values, intellect and persona allowing them to make unique and narrative relevant decisions (Mateas and Stern 2005, Aylett, et. al. 2005). In the Oz Project a set of requirements were defined for creating believable characters which are *Personality*, *Emotion*, *Self-Motivation*, *Change*, *Social Relationships* and *Illusion of Life* (Mateas 1997).

C.3.11 Directing the Plot

To balance the plot three things must be considered, *local* and *global agency*, *granularity* (the levels of detail that are controlled) and *generation* (the amount the manager introduces new characters or branches of the plot) (Mateas 1997). In order to maintain the dramatic tension and direction of the plot it is common to have a Director or Drama Manager (Mateas 1997, Mateas and Stern 2005), however this can be problematic as even with believable characters the immersion can still be broken if the director forces the a character to perform an action that does not make sense. A director can be used to either select the best possible plot segment from a pre-authored list (Mateas and Stern 2005, Szilas 2004), although this can be very time consuming as it is very difficult to predict all of the players possible choices or alternatively by procedurally generating plot segments from more general forms (Barber 2009, Aylett et. al. 2005), although this requires a complex generation system.

C.3.12 Plot Structure

In order to have strong agency within the narrative the structure must be designed to allow for sufficient plot manipulation. This can be done with either an open narrative structure or a widely scoped modulating narrative structure; however an open narrative structure is very difficult to control (McRobbie 2007) (Figure 7). There have been various approaches to implementing plot structure such as Graph Theory (McRobbie 2007) and Bayesian networks (Bangso et. al. 2004).

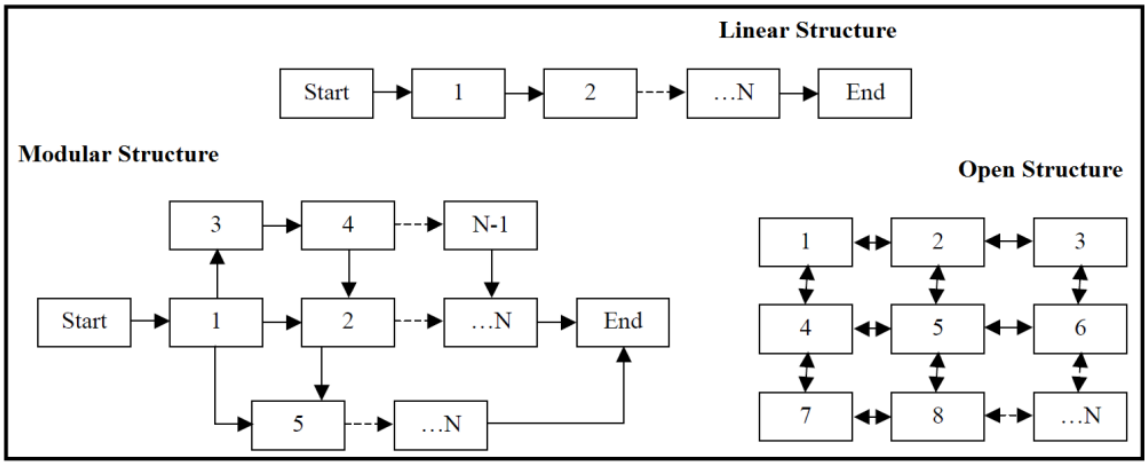


Figure 7: Plot Structures

C.3.13 Additional Features

In addition to the features mentioned above many have looked into other aspects relative to interactive narrative such as emotion (Mei and Marsella 2011), game time (Eskelinen 2004), presentation (Laurel 1986) and user interfaces (Mateas and Stern 2000).

C.3.14 Conclusions

Interactive narrative is growing quickly although there is still much debate about how the definition of the new media should be formed. There has however been extensive progress in defining the key components required to model and implement it; although many of these components are extremely variable and still have problems associated with them.

C.4. Methodology

C.4.1 Overview

The ultimate goal of this study is to develop an interactive narrative model for a video game which allows the player to make a wide range choices, have those choices make a meaningful impact on the plot of the game, have rich believable characters to enable this impact, add the aspect of time to allow for choices and consequences and ultimately create a unique experience for every player. The biggest difference in the approach of this study as opposed to others is that this study will aim to place the control of the plot within the characters, i.e. instead of having plot relative global

goals that every character must adhere to have local goals for each individual characters and then the dramatic tension will theoretically arise from the conflict between characters. At this stage the design of the model is still very preliminary (Figure 8) however following is a list of desired model components:

- *Neo-Aristotelian interactive narrative theory.*
- *Open plot structure.*
- *Rich autonomous characters capable of decisions based on intellect, goals, values, persona and emotion.*
- *Wide range of narrative agency and granularity.*
- *Enforcement of choice and consequence.*
- *Time relative decision making.*
- *Non intrusive plot director using a combination of selection and generation techniques.*
- *Simple choice based user interface.*

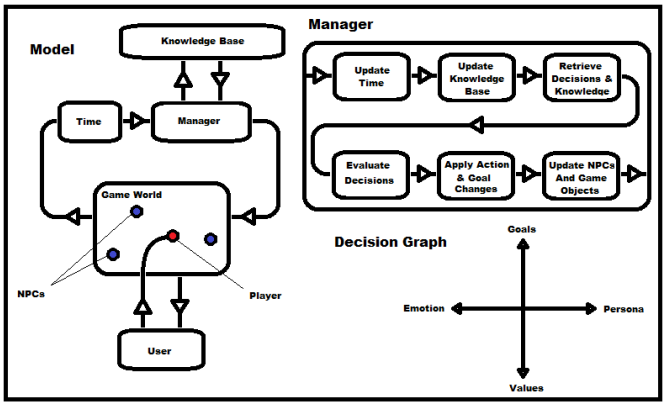


Figure 8: Preliminary Model

C.4.2 Further Research

The first stage of this study is to research the topic area in further detail, specifically towards the four projects mentioned earlier (2.1) in terms of their model, implementation and outcome. Additionally further research into the *Narratology* vs. *Ludology* argument, an evaluation of previous interactive video games and an investigation into decision making techniques (Millington 2009).

C.4.3 Designing the Requirements

After gaining a deeper understanding the next stage will be to establish a set of components required for developing the model and place them into a structure of rules to which the model must adhere to in order of priority.

C.4.4 Implementing the Model

Once the rules for the interactive narrative model have been established the next stage will be to iteratively implement the rules of the model in order of priority starting with a basic structure since it will be hard to determine how long each stage of the implementation will take.

C.4.5 Application Demo

The application demo will be a simple 2D top down game that will be primarily to allow for user testing and demonstration and will be developed iteratively at the end of each stage of the implementation as the implementation of the model will be complex and will take the majority of the timescale of the study.

C.4.6 Evaluation

The last stage of the study will be the evaluation at which time the last successful stage of the implementation will be evaluated by firstly performing test runs of the application demo and analysing the resultant metric data for the behaviour and structural integrity of the model and secondly by having test users play through a scenario and evaluate their experience afterwards.

C.4.7 Risk Assessment

There are specific areas which present potential risks which will be looked at in more detail when designing the rules of the model. One major issue will be in maintaining dramatic tension as this study will be putting the majority of the plot control with the characters, additionally since this study will be using an open plot structure it will be very difficult to maintain and debug the plot scope.

C.4.8 Project Requirements

The model and application demo for this project will be implemented with Visual C++ and the DirectX 9.0c API.

C.5. Research Question and Schedule

C.5.1 Research Question

How effective would a character oriented interactive narrative model be in increasing the interactivity, immersion and playability of a story driven game?

C.5.2 Sub Questions

- *Can an open interactive narrative be controlled without directing the plot significantly?*
- *Can dramatic tension be generated naturally through conflict of individual character goals?*
- *Is it possible to develop an interactive narrative game with a reasonably low amount of design time?*
- *Can a video game give each player a genuinely unique experience through the use of an interactive narrative model?*
- *How significant is the effect of rich believable characters on the immersive quality of a video game.*
- *Would the addition of choice and consequences to an interactive narrative model improve the immersion of a video game?*
- *Would the addition of time relativity to an interactive narrative model improve the immersion of a video game?*

C.5.3 Aims

- Research current interactive narrative models and the techniques used to implement them.
- Compare and evaluate the models in terms of immersion, interactivity and scalability.
- Develop an interactive drama model that utilises an object oriented approach.

- Adopt a decision making technique that can facilitate all of the required features of the model.
- Implement and test this model within a video game environment.
- Obtain performance data and analyse it in terms of the desirable attributes of interactive drama.
- Using the data collected give conclusions and recommendations.

C.5.4 Tasks

- Further research the *Narratology* vs. *Ludology* argument.
- Research and evaluate current story driven games and other media in terms of their interaction and immersive capabilities.
- Evaluate the interactive narrative theories within the context of a video game.
- Research and evaluate *Facade, FearNot, IDtension* and *OZ Project* interactive narratives.
- Author a game story to be written into the model for evaluation purposes.
- Derive a set of required features and components for a story driven video game based model.
- Develop these requirements into a set of rules that the model must adhere to.
- Design the structure of the model to accommodate for all of the rules.
- Implement the basic structure of the model involving the essential rules.
- Iteratively implement further rules of the model and develop the application demo to illustrate the model in practice.
- Evaluate the model at its current stage through test data and user testing.
- Conclude the project and provide recommendations.

C.5.5 Schedule

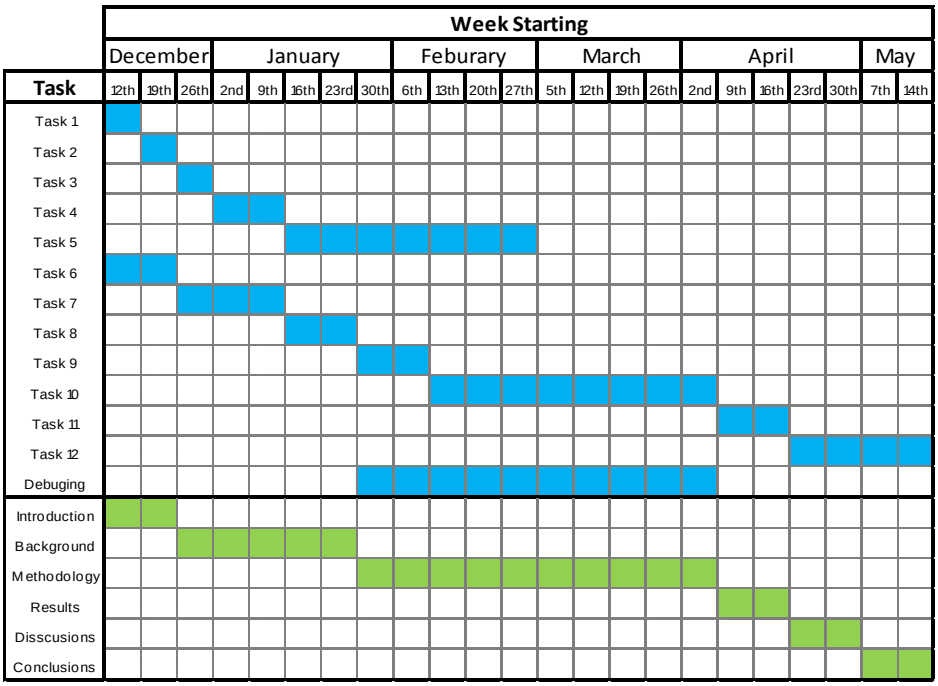


Figure 9: Schedule

Appendix D: Bibliography and References

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