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/PARALLAX/

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"But the number of Realities in which I was the agent in destroying Eternity was also infinite. I was offered a choice among five Realities that seemed least complex. I chose this one, the one involving you, the only Reality system involving you."

Harlan said, "Why did you chose it?"

Noÿs looked away. "Because I loved you, you see. I loved you long before I met you"

- Isaac Asimov,
"The End of Eternity"

Resumé

Ce projet explore les théories des univers parallèles (ou multivers) en association avec les rêves et les souhaites de l'homme, le contrôle (ou non) sur les événements (futur) et comment les différentes décisions peuvent conduire à des fils de l'espace-temps, qui peut en fait exister simultanément ou même se croisent à la fois.   Ce que peu résulte dans une situation négatif dans une réalité peu aboutir à la rédemption ou le bonheur dans une autre un. Le œuvre concentre a introspection, les possibilités théoriques/fictives ou d'événements futurs qui existent en esprit, à la création, manipulation et le passage entre multivers dans lesquels l'individu pourrait échapper, trouver bonheur ou rédemption.

Abstract

This project explores the theories of parallel universes (or multiverses) in association with a person's dreams and desires, the control (or not) over (future) events and how different decisions may result in different threads of time-space, which may in fact exist simultaneously or even cross one another at times. With this in mind, what may result in a negative situation in one reality may lead to redemption or happiness in an alternate one. The work focuses on introspection, the theoretical/fictional possibilities or future events that exist in the mind, creating, manipulating and travelling along and between multiverses in which the individual might 'escape', find happiness or redemption.

INTRODUCTION

"You know perfectly well that I am going to work now."
"You know perfectly well that you'll do as I say! Au revoir. In two minutes! …"

- Yevgeny Zamyatin,
"We"

The purpose of this project was to create a digital work of art that addresses the concept of alternate realities through the active participation of the spectator with a computer-simulated virtual immersive environment.

A piece of work which is regarded (by its creator or by the public) as art is usually expected to be self-explanatory (and at the same time open to multiple interpretations), meaning that documentation accompanying it should be minimal, unless the documentation is in itself (part of) the artwork. Artwork has of course been the subject of studies by critics and researchers in a (not always successful) attempt to uncover the motives and intentions of the artists and their work. But as a certain professor at the Athens School of Fine Arts once told us, "It is better that *you* talk about your work than let others do it for you."

With this in mind and taking into account that an artistic projection employing Virtual Reality tools and technologies is at the same time a software project, this document attempts to describe both the conceptual motives of the creator as well as the design and development process of the end product.

As far as implementation is concerned, the process required for an art project is no more different from that of a software project. Passionate expression of an initial inspiration may be a characteristic of artists (as well as what many people think artists do all the time) however the reality of what follows after that, if one is to produce something meaningful and decent, if very different. A methodology needs to be established, lengthy research and experimentation is required, both in the conceptual as well as the practical/technical part of the implementation.

Having said that, it should be made clear that this document does not constitute a scientific research in physics or in virtual reality technologies; it is rather an analysis of the artistic *problématique* at a conceptual level, of the motives and inspiration, together with the technologies, tools and methodology used during the implementation.

There is no attempt to either accept or reject the existence of parallel universes, the scientific validity is inconsequential for this project, what is important is the inspiration this theory provides to tackle the issues of reality versus dreams and desires.

On a conceptual level, *Parallax* investigates the concept of parallel worlds and alternate realities in relation to a person's path in life, our will, our dreams and expectations as opposed to the reality of what is actually happening

or has happened in the past and how past events influence the rest of our lives. In this context we often wish that things were different, that we could change the past and shape the future, that we can switch to a different reality. Not being possible, this work conceives such a (system of) universe(s) as a construct of the mind, as our dreams or as wishful thinking. At the same time, artists have their personal reasons, their inner motives which they wish to express hoping some times to communicate their questions to the viewer or perhaps expect/hope for empathy.

Parallax draws on physics, cosmology and philosophy for inspiration, and employs multimedia and computer science for its implementation. The title was selected so as to suggest the visual displacement of a single reality which is the result of the Parallax effect: 'the apparent displacement or the difference in apparent direction of an object as seen from two different points not on a straight line with the object; especially: the angular difference in direction of a celestial body as measured from two points on the earth's orbit' (Meriam-Webster dictionary, n.)

This document has five main parts. Part one introduces us to the basic concepts of parallel universes. In part two we examine the way this theme has been addressed in art up to now. Part three discusses the artistic intention of this work and part four describes its implementation. Finally part five presents the results of this effort, the current status of the project as well as future plans.

THE CONCEPT OF PARALLEL UNIVERSES

With time-travel made possible through the General Field Theory, they could change any past probability wave, creating a new universe where each entity would take the best possible path instead of whatever sad paths it had taken to arouse their compassion and intervention.

- Robert A. Wilson,
"Schrödinger's Cat Trilogy"
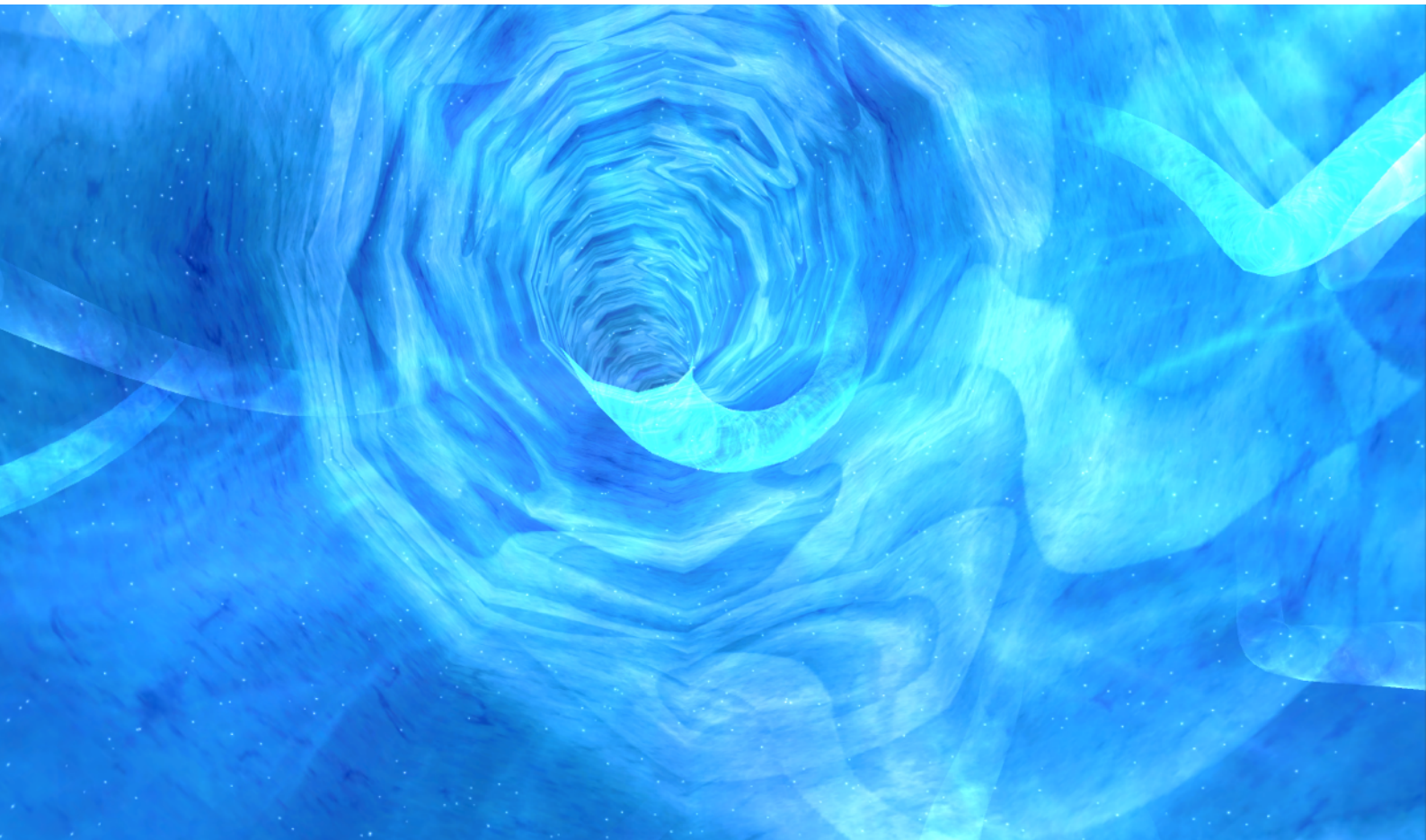
Parallax wormhole texture experiments

The theories of parallel worlds and alternate realities have been a source of inspiration for this work. Although this document does not constitute a scientific discourse on this topic, it is worth familiarising one's self with the basic concepts.

The basic theory behind parallel universes is that different worlds can exist in parallel, each representing an alternate reality, so that for all entities, all events, for everything that can exist and for everything that is happening, all possible states can and do exist, in all possible combinations, each in one of the different universes. In general, the term Multiverse is used to describe the realm of all possible (infinite) parallel universes that may exist.

The concept of a parallel universe has in one way or another been addressed by cosmology theories, philosophy and (science) fiction. Scientific discoveries of the past few decades however have indicated that these parallel universes could, in fact exist. There are advocates both for and against the Multiverse theories.

ORIGINS

The term Multiverse was first used be American philosopher and psychologist William James in an attempt to describe "every possible configuration of existence, a totality that is now sometimes also referred to as the Omniverse" (Ash 2012). The concept of parallel worlds first appeared in science fiction works such as *Men Like Gods* by H. G. Wells (1923), *Legions of Time* by Jack Williamson (1930) and works by H. P. Lovecraft. In most cases this was pure fantasy but sometimes there was an attempt to provide plausible explanations or at least it was based (read: inspired) on scientific discoveries such as the Quantum Theory. What is interesting is that science inspired writers who in turn offered food for though to the scientists (ibid).

SCIENCE

There are two main approaches when addressing the concept of multiverses on a scientific[1] level. The one approach is based on *Quantum Physics* (the *Many Worlds Interpretation of Quantum Physics*) and the other on *Cosmological* theories (*Inflation* and *M-Theory*) and the creation of the Universe.

Incidentally there is research currently taking place in CERN that may provide indications for the existence of the multiverse (http://timewheel.net/Tome-Could-A-Parallel-Reality-Be-Glimpsed-By-Researchers-At-CERN). On a different approach, a cosmologist says he's found possible signs of a parallel universe (http://www.sciencealert.com/a-cosmologist-says-he-s-found-possible-signs-of-a-parallel-universe).

Quantum Physics

The idea of the *Many Worlds Interpretation of Quantum Physics*[2] was first proposed by Physicist Hugh Everett in his 1957 Ph.D. thesis "The Theory of the Universal Wave Function". Without going too much into scientific details, it suggests that infinite universes exist in all possible states, despite the fact that only one is observed during the collapse of the wave function in quantum mechanics (that observation does in fact represent a split point in the universe[3]):

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[1] Despite the fact that the scientific community is divided as to whether the related theories qualify as true science.

[2] This term was given by Everett's supervisor Bryce DeWitt who accepted and promoted this theory.

[3] See also the Schrödinger's cat paradox (Schrödinger 1935)

Everett rejected the Participatory Anthropic Principle in Physics, maintaining the strict Realist view, that Reality and Consciousness were totally separate and could never interact, something he saw as fundamental to any rational empirical Science. He also rejected the slightly different idea that nothing was real until it was measured by an observer, as seemed to be implied by the Copenhagen Interpretation. Everett's solution was to declare all talk of the collapse of the Wave Function to be nonsensical as it was in fact a mathematical description of reality, the same as any scientific formulation, and not a probability function at all. That is all the possible states after a measurement, described in the function, were equally real and concrete, but existed in other Universes to ours! The equation was thus a true description of the Multiverse, which from the perspective of an observer in any local Universe only appeared to be a 'probability description'. When a measurement was made the observer had caused a split in the Universe (including themselves) in which only one of the possibilities becomes actual for them in their particular Universe. Though other observers may experience another alternative Universe. (Ash 2012).

Cosmology

The cosmological approach discusses the multiverse in relation to space-time and creation of the Universe. Various alternatives have been proposed based on different theories about the beginnings and evolution of the cosmos. Max Tegmark and Brian Greene have proposed different classification schemes for various types of multiverses.

In "The Hidden Reality: Parallel Universes and the Deep Laws of the Cosmos" Physicist Brian Greene discusses nine types of parallel universes:

*The **quilted multiverse** works only in an infinite universe. With an infinite amount of space, every possible event will occur an infinite number of times. However, the speed of light prevents us from being aware of these other identical areas.*

*The **inflationary multiverse** is composed of various pockets in which inflation fields collapse and form new universes.*

*The **brane multiverse** follows from M-theory and states that our universe is a 3-dimensional brane that exists with many others on a higher-dimensional brane or "bulk". Particles are bound to their respective branes except for gravity.*

*The **cyclic multiverse** (via the ekpyrotic scenario) has multiple branes (each a universe) that have collided, causing Big Bangs. The universes bounce back and pass through time until they are pulled back together and again collide, destroying the old contents and creating them anew.*

*The **landscape multiverse** relies on string theory's Calabi–Yau spaces. Quantum fluctuations drop the shapes to a lower energy level, creating a pocket with a set of laws different from that of the surrounding space.*

*The **quantum multiverse** creates a new universe when a diversion in events occurs, as in the many-worlds interpretation of quantum mechanics.*

*The **holographic multiverse** is derived from the theory that the surface area of a space can simulate the volume of the region.*

The ***simulated multiverse[4]*** *exists on complex computer systems that simulate entire universes.*

The ***ultimate multiverse*** *contains every mathematically possible universe under different laws of physics. (Wikipedia)*

In his book Greene provides the following summary:

*[..] if space extends infinitely far—a proposition that is consistent with all observations and that is part of the cosmological model favored by many physicists and astronomers—then there must be realms out there (likely way out there) where copies of you and me and everything else are enjoying alternate versions of the reality we experience here. [..] the **inflationary theory**, an approach that posits an enormous burst of superfast spatial expansion during the universe's earliest moments, generates its own version of parallel worlds. If inflation is correct, as the most refined astronomical observations suggest, the burst that created our region of space may not have been unique. Instead, right now, inflationary expansion in distant realms may be spawning universe upon universe and may continue to do so for all eternity. What's more, each of these ballooning universes has its own infinite spatial expanse, and hence contains infinitely many of the parallel worlds [..].*

*[..] recent developments in string theory that suggest three new kinds of parallel universes. One is string theory's **braneworld** scenario, which posits that our universe is one of potentially numerous "slabs" floating in a higher-dimensional space, much like a slice of bread within a grander cosmic loaf. If we're lucky, it's an approach that may provide an observable signature at the Large Hadron Collider in Geneva, Switzerland, in the not too distant future. A second variety emerges from braneworlds that slam into one another, wiping away all they contain and initiating a new, fiery big bang–like beginning in each. As if two giant hands were clapping, this could happen over and over—branes might collide, bounce apart, attract each other gravitationally, and then collide again, a **cyclic process** generating universes that are parallel not in space but in time. The third scenario is the string theory "**landscape**," founded on the enormous number of possible shapes and sizes for the theory's required extra spatial dimensions. We'll see that, when joined with the Inflationary Multiverse, the string landscape suggests a vast collection of universes in which every possible form for the extra dimensions is realized.*

[..] Quantum mechanics, with its Many Worlds version of parallel universes, [..] its most formidable problem: how to extract definite outcomes from a theory whose basic paradigm allows for mutually contradictory realities to coexist in anamorphous, but mathematically precise, probabilistic haze. [..]

*[..] the strangest version of all parallel universe proposals. It's a proposal that emerged gradually over thirty years of theoretical studies on the quantum properties of blackholes. The work culminated in the last decade, with a stunning result from string theory, and it suggests, remarkably, that all we experience is nothing but a **holographic projection** of processes taking place on some distant surface that surrounds us. You can pinch yourself, and what you feel will be real, but it mirrors a parallel process taking place in a different, distant reality.*

*[..] universes created not with hardware but with software—universes that might be **simulated** on a superadvanced computer—and investigate whether we can be confident that we're not now living in someone's or something else's simulation. This will lead to the most unrestrained parallel universe proposal, originating in the philosophical community: that **every possible universe is realized somewhere in what's surely the grandest of all multiverses**. The*

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[4] Since this concept may be interesting to people working with virtual reality, there are three interesting articles for further reading:

"Are You Living in a Computer Simulation?" (Bostrom, 2003)

"Simulation, Consciousness, Existence" (Moravec, 1998)

"Simulated Reality: The Big Brother Universe" (Thomas, 2007)

discussion naturally unfolds into an inquiry about the role mathematics has in unraveling the mysteries of science and, ultimately, our ability, or lack thereof, to gain an ever-deeper understanding of reality. (Greene, 2011)

Cosmologist Max Tegmark suggests four levels of multiverse. From the abstract of his paper "Parallel Universes":

*I survey physics theories involving parallel universes, which form a natural **four-level hierarchy of multiverses** allowing progressively greater diversity. **Level I:** A generic prediction of inflation is an infinite ergodic universe, which contains Hubble volumes realizing all initial conditions — including an identical copy of you about $10^{10^{29}}$ m away. **Level II**: In chaotic inflation, other thermalized regions may have different physical constants, dimensionality and particle content. **Level III**: In unitary quantum mechanics, other branches of the wavefunction add nothing qualitatively new, which is ironic given that this level has historically been the most controversial. **Level IV**: Other mathematical structures give different fundamental equations of physics. The key question is not whether parallel universes exist (Level I is the uncontroversial cosmological concordance model), but how many levels there are. I discuss how multiverse models can be falsified and argue that there is a severe "measure problem" that must be solved to make testable predictions at levels II-IV. (Tegmark, 2003)*

PHILOSOPHY AND RELIGIONS

Multiverse theories have also an impact on philosophical thinking, especially in relation to the way humans comprehend their (non) uniqueness in the universe, dilemmas regarding multiple instances of the self as well as the beginnings of the universe, life and teleological theories.

For example, Joshua Knobe, Ken D. Olum and Alexander Vilenkin discuss about the "The Philosophical Implications of Inflationary Cosmology":

Recent developments in cosmology indicate that every history having a nonzero probability is realised in infinitely many distinct regions of spacetime. Thus, it appears that the universe contains infinitely many civilisations exactly like our own, as well as infinitely many civilisations that differ from our own in any way permitted by the physical laws. We explore the implications of this conclusion for ethical theory and for the doomsday argument. In the infinite universe, we find that the doomsday argument applies only to the effects which change the average lifetime of all civilisations, and not those which affect our civilisation alone. (Knobe, 2006)

Crossing the philosophical-theological boundaries, the discourse on the relation of the scientific attempts to explain the universe and life (let along the multiverse) with or without divine intention or intervention, seems at best inconclusive. Halvorson and Kragh conclude at a related article in the Stanford Encyclopaedia of Philosophy:

The question, "why does the universe exist?" admits of answers from traditional religions as well as from contemporary cosmological theories. However, according to Bede Rundle (2004), neither of these answers are needed, for philosophical analysis is sufficient to prove the existence of a physical universe. While some claim that the scientific answer has superseded all theological answers, others claim that the scientific answer reinforces the claim that God created the universe. Indeed, the story of the interaction between scientific cosmology and theology is by no means a simple tale of a better theory replacing an inferior; nor a simple tale of the convergence of diverse sources of knowledge. A naive or ideological reading of twentieth century cosmology might count big bang cosmology as providing new support for theism, and alternatives such as steady-state cosmology as atheistic backlashes. (And of course, the work of apologists such as W.L. Craig lends credence to this sort of picture.) But such a view misses many nuances,

both in the historical record, as well as in the logical structure of these issues. From a historical point of view, there has been little correlation between religious views of scientific cosmologists and their proposed cosmological models. From a epistemological point of view, there are numerous obstacles to claiming that the big bang confirms the hypothesis that God exists. And from a metaphysical point of view, God's hand is not manifest even in big bang models: these models have no first state for God to create, and these models have no time for God to exist in before the big bang. (Halvorson & Kragh, 2013).

References to the concept to multiple universes can be found in many religions but as one would expect many times they are mentioned in relation to the greatness and omnipresence of the divine entity or in relation to the soul in a previous/after-life. In some cases (Hinduism for example) there is a hint that these universes may be alternate realities with respect to an individual (which is the case study of this project).

Gary Zabel comments on the beliefs of ancient religions and philosophers regarding alternative worlds, the effect of Jewish, Christian, and Islamic religions and science later on :

The idea that our world is one of an unfathomably large, perhaps infinite, number of alternative worlds is an old one. In the East, it was developed thousands of years ago in the cosmological discussions of the Hindu puranas, as well as many of the early Buddhist sutras. In the ancient Geek and Roman West, Empedocles, Epicurus, Lucretius, and even Plato were advocates of the idea of multiple worlds. The triumph of mainstream Jewish, Christian, and Islamic traditions put an end to the development of a many-worlds cosmology in the lands west of India for more than a thousand years, but the rise of a mathematical science of nature, beginning in the Renaissance, reintroduced the theme into European thought. (http://www.faculty.umb.edu/gary_zabel/Courses/Parallel%20Universes/Parallel%20Universes-Th%20Idea%20of%20Multiple%20Worlds.htm).

PARALLEL UNIVERSES IN ART

By now, from that real or hypothetical past of his, he is excluded; he cannot stop; he must go on to another city, where another of his pasts awaits him, or something perhaps that had been a possible future of his and is note [sic] someone else's present. Futures not achieved are only branches of the past: dead branches.

- Italo Calvino,
"Invisible Cities"

Gwen Gunter, "Parallel Universes"

In understanding how parallel worlds may be better expressed it is essential that we look into what has been done already in different artistic fields regarding that theme.

VISUAL ARTS

The theme of alternate realities has inspired artists since the ancient times[5]. However, what is usually depicted (at least in two-dimensional renderings) is a snapshot of a single alternate reality or at best an impression of the collapsed state of parallel universes and there has been controversy as to how contemporary artists can depict such concepts[6]. For example, Christina Mitrentse, Geta Romanescu, Graham Pope, Warren Bellows and Gwen Gunter use the theme of the multiverse as cause for more or less abstract representations of the concept. Jerry Gretzinger has been creating for 50 years now a map of an alternate world while artists like Carol Prusa look among other things into the mathematics and science as means of expression[7]. Of course one has to take into account the illustrations based on or created for the related fiction, like the parallel universe works of Chris Moore. Visual art in three dimensions (sculpture, installations) as well as the employment of modern technologies offers the possibility for enhanced perception by the spectator. Leo Villareal's Multiverse installation,

> *features movement and light, qualities that make this installation particularly well suited for the Gallery's underground walkway, an area through which thousands of people pass daily. Once the appropriate hardware was installed in the existing architecture, the artist programmed sequences through his custom-designed software to create abstract configurations of light. His programming both instructs the lights and allows for an element of chance. While it is possible that a pattern will repeat during a viewer's experience, it is highly unlikely. Still, the eye will seek patterns in the motion, a perceptual effect of the hypnotic trailing lights. (2008 National Gallery of Art, Washington, DC).*

Leo Villareal, "Multiverse"

Crawick Multiverse is a land art project designed by artist and landscape architect Charles Jencks in an abandoned Scottish coal mine.

Recently there has been increased artistic activity regarding the multiverse and related themes. Wysing Art Center, Cambridge, United Kingdom, has offered a residency in Spring 2015 on the topic of Multiverse. The Claremont

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[5] For example, the theme of gods and demi-gods living with or affecting the lives of mortals in the mythology of ancient civilisations.
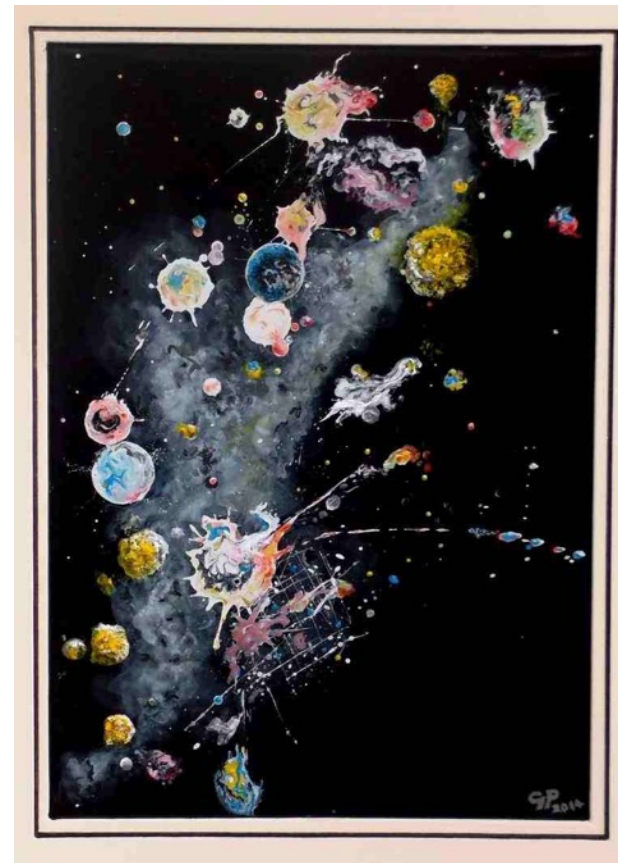
[6] Eyland, Cliff. (2003). *Painting the Multiverse*. University Art Association, Kingston, Canada.

[7] Artist's statement

Jerry Gretzinger, "Map of Alternate World"

Chris Moore, "Grand Designs"

Graham Pope, "Parallel Universe"

Romanescu Geta, "Parallel universes"

Museum of Art, California, United States, hosted an exhibition with the same name in 2008. The Katara Art Center, Katara Cultural Village, Qatar, hosted in 2014 the exhibition Alternative Realities featuring the artworks of VCUQatar senior Painting & Printmaking students Emelina Soares, Hana Al Saadi, Roda Al Nassr, Salma Hassan and Sumam Azzam.

VIDEO GAMES

Video games are directly associated to the formalistic aspects of this work and for this research a few have been singled out, as a source of inspiration or reference, regardless of the topic, storyline or their visual appearance.

The games *Void*, *Elegy for a Dead World*, *Neverending Nightmares* and *Spate* have been singled out for their introspective, psychological and somewhat metaphysical themes. *Limbo* and *Closure* are good examples of innovative gameplay and very interesting yet minimalist art, together with *NaissanceE*, which is also closer to spatial concepts as understood in this project. *Remember Me* presents a future technology allowing the retrieval, modification and injection of memories, resulting in alternate realities for the individual whose memory has been modified *(see Appendix A for short descriptions of the games)*.

On the issue of alternate realities however, most games referencing that topic do it usually just as to establish a framework (a different fantastic world, an alternate historical or fictional situation) upon which the story takes place. None of them addresses the concept of parallel universes itself. There are a few exceptions whose depiction and storytelling, the passage through different realities is interesting and close to the approach envisioned in this project.

In *The Stanley Parable (Galactic Cafe. 2013)* the player controls the main character (Stanley) as he explores the office building where he works, every time starting all over again and every time he is presented with a different reality. There are several possible 'endings' to the game but in essence, it never ends:
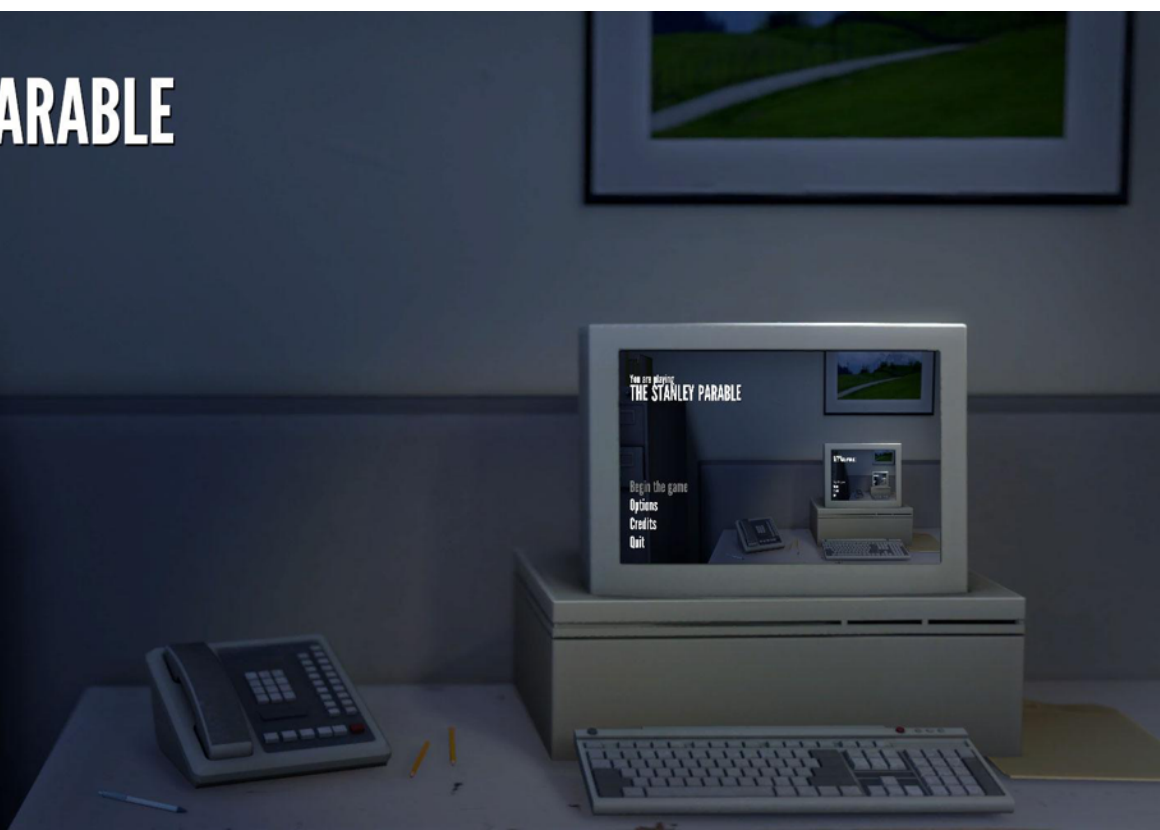
The Stanley Parable is a first person exploration game. You will play as Stanley, and you will not play as Stanley. You will follow a story, you will not follow a story. You will have a choice, you will have no choice. The game will end, the game will never end. Contradiction follows contradiction, the rules of how games should work are broken, then broken again. This world was not made for you to understand.

But as you explore, slowly, meaning begins to arise, the paradoxes might start to make sense, perhaps you are powerful after all. The game is not here to fight you; it is inviting you to dance. (http://www.stanleyparable.com)

The *Silent Hill* series by *Konami* address the theme of travelling between alternate worlds:

Silent Hill is a series of games that can leave you with recurring nightmares and have you questioning your own reality. A major theme in the Silent Hill series is the travelling between parallel universes: fogworld, an abandoned world clouded in fog with few monsters present, and otherworld, a much darker version of Silent Hill that reflects the psychological state of its inhabitants. The character slowly transitions from the "real world" to fogworld. (Katelyn Ginn, gamedynamo.com, 2013).

Konami, "Silent Hill P.T"

In *Silent Hill 4: The Room (Konami. 2004)* in particular the main character visits multiple alternate dimensions through a hole in his bathroom wall. But it is *Silent Hill P.T. (Konami, 2014)* which is especially interesting for this project due to its gameplay. The player passes again an again though the same rooms of a house, round and round in a continuous loop and each time things are a bit different, darker more sinister.

As far as the relation between computer games and art is concerned, Brian Schrank's *Avant-garde Videogames* (2014) provides a great insight on what may be seen to constitute art in games. On a more technical level, D. Fox Harrell's *Phantasmal Media* (2013) is of particular interest for this project. The latter

Considers the expressive power of computational media. He argues, forcefully and persuasively, that the great expressive potential of computational media comes from the ability to construct and reveal phantasms—blends of cultural ideas and sensory imagination. These ubiquitous and often-unseen phantasms—cognitive phenomena that include sense of self, metaphors, social categories, narrative, and poetic thinking—influence almost all our everyday experiences.

FILMOGRAPHY AND THEATROGRAPHY

Alternate realities have also been a cinema favourite, and although many of the films that explore the topic are mainstream action films, there are notable exceptions such as 12 Monkeys (1995, directed by Terry Gilliam and produced by Charles Roven), Lola rennt (1998, directed by Tom Tykwer and produced by Stefan Arndt) and Donnie Darko (2001, directed by Richard Kelly and produced by Sean McKittrick, Nancy Juvonen, Adam Fields).

12 Monkeys features the notion of time-travel as a means to change future events and thus provides alternate realities. The main character travels to a (wrong) past in an attempt to help save humanity from a devastation in the future. The story unfolds simultaneously in three different times (1990, 1996 and 2035).

In Lola rennt we follow the heroine in three alternate realities where she runs to find money in order to help her boyfriend. Each time there is a different outcome and each time we observe how the 'universe' (peoples lives) around Lola is affected by her actions.

In Donnie Darko, apart from the fact that we are presented (eventually) with different versions of reality, the story directly references the notions of time travel and parallel universes in the form of a book ("The Philosophy of Time Travel") given to the main character by "Frank".

Nick Payne's theatre play Constellations (first staged in January 19, 2012, in Royal Court Theatre, London, directed by Michael Longhurst) deals with the possible alternate realities in the life and relation of a couple, quantum multiverse theory, free will and love.

LITERATURE/FICTION

Literature and especially science fiction has been of course greatly inspired by the concepts behind parallel worlds and alternate realities.

Directly influenced by the theories of quantum mechanics and alternate realities, "Schrödinger's Cat Trilogy: The Universe Next Door, The Trick Top Hat, & The Homing Pigeons" (Robert Wilson, 1979) describes an alternate reality (or rather a set of alternate realities) taking place mainly in Unistat (United States) in a society with various degrees of technological advances, alternative world histories, real and fictional characters assuming different historical roles and where the parallel worlds get occasionally mixed up.

Isaac Asimov's "The End of Eternity" (1995) also addresses the issue of alternate realities which can be effected thanks to the ability of time travel. Agents of the *Eternity* organisation travelling back and forth in time not only alter subsequent realities but also interact and even trade with people in different times.

In volume 6, the last of *Venus Prime* series, "The Shining Ones" (Paul Preus & Arthur Clarke, 1991) the heroine Ellen Troy (aka Sparta) jumps through time and parallel universes in an alien world-ship.

In yet another alternate reality scenario, "The Man in the High Castle" (Philip Dick, 1962) describes a post Second World War world where the Axis powers are the victors and where Germany and Japan jointly occupy the United States.

Other noteworthy works include "The Difference Engine" (William Gibson, 1990), the "Neanderthal Parallax" (Robert Sawyer, 2003), "One: a novel" (Richard Bach[8], 2001) and the dark fantasy children's novella[9] "Coraline" (Neil Gaiman & Dave McKean, 2002).
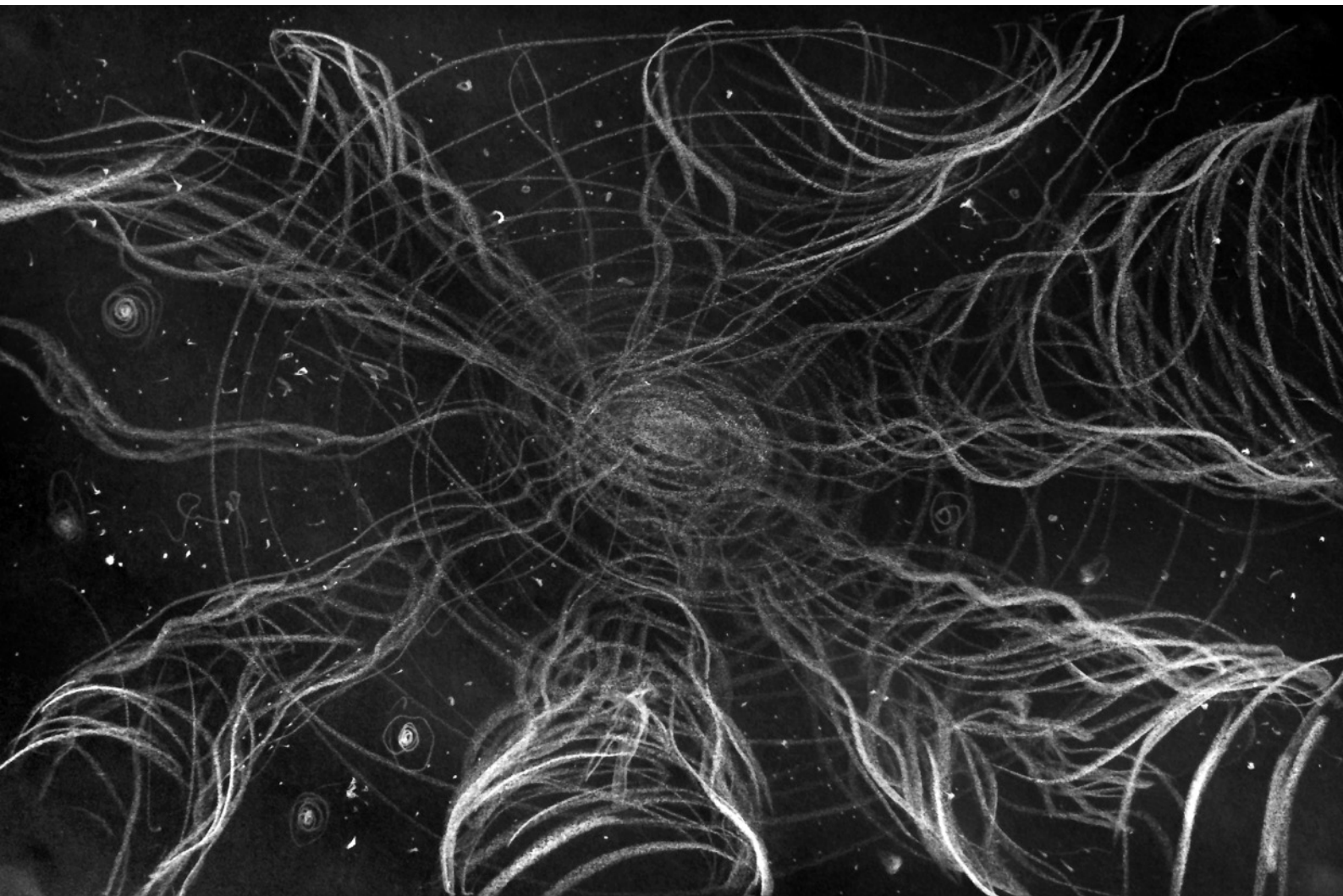
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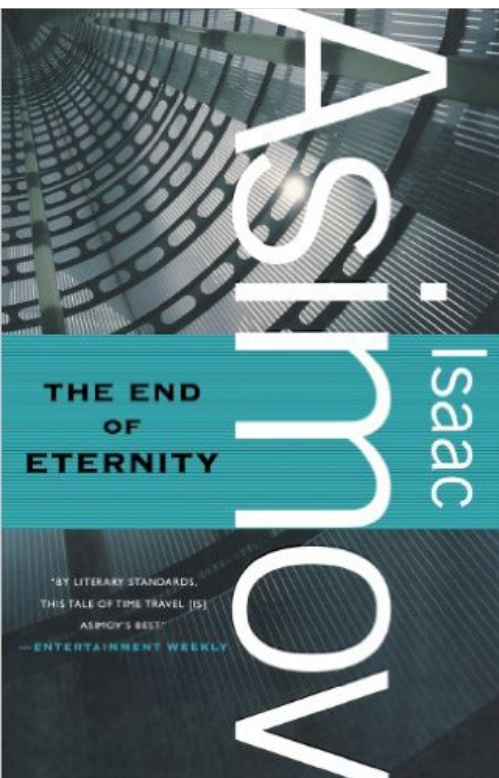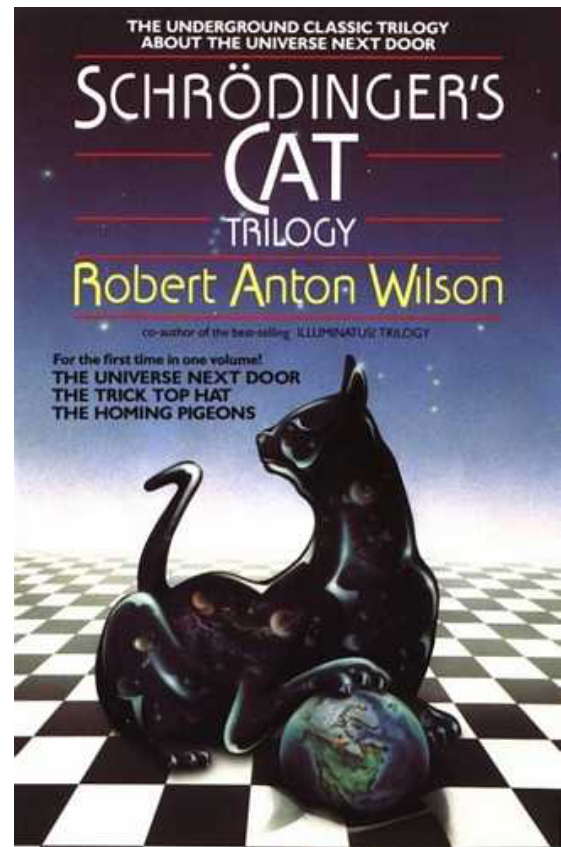
[8] Author of "Jonathan Livingston Seagull" (1970)

[9] Later adapted to a graphic novel and video game and a musical.

ARTISTIC INTENTION

Everything is perspective... and the voices that describe the world to you, I suppose. They matter. The voices inside your head.

- Stephen King,
"Gerald's Game"

Parallax concept art

Very often there are specific themes that preoccupy artists throughout their lives, themes than come back again and again, in an attempt to be understood, expressed better, in different ways, because they are the artist's obsession or because they need to be exorcised.

CENTRAL THEME

In the author's case the themes of his work have in most cases revolved around a person's path in life, the consequences of his/her own actions and those of the others, the (non) control over events past and future, in relation to that person's dreams and desires. *Soul Theatre* (2014) was a journey through a world of symbols which signified the contrast between dreams (both literary and metaphorically) and reality in one's lifetime, the irreversible consequences of decisions and actions (of both the subject and of the others as well), the unfulfilled expectations and perhaps a glint of hope.

Dimitris Trakas, "Soul Theatre"

Parallax investigates the 'what-ifs' in our lives, how the paths we have curved up to now could have been different, have we made different decisions or have external factors been different. On the one hand it is the realisation of our lives so far, an introspection into the paths followed, the choices that have been made, our stance towards external agents. On the other hand it is a reminder of the fact that what we are, what we do, the way we live, most of the times depends on random factors. It is neither pessimistic nor optimistic, it just states the situation. Parallax addresses the anguish of the person in relation to the non-realisation of his dreams and desires.

The question the 'hero' poses to himself is "What if I could change the past? What if I could I control the future?". Based on the (scientific) theories, the possibilities are infinite. We dream of those we like, we'd like for them to exist, we'd like to jump between realities, select a 'better' life. The theories of parallel universes are so vague and out of touch so difficult to be proven, much less to be controlled. Yet the alternate realities humans dream of are not in outer-space, they're all in our heads, our thoughts and wishes, our regrets. Even if there are infinite worlds, they're out of reach. Even if there are infinite doppelgängers of us, each lives his/her own life in another dimension, it doesn't affect ours, we cannot benefit from it. All we can do, all we're left with, is ponder over those other realities and perhaps (the best case scenario) change our attitude towards life.

Parallax offers no solution to the viewers, they have limited or no control, they have to think for themselves about their lives and decide on their attitude towards it, hopefully to appreciate the positive aspects. The work exposes the visitors to a wholistic representation of these concepts and by immersing them into the artist's state of mind it invites them to consider the own personal paths in life and come in terms with their own wishes for alternate realities, alternate lives. In the end catharsis (hopefully for both the artist and the visitors) comes from the realisation of our one and only reality, in accepting it for what it is and in assuming a positive attitude towards it. For this reason in the end of the exhibition visitors are requested to provide a short testimonial of their experience.

VIRTUAL REALITY

Although painting is one of my greatest passions, I'm also an advocate of the fact that different topics and ideas require specific ways (the use of different media) by which they can be expressed. With that in mind, painting seems to be problematic in trying to express the notion of parallel universes and any serious attempt (besides the sometimes remarkable illustrations for, or inspired by, fiction or in most cases decorative paintings) necessarily depicts what seems to be the collapsed state of space-time events (although is certain cases the result does exhibit remarkable plastic qualities). Art in three dimensions (perhaps installations or sculpture) may be more suitable, but modern digital media and especially VR technologies and tools, provide an opportunity to truly envision and experience the alternate states of parallel universes.

With Virtual Reality visitors can completely immerse themselves in interactive fantastic worlds, especially when using stereoscopic Head Mounted Displays (HMD) like the Oculus Rift and a good set of headphones to isolate them from the real world and provide a virtual soundscape. The feeling of 'actually being there' is an additional advantage to other expressive means, like for example the cinema.

ENTER PARALLAX

Initially variations on a single theme/story were envisioned[10] but this scenario was discarded in favour of multiple sets of similar (or rather, familiar) locations, with different combinations of situations and events in every timeline thread. In this way visitors would be able to better perceive the concept of infinite possibilities.

Concept and Storyline

Parallax concept art

Each alternate reality is represented as a room without walls[11] or as a platform where a certain scene is depicted over and over again, with random alterations regarding the objects/symbols placed in it. Such items could be for example a pair of shoes, a dress on a chair, a passport on a table, a child's toys, a gun, blood stains on the floor and so on[12].

Despite the fact that according to the many worlds theories any possible combination of states could exist, the use of a simple rule-based system[13] is under consideration so as to only allow object combinations whose meaning facilitates the story telling but also in order to avoid immediate repetitions of the same scenes for better visual results.

The rooms/platforms are placed floating in a black empty void where the visitors arrive after travelling through the time-space thread. Far away all around them other time-threads will be barely visible or perhaps the other platforms of events.

In all scenes users can only control their view not their movement. Their character walks automatically, signifying in that way the inevitable flow of events in life. There is no way to stop time and ultimately, we really only have little control over what is happening on us and around us.

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[10] for example, it could have been some kind of drama, something about life and death, fear or anxiety or a love story - like Nick Payne's theatre play *Constellations* (first staged in January 19, 2012, in Royal Court Theatre, London, directed by Michael Longhurst). Or perhaps it could be something closer to society's contemporary problems like war, refugees and terrorism.

[11] Another idea would have been to draw the walls on the floor as in the film *Dogville* (2003, directed by Lars von Trier and produced by Vibeke Windeløv).

[12] One of the objects that may appear in the room could be a mirror, but in this case an avatar should be constructed so it can be mirrored on it and this raises concern of how the Self should look like and what does that mean at a conceptual level.

[13] Integration of the *tuProlog* .NET library is under consideration.

A brief outline of the scenario follows below.

Scene 1 (The Park)

This is the introductory scene. Fade-in. Walking (automatically) between two rows of trees and benches, in what seems to be a surrealistic park flooded with water. Black and white or sepia tones. The sound of steps in the water. Visitors can hear their own breathing. Optionally, a man's voice can be heard saying again and again "if only I could change things, if only I could change the past, if only I could control the future...". There is a mirror-like object at the far end and as visitors approach it, it turns out to be a portal, the gateway to the multiverse. The scene then fades to black while text appears (or is spoken by a female voice) reciting a technical passage about the *"Collapse of the Wave Function"*. If the man's voice is used, the female voice gradually fades in while the man's fades out. The collapse of a wave function into a single state signifies the beginning of the journey through parallel worlds since by passing through the portal, the visitors find themselves into one of these universes.

Scene 2 (Wormholes)

Fade into the wormhole space. Long animated twisting tunnels (wormholes) represent the timelines of different realities. Visitors land in a random wormhole where floating platforms/rooms (without walls) slowly move towards
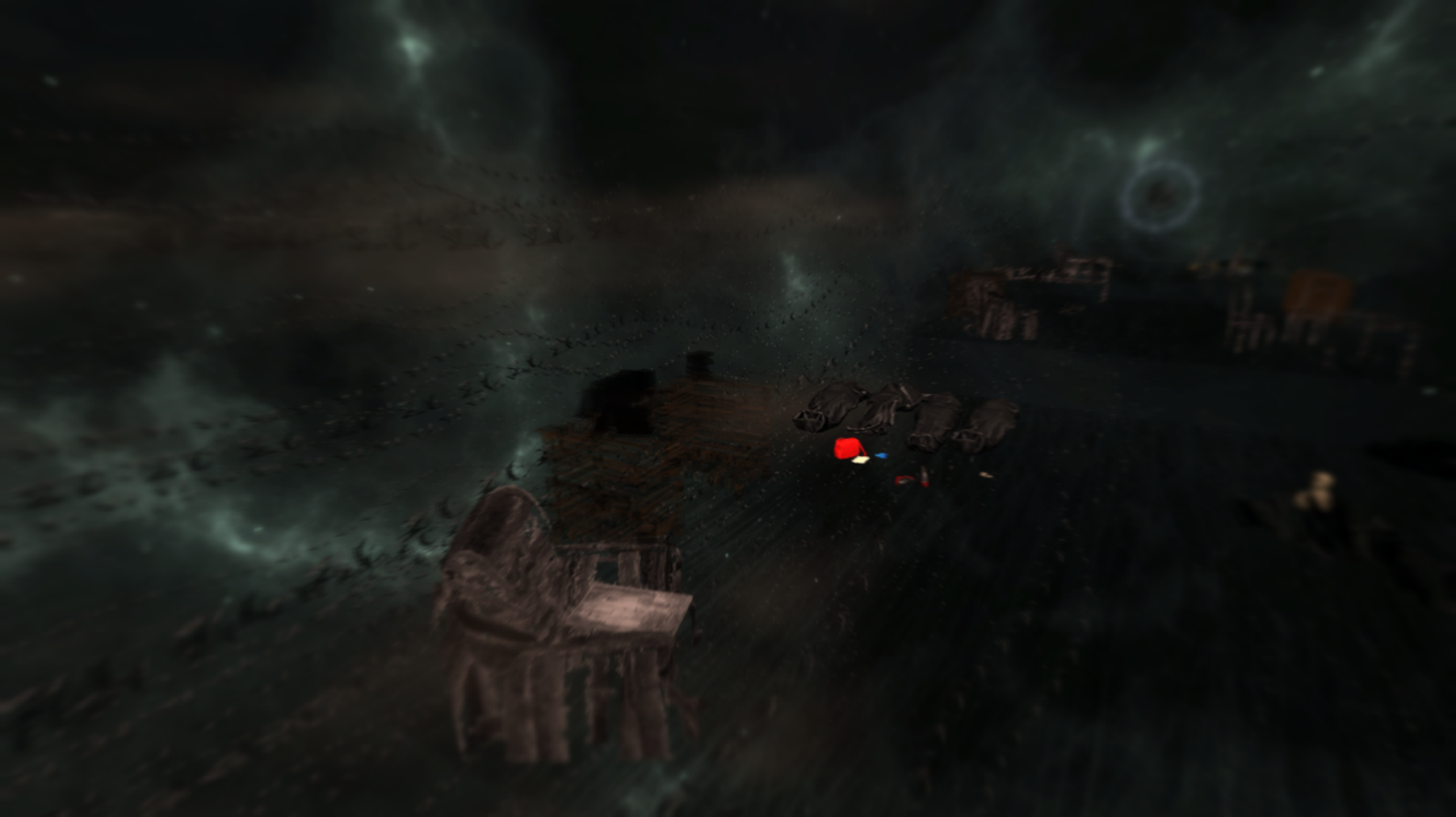
them[14]. All around the rest of the wormholes are visible at a distance. Each room represents a different lifetime event, a different reality and this is reflected by the way it is set up, the position and choice of objects which constitute symbols of important elements in our lives. The scene has mostly desaturated and greyish colours. In the rare occasions where more vibrant colours are used, it is usually for some reason, it signifies crucial concepts.

As time progresses, a dark spherical object (representing The End) slowly approaches the viewers. Ideally the users should be able to jump[15] to a different universe and change realities by blinking. This is meaningful at a conceptual level for two reasons. People may close their eyes when they want to avoid seeing something. In this case, it may be a reality they don't like, a reality that is annoying or painful. It denotes our wish that things were different. At the same time, even if we are experiencing a pleasant reality we cannot keep our eyes open indefinitely without blinking[16]. At some point visitors will blink and then they will be forced to jump to a different timeline. This amounts to the fact that life never turns out exactly as we would like it and that external (random) factors (events and people) affect out paths, it is a reminder of the futility of real life.

So when the visitors do blink the reality changes, they are transferred within a few seconds to a parallel universe, a different wormhole, where they encounter a new sequence of platforms/rooms and they continue their journey there. Otherwise, if they stay too long in a single reality and the dark sphere catches up with them, the scene fades into white and they are transferred to their final moment, the *Singularity*[17].

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[14] This can be imagined as a chain of train wagons, where viewer stand motionless and the wagons move towards them.

[15] An indirect reference to quantum leap or quantum jump.

[16] Unless you're Michael Caine: https://www.youtube.com/watch?v=ddUbsWnFVXM

[17] An indirect reference to the gravitational singularity, where density and gravity become infinite and space-time curves infinitely; here denoting the end of our lives.
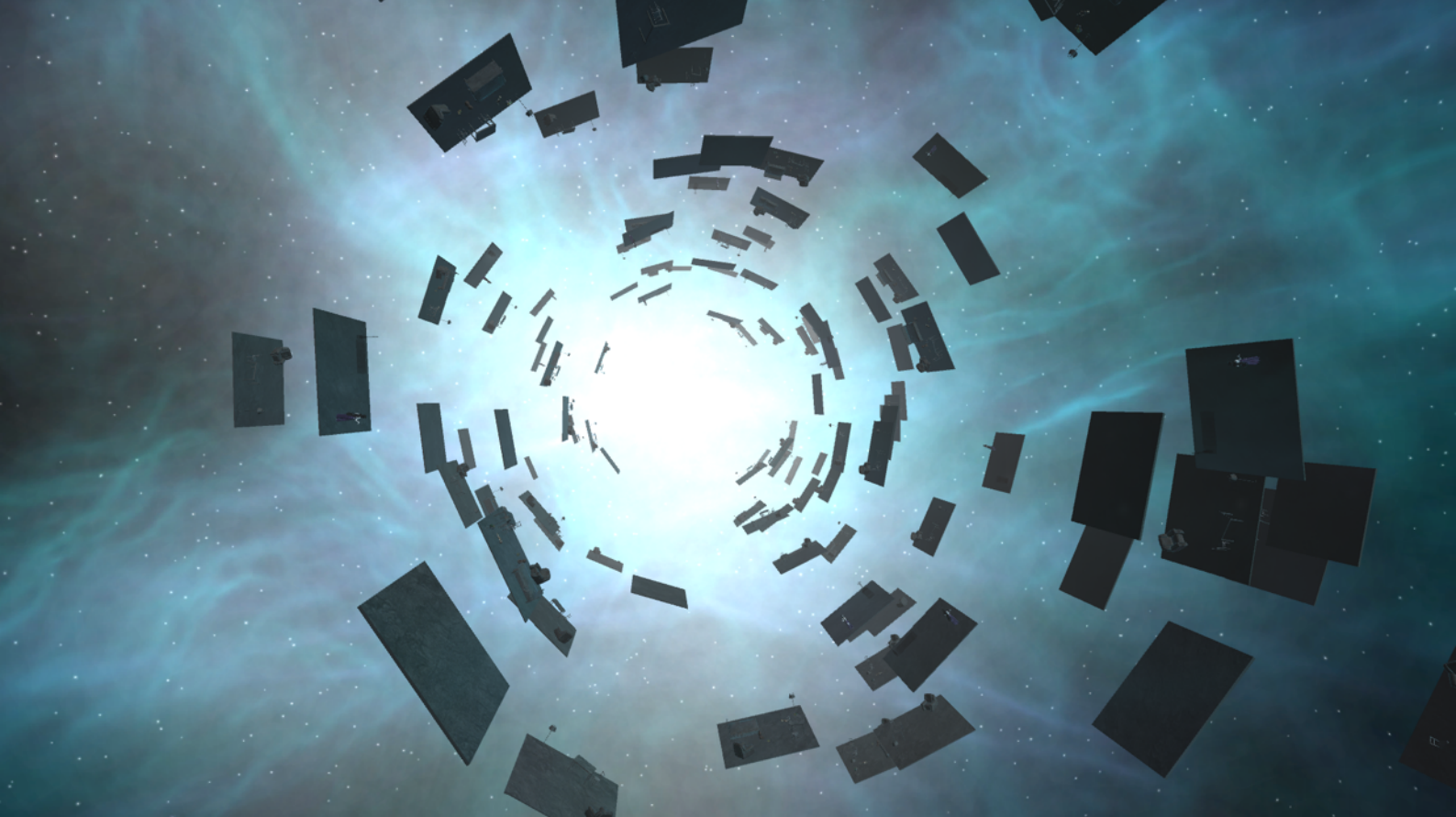
Scene 3 (Singularity)

 Visitors find themselves suspended in space, in the middle of rings of rotating platforms/rooms, the collapsed collection of memories, thoughts, dreams and wishes in one final moment. This scene signifies the end of our lives, the point at which we remember everything, the moment we regret everything and then we cease to exist. Yet, the scene fades to one final scene…

Scene 4 (The End?)

There are two alternatives envisioned for this scene. The one is just the empty space, full of stars. The other is a video projection, a close-up on a very-old person's hand, trembling and writing a giant 'X' on a blackboard (which may or may not have something written on it) then taking a sponge and erasing it.

In both cases, this scene denotes that life in general and the cosmos will continue to exist beyond our lives, the whole cycle will start all over again for some other being.

VISUALS AND AUDIO

As far as the visuals are concerned, this work aims at rendering mainly non-realistic depictions of imaginary places which are however reminiscent of specific situations with the use of symbolic objects. The aim is to create a certain atmosphere of anxiety and mild depression sometimes, through the use of a desaturated palette and of non-realistic (hand-drawn) textures in most cases. The initial scene is the only semi-realistic reference to the real world; the following scenes are almost surrealistic depictions of imaginary, impossible worlds.

In a similar fashion the sound should support and enhance the atmospheric and mysterious qualifiers of the scenes, with the exception perhaps of the initial scene which serves as a link to this world and therefore should contain more natural sounds. Ideally, aural feedback should be available for each different reality.

DESIGN & IMPLEMENTATION

To them, equipment failure is terrifying. To me, it's "Tuesday."

- Andy Weir,
"The Martian"
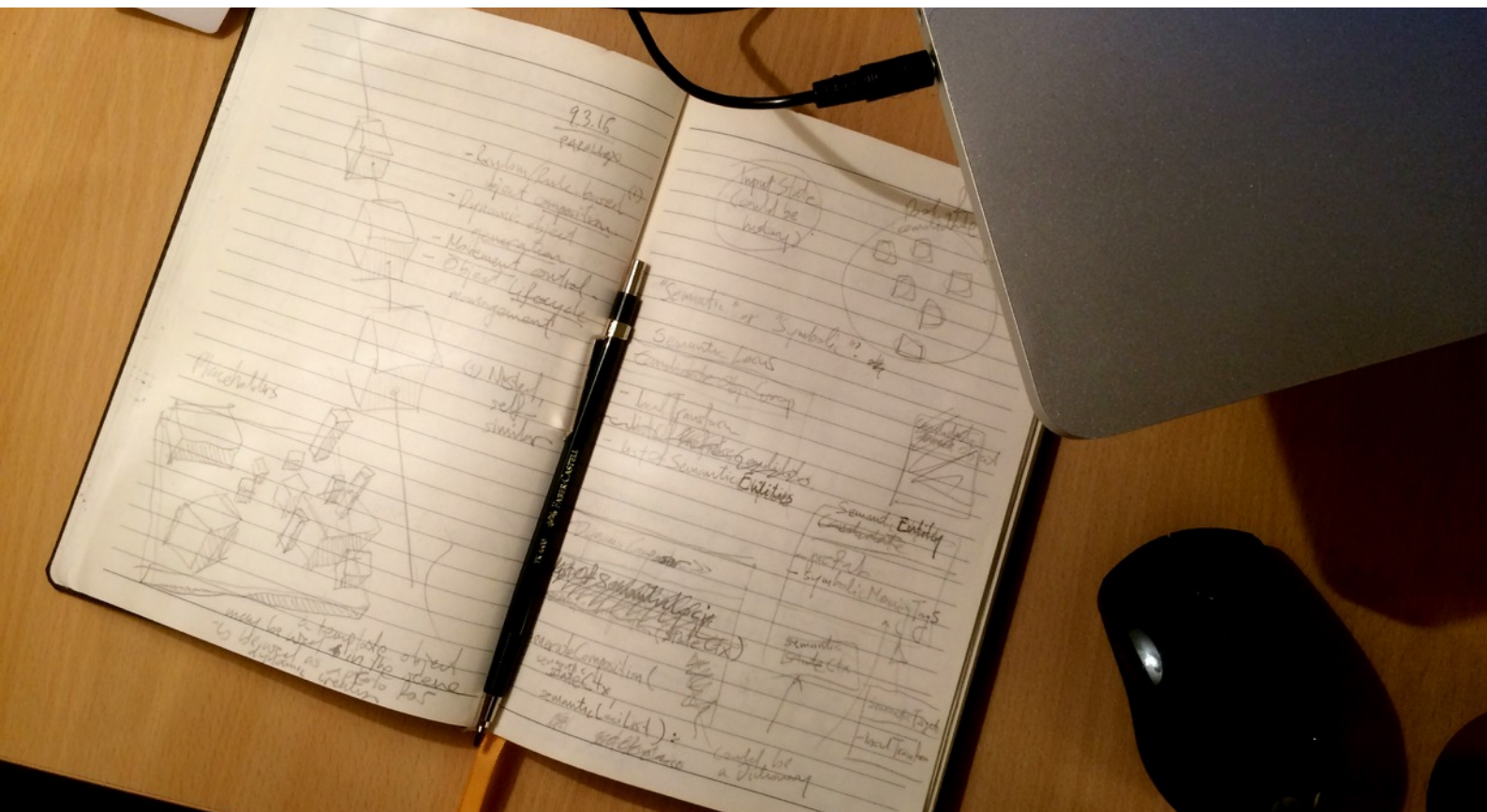
This chapter addresses the application requirements, design and implementation mainly from a software development point of view. The deployment of the system as an artistic installation is discussed as well.

REQUIREMENTS SPECIFICATION

Application Requirements

The work is envisioned as an interactive, immersive, dynamic virtual world where the users find themselves stranded in a 'problem-space' which they explore until multiple problem-solution sets spawn alternate paths/

threads of timelines. They are presented with alternative realities in the form of different environmental setups, they are given in this way a chance to discover themselves, face reality and attempt to come in terms with it, to attempt to alter reality by visiting parallel worlds. The existence of multiple universes in VR means that (unlike in real life) visitors believe they may get a second chance. Users will be offered the opportunity to jump across realities and explore various possibilities, experiencing different threads of events as they strive to face their problems or to encounter (more) pleasant situations.

The core of this project is the construction of virtual environments (landscapes/architecture/entities) which represent alternative realities. The visual representation will mostly be minimalistic, non-realistic and non-descriptive, with abstract representation of the key concepts (problems/solutions) and sporadic but precise use of symbols.

The main area of interest is that of a first person, interactive and immersive virtual-world audiovisual experience. The project intends to explore, and experiment with, procedural and dynamic object generation, limited rule-based systems and available technologies such as 3D game design (Unity 3D), stereoscopic vision (Oculus Rift) and motion sensing devices (Kinect).

In general, the user is floating (in space or an abstract void) and all movement should feel as such, like 'swimming' in nothingness. Stereoscopic HMD and headphones will be used for a completely immersive experience.

The original intention was for the player to switch between universes using hand gestures. Since however the alternate realities are related (in the point of view of this project) to a mental state (they exist in the mind, they are the dreams, thoughts and desires of the individual) utilisation of the user's eyes blinking seems preferable. If effect, visitors will able to switch between realities by closing and opening their eyes.

Installation and Presentation Requirements

As far as installation and presentation of the work is concerned, three options were investigated, an Oculus Rift based, a PC Computer Vision based and a Projection based. Note that depending on available presentation space and expected audience any of the three may be used. Some of them however are more effective in communicating the main concept than others.

Also note that since this work is not intended for mass (game-like) distribution, the requirement for a high performance (VR) platform is not considered a problem, since only one setup will be need each time the work is presented.

The specific hardware & presentation requirements are as follows:

Oculus Rift option

A VR capable workstation (PC), mouse, keyboard, a gamepad, Oculus Rift and headphones. Space requirements are medium, just a desk where the hardware will be placed and an area at most 4x4 meters where the visitor will stand. Lighting conditions do not matter.

Ideally, if HMD/eye-blink detection is possible, the following installation could be used to induce the feeling of floating to the users. A harness hanging by four elastic ropes will be used to secure the players in such a way so that they suspend a few centimetres above the floor. Inertia and the viewers' movements will ensure that there is always a slight motion of their body. As the HMD moves along with the players' body, the Oculus Rift tracker detects the displacement and translates it in the virtual world. In this way, the players' position and floating in the virtual world will correspond to that of the real world, thus enhancing the immersive experience.

Computer Vision option

A high-end gaming workstation (PC), >22'' display (preferably 27'') a mouse, keyboard, a gamepad, speakers and a Kinect 2. Space requirements are minimum, just a desk where the hardware will be placed and a chair for the visitor to sit. Low lighting is required.

Projection option

A high-end gaming workstation (PC), HD projector, a mouse, keyboard, a gamepad and speakers. A projection area of at least 3-4 m in width is required with at least 5-6 meters in depth (distance from projection area) with a stand where hardware will be placed. The room should be dark.

Visitor Involvement

After visitors have interacted with the system, they will be asked to give (if they wish, anonymously) a short interpretation of what they've seen, give a description of what they think the story was. Notebooks and pens will be available. The resulting text will be used as a form of documentation of the work, a collective interpretation as well as an anthology of short stories.

TECHNICAL RESEARCH AND CHALLENGES

Eye Blink Detection

Eye movement recognition is general in feasible and there is existing software and/or algorithms that may be used. The challenge in this case is combining a miniature camera with a Head Mounted Display.

In a custom solution, the first problem is how a camera will be placed in such a way that it will be able to detect the eye movement of the players without hindering their vision. The second problem is how well will this camera be able to perform (even if we assume that it is an IR one) within the dark environment and the close proximity of the HMD's eye-piece. If everything else fails, a non HDM solution can be used (i.e. webcam/Kinect based solution).

FOVE

With respect to eye movement detection, the FOVE VR headset[18] has come to our attention, which supports eye tracking:

FOVE combines a 2560x1440 VR display with precision eye-tracking and motion tracking, allowing users to fully explore 360-by-360-degree virtual worlds using both their head and eyes. FOVE projects your gaze into 3D space, enabling you to quickly and accurately communicate with and control the virtual environment like never before. With FOVE, eyes are used for enhanced input control, providing faster, more accurate, and more natural input than with traditional mouse, keyboard, or controller; which were developed primarily for interactions in 2 dimensions. (FOVE launch press release, May 6, 2015)

According to FOVE's production timeline, developer kits[19] were supposed to start shipping by Spring 2016 which did not happen.

SMI Eye Tracking

The *SMI Solutions* option was also considered, regarding the eye tracking solution[20] they provide for the Oculus Rift, but it was way too expensive[21] and it didn't seem like they could sponsor the project in some way.

SMI integrated eye tracking in the Oculus Rift DK 2 even works calibrationless allowing instant:
•Gaze triggered interaction
•Personalized calibration and 3D visualisation
•Fully immersive visual perception analysis

The SMI Eye Tracking Upgrade Package is available for already purchased Oculus Rift DK2, which you send to them and they modify it.

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[18] http://www.getfove.com/

[19] The stated retail price will range from $400-$500, Kickstarter supporters starting at $375 (May 2015)

[20] http://www.smivision.com/en/gaze-and-eye-tracking-systems/products/eye-tracking-oculus-rift.html

[21] €14,900 (January 2016)

Emotiv Insight

Next the utilisation of *Emotiv Insight* to detect eye blinking was examined. This could be worn together with a HMD. Emotive provides mobile EEG[22] solutions. *Epoc+* is their flagship product (14 channels) with *Insight* (5 channels) providing a more affordable solution[23]. They both support eye blink detection but the main problem is that the system requires a lengthy calibration (about 20 minutes) for every different user, which makes it prohibitive for exhibition purposes.

Webcam CV

Another alternative would be using webcam-based computer vision (*OpenCV*[24] was considered and there is also a port of it available in the Unity's Asset Store[25]) eye-blink detection. There are well known algorithms but these solutions have similar problems with *Emotiv's* products, they need to be trained based on sample input (usually open/closed eye images).

Kinect 2

Finally *Kinect 2* came to our attention with its face recognition approach. Assuming that *Oculus Rift* is not used, this seems like the most plausible solution. Using the *Kinect for Windows v2 SDK*, the improved Face API among other things detects wherever the left or right eye is open or closed. *Vangos Pterneas* of *LightBuzz Software* (creators of the *Vitruvius*[26] Kinect avateering system) has a helpful entry in his blog on how to used Kinect v2 Face Basics[27].

With that information at hand, a library could be written in C# to provide the necessary functionality and interfaces to Unity projects. Unfortunately this information was acquired late in the project and in was not included in the initial release of Parallax, it is planned for future versions.

Timeline Wormholes

The time-space threads which the player uses to travel between different alternate realities are envisioned as a great number of wormhole-like flexible tunnels. They have been implemented in Unity by procedurally generating tubes whose ring vertices are then transposed over time using a sine-based function, resulting in a wave-like movement.

Regarding the visualisation of the time-thread tunnels, two approaches were considered. The one involved the utilisation of animated textures on the walls of the tube. The other involved particle effects emitted from the tube surface or line renderers. The tunnels will be dynamically and randomly generated in both cases. Tests were conducted for both scenarios, but the results with the animated textures were more satisfactory. Instead of having the visitor moving through a very long tunnel (that would require very long objects and/or more complicated dynamic generation of tunnel components) the texture of the material is animated (shifted towards the direction of the player) to give the sense of motion. There has been experimentation with various third-party textures but custom ones were made for the final release. A global fog effect has been used to hide the end of the tunnels and imply infinity.

Another area of experimentation has been that of the placement of the alternate realities platforms of events. The ideas under consideration included the platforms flying through the time-space threads, being placed at the end of such a tunnel (fade out/in) or being placed at the walls of the end of the tunnel[28]. In the end the former alternative was implemented. For the support of the dynamic procedural behaviour of these features, custom libraries have been written.

Initially the rooms/platforms representing alternate realities were intended to be explorable, i.e. traversed by the users, implying that the Oculus tracker would be used to track them while walking around (it could be arranged so that the presentation room had the dimensions of the Oculus tracker's scan box). In that case though, that contradicted the initial intention of the viewer feeling unable to control events. It would also not be compatible if the exhibition idea of having the visitors suspended with elastic ropes was to be implemented.

The system logic

Ideally a decision tree (with rules and random variables) should be used to control the generation and progression of valid alternate realities and the way a prior combination of factors in a given reality affects the subsequent ones. Given that an infinite number of parallel universes would allow any possible combination this sounds contradicting.

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[28] This layout was finally used in the Singularity scene.

But it would mainly be done for 'aesthetic' purposes, especially to avoid repeating patterns appearing one immediately after another.

The most important reason for having a rule based system however would be to have the rooms in each wormhole represent a different milestone in life (see the table bellow) along with the corresponding characteristics. In this way each wormhole represents a different lifetime, and jumping between them would allow the visitors to experience the alternate realities, the alternate lives, from beginning to end.

The following table presents samples of possible milestones/characteristics/symbols:

The Milestones	The Characteristics	The Symbols
Birth	Health	Flowers - medicines
Childhood	Love	Type of food
Young adult	Social stability, peace	Two glasses - one glass
Professional life	Content (academic/professional/ etc)	Double bed - single bed - grave (in place of the bed)
Marriage/family		
Middle Age	Wealth	Passport
Old age		Children's toys - Weapons
Death		Blood
		and more

On a technical level, one idea would be to integrate in *Unity tuProlog* as the rule engine for which the semantic composition rules would be written. *tuProlog* is

> … a light-weight Prolog system for distributed applications and infrastructures, intentionally designed around a minimal core, to be later configured by (statically and dynamically) loading/unloading libraries of predicates. tuProlog natively supports multi-paradigm programming, providing a clean, seamless integration model between Prolog and mainstream object-oriented languages -- namely Java, for tuProlog Java version, and any .NET-based language (C#, F#..), for tuProlog .NET version. (http://apice.unibo.it/xwiki/bin/view/Tuprolog/)

Due to prior work and familiarisation with *tuProlog*, it is considered that it would be easy to write the necessary *Unity* scripts that would use that inference engine in the decision making of the semantic compositions of the rooms. Since the computational requirements for the semantic compositions are not demanding, it is deemed that the interpretational nature of Prolog would not cause any performance issues. In addition, by externalising the logic in separate facts and rules files, it would be easier to experiment and make alterations to the logic of the system.

APPLICATION DESIGN

Overall Structure

The application has two main parts: the static scenes (mainly the introductory semi-realistic *Park* scene but also the simple *End* scene) and the dynamic scenes (the timeline *Wormholes* and the rotating *Singularity*).

Procedural Structures

The dynamic scenes mainly contain scene/game management objects and empty containers with attached code for the dynamic, procedurally created objects. Custom code has been written for dynamically generating each wormhole as well as the swarm of wormholes visible in that scene. All the procedural structures may be extensively configured via public parameters exposed on the Inspector.

Wormhole

Each wormhole is modelled as a long tube whose radial segments vertices are continuously transposed by geometric functions, thus creating the effect of continuous worm-like animation of the tube (`DtWormhole.cs`). To create the illusion of movement within a wormhole, instead of moving the *Player* object within the tube, the tube's texture is animated, i.e. scrolled towards the direction of the viewer. In this way we can avoid having very long and 'heavy' objects but we also simplify the management of such components (for example the size that would be required depending on how long the visitor stayed in that scene and so on). A custom Shader is also used so that both sides of the tube may be rendered (`DoubleSidedTransparentCutout.shader`).

The floating *room platforms* (see the *Semantic Compositions* below) that move towards the viewer are also dynamically generated by a custom *SpawnEngine* (`DtSpawnAndDispatch.cs`) and moved using the third-party *iTween*[29] component. The behaviour of the *SpawnEngine* can be parameterised through the *Inspector*; thus the number of active room platform instances at any time and their life-cycle can be controlled.

In order for the wormholes to give the illusion that they extend both ways towards infinity, two `DtWormhole.cs` components ate joined back-to-back forming double-ended wormhole objects (`DtDoubleEndWormhole.cs`).
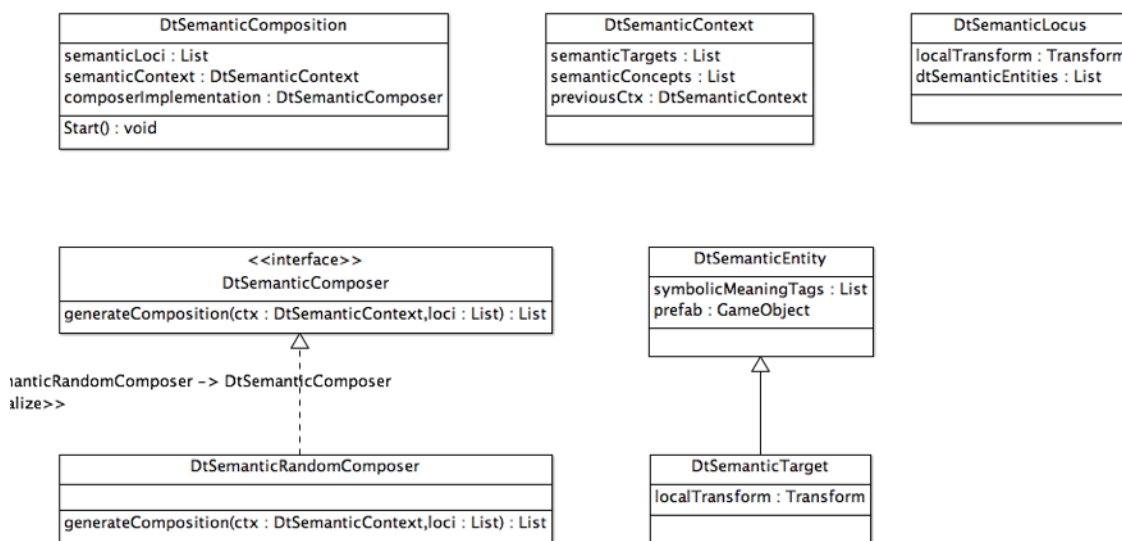
Swarm of Wormholes

The group of wormholes (*WormholesRing*) present in the scene is also dynamically generated at random positions (on the circumference as well as at random distances from the centre) along a ring (`DtAutoCreateRing.cs`).

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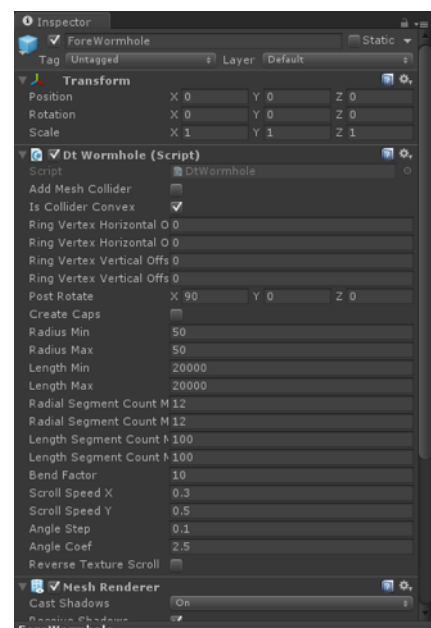
[29] iTween is a simple, powerful and easy to use C# animation system for Unity, created by Bob Berkebile (itween.pixelplacement.com)

Semantic Compositions

This subsystem is responsible for the conceptual core of the project. *Room platforms* are dynamically composed by instantiating *prefabs* selected among a set of all possible objects that may be used and placing them at specific *room* positions. The current implementation is bound to Unity constructs but it could be converted to be platform-agnostic.

DtSemanticComposition
semanticLoci : List semanticContext : DtSemanticContext composerImplementation : DtSemanticComposer
Start() : void

DtSemanticContext
semanticTargets : List semanticConcepts : List previousCtx : DtSemanticContext

DtSemanticLocus
localTransform : Transform dtSemanticEntities : List

<<interface>> DtSemanticComposer
generateComposition(ctx : DtSemanticContext,loci : List) : List

anticRandomComposer -> DtSemanticComposer
alize>>

DtSemanticRandomComposer
generateComposition(ctx : DtSemanticContext,loci : List) : List

DtSemanticEntity
symbolicMeaningTags : List prefab : GameObject

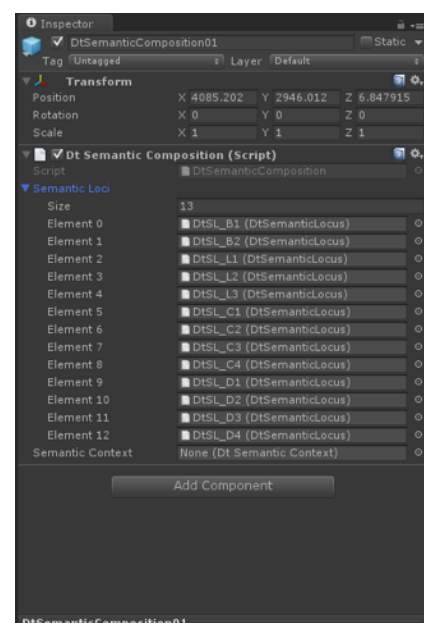| DtSemanticTarget |
|---|
| localTransform : Transform |
| |

DtSemanticComposition

Each composition consists of a list of locations with the corresponding entities (`semanticLoci`) on the room platform where objects generated by the `composerImplementation` (`DtSemanticComposer.cs`) are placed, taking into account the current semanticContext (`DtSemanticContext.cs`).

DtSemanticLocus

A semantic locus represents a position on the platform room (currently a Unity `Transform`) together with a list of semantic Entities (see below).

DtSemanticEntity

A semantic entity stands for the object to be created (Unity prefab) and a list of *symbolicMeaningTags*, meanings associated with the specific entity. The *symbolicMeaningTags* are meant to be used by the *DtSemanticComposer* implementation in intelligently setting up the scene.
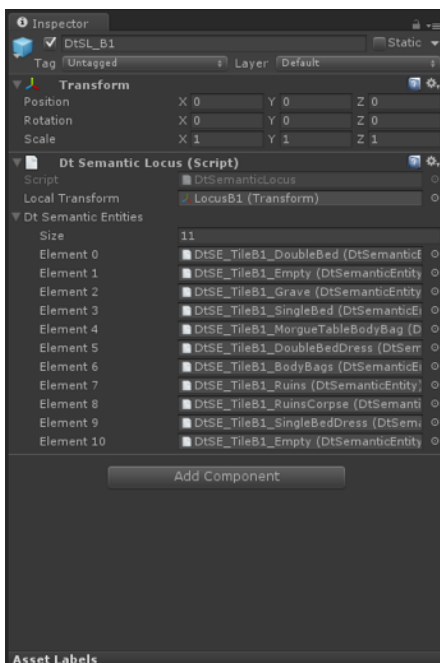
DtSemanticTarget

The semantic target is an extension of a semantic entity to include its specific position (Unity `Transform`) on the room platform. Semantic targets represent entities instantiated at specific positions and are used by the semantic *Context* and *Composer* (see below)

DtSemanticContext

Holds the list of current *Semantic Targets*, a list of *Symbolic Strings* pertinent to this session and a reference to the previous *Semantic Context*. The *Symbolic Strings* are used to 'describe' the current situation, give 'meaning' to the current reality. So for example they could signify sickness or health, poverty, war, peace, love and so on.

An instance of this object is passed between *Semantic Compositions* and can be used by the *Semantic Composer* in order to make meaningful decisions regarding the platform rooms to be instantiated[30].

DtSemanticComposer

The architecture allows for pluggable implementations of `DtSemanticComposer` objects, implementations that determine how the scenes will be composed. By default, random prefabs are selected[31] (`DtSemanticRandomComposer`) but in the final release a rule-based algorithm may be used to make intelligent selections. Please note that since according to parallel worlds theories any possible (random) combination may exist, the use of a rule-based system should only be limited in tweaking the generated scenes just for the sake of the artistic visual result (for example avoid repeating the same major objects in consecutive scenes) or in the case life milestone representation per room.

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[30] Intended for future implementations since the initial release only supports semi-random compositions.

[31] As a matter of fact, per-locus compositions are not random, a collection of objects has been combined for each locus providing different 'meaningful' alternatives, so for example, a table with a bottle and a single glass may signify a lonely person whereas a bottle with two glasses hints to companion.

The Spawn Engine

`DtSpawnAndDispatch.cs` is responsible for instantiating new *Semantic Compositions* and feeding them with the current *Semantic Context* at pre-defined intervals, moving (using *iTween*) towards the viewer at a given speed. All parameters are configurable via the *Inspector*. A *Spawn Engine* is bound to the current *Reality Wormhole*.
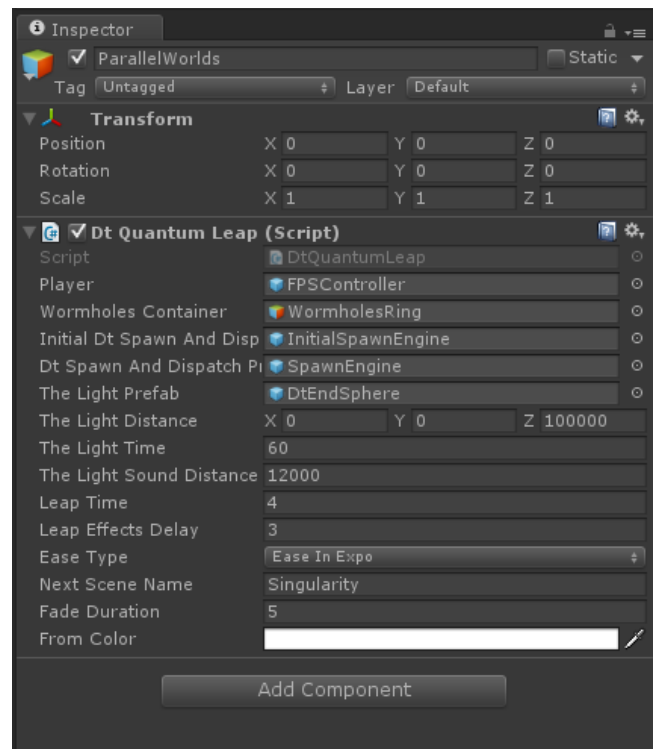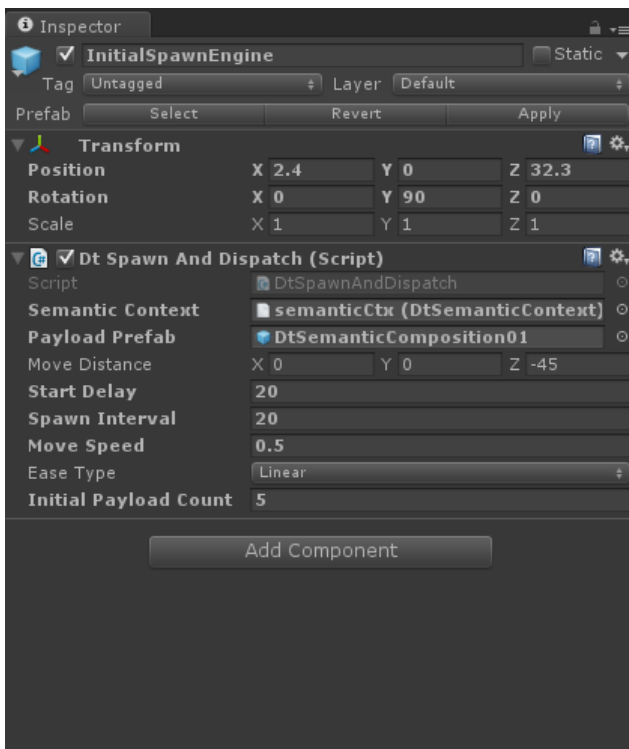
The Quantum Leap

`DtQuantumLeap.cs` implements the jump-between-realities functionality. The viewer is transferred to a different random *Reality Wormhole* where a new *Spawn Engine* is instantiated and the one at the previous *Wormhole* destroyed. The *End Sphere* (an object slowly approaching the user and which upon impact terminates the scene) is also managed by this component.

Assets

The objects used in this project (with the notable exception of all the dynamic procedural components which are custom) were acquired in their vast majority either through the Unity Asset Store or via other third-party free sources[32]. Many of them were modified and in most of them custom materials were used.

Lighting and Visual Effects

In the introductory Park scene apart from a low ambient light, the rest of the lighting comes from the point lights that have been attached to all park lamps. The rest of the scenes simply have ambient and directional lights. I experimented in using spotlights it order to highlight some of the dynamically-placed objects in the Wormhole scene but there wasn't any real added value in the visual result, especially since the textures have that drawing strokes effect.

Volumetric fog[33] has been used in the first two scenes. In Wormholes, among others, a camera glitch effect[34] has been used when jumping between realities.

Audio

The ambient audio used in the Wormholes was composed in *Audition*. For initial noise generation *Audacity* was used. The sound played when the dark sphere moving towards the viewer get close is actually a processed death metal growl. The rest of the sounds (effects, ambient sounds of the introductory scene and so on) were downloaded from freesound.org and were further processed in *Audition*.

Custom Textures

For most of the objects, custom textures were created. The idea was to draw abstract surfaces with manneristic qualities, then process them in the computer. Charcoal and pencils were used as well as the *Procreate*[35] iPad painting app together with *FiftyThree*[36] stylus. The later combination was used because it simplifies the image processing since in *Procreate* natural media could be simulated over a transparent background.

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[32] 123dap, archive3d, artists3d, baument, zygote.

[33] FogVolume (by David Miranda via the Unity Asset Store)

[34] Camera Filter Pack (by Vetasoft, via the Unity Asset Store)

[35] http://procreate.si

[36] https://www.fiftythree.com

CONCLUSION AND THE FUTURE

I'll make all your dreams come to life,
then slay them as quickly as they came.

- Lamb of God,
"Laid to Rest"

Working with virtual reality technologies during the past few years has offered me the opportunity to grasp the important aspects of it and to experiment in applying it into art projects. While sceptical at the beginning due to my previous computer science background (and feeling the need to break away from it) I did however realise in the end that (for me at least) computer science can also be an artistic media as well, at an equal standing as oil colours, charcoal, clay and all other media I have used in the past.

With that in mind and feeling confident about the potential of virtual reality, this time more attention was given to the conceptual part of the work and how the setup of the scenes, the immersion, the whole user experience,

conveyed the intended meaning. In that respect I believe that while not being 100% complete yet as far as the implementation is concerned, this work succeeded in being 'atmospheric' the way is was intended to be and I believe that it certainly puts the viewer into a certain mood. Hopefully the visitors will feel the same way as well.

On the technological part, this project was a great opportunity to further investigate related technologies and expand my cognitive field, especially in the area of eye detection techniques but also in quantum physics and cosmology (even at a rather encyclopaedic level).

CURRENT APPLICATION STATUS

Due to time restrictions, technological or economic shortcomings and perhaps due to having set rather ambitious objectives, many of the desired features have not made it into the initial release, however most of them have been researched. The most important areas are the following:

Eye Blinking Control

As mentioned earlier the initial approach of integrating an eye detection system with a head-mounted display has been abandoned due to the high cost or non-availability of commercial solutions (*SMI* and *Fove*). Custom implementations were also deemed not feasible, especially with respect to a web-cam based solution. Apart from the fact that it negates the benefits of having a head-mounted display, it 'ties' the viewer in from of a workstation but most importantly, the existing algorithms require training based on sample input. It is for this reason that the *Emotive's Epoc* option was also rejected since it requires calibration before each different visitor may used it.

The latest and most promising attempt relied on the Kinect 2 which already supports detection of facial features including open and close eyes. However, since this technology came into my knowledge in the latest stages of the project, there was no time to include it. For that reason, simple input controls using game controllers or a mouse are currently used for jumping between timeline wormholes in conjunction with the *Oculus Rift* for stereoscopic vision.

Semantic AI

Although the infrastructure is in place, this release incorporates a default implementation of the *DtSemanticComposer* that makes random compositions using the available prefabs.

Sound Design

Probably the weakest part of the system right now is the audio. The voice recordings of the introductory scene are missing. The ambient sound of the Wormholes scene could be improved, perhaps provide a bit more variation. Also having sounds as symbols or associating them with visual symbols has not been attempted yet. Finally the Singularity scene has no sound at all.

EVOLUTION AND FUTURE PLANS

It is my intention to continue and extend this project beyond the scope of the associated masters programme, to meet to the fullest the goals originally envisioned. There are already plans for presenting this work in the summer of 2016 at an exhibition at Kythera, Greece.

The immediate plans for the next release include implementing a more complex recursive object composition algorithm, utilising a simple rule-based system build around *tuProlog*, more prefabs to choose from for the compositions and a greater variety of custom textures. Additionally, the voices specified for the first scene will be included.

Beyond that, the eye-blink detection is an important next step, closely associated with the conceptual aspect of the project. Processing and presentation of conclusions based on visitor feedback is also desirable.

A final step would be to incorporate more animated elements in the scenes, especially in replacing the dark sphere of the Wormholes scene with dark organic figures which gradually surround and overwhelm the visitor.
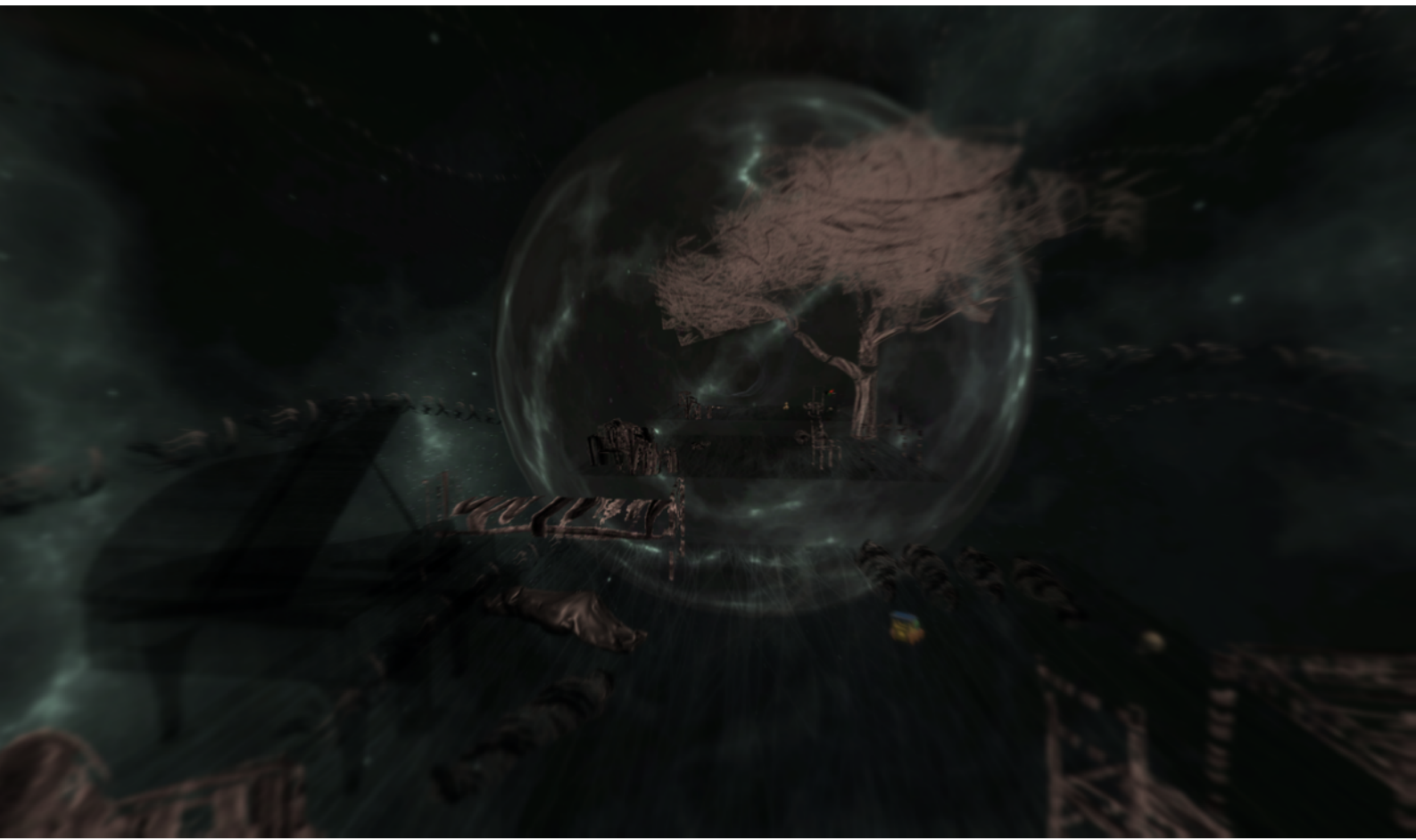
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Video Games

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Mémoire de Master 2, 2015-2016   44

APPENDIX A: VIDEOGAME DESCRIPTIONS

Dejobaan Games, LLC, Popcannibal. (2014). *Elegy for a Dead World* [Video game]. Dejobaan Games, LLC.

> *'In Elegy, you'll travel to three worlds and write stories about their long-dead societies. You'll lose yourself in settings inspired by the works of poets Keats, Byron, and Shelley, and use the game's system of writing prompts to help create your own masterpieces.' (Steam)*

Limasse Five. (2014). *NaissanceE* [Video Game]. Limasse Five.

> *'The adventure takes place in a primitive mysterious structure and the game mainly consists to explore and feel the deep and strong ambiance of this atemporal world but platforming and puzzles areas will also enrich the experience.' (Steam)*

Eyebrow Interactive. (2012). *Closure.* [Video Game]. Eyebrow Interactive.

> *'In the dark and mysterious world of Closure, only what you see exists. Manipulate lights to phase objects in and out of reality in this multiple-award-winning puzzle game. Play as a strange spider-like demon who explores the stories of three human characters through beautiful, eerie environments such as a decrepit factory, a murky forest, an abandoned carnival, and the strange, surreal realm that connects them together.' (Steam)*

Infinitap Games. (2014). *Neverending Nightmares.* [Video Game]. Infinitap Games.

> *'Neverending Nightmares is a psychological horror game inspired by the developer's actual battle with mental illness. In the game, you take on the role of Thomas who awakens from a terrible nightmare only to find that he is still dreaming. As he descends deeper through the layers of hellish dreamscapes, he must hide from horrifying apparitions and outrun his inner demons. He must discover which of the horrors he encounters are a manifestation of his own psychological state and figure out what reality will be when he finally wakes up.' (Steam)*

Ice-pick Lodge. (2009). *The Void.* [Video Game]. ND Games, bitComposer Games.

> *'When one gives up living and using his soul, he can't only lose the soul but can also devote it to death… Before souls completely die they stick in The Void – an odd space between life and death. There is an outside chance to survive in The Void and even to come back from it.' (Steam)*

Eric Provan - Ayyo Games. (2014). *Spate.* [Video Game]. Ayyo Games.

> *'Spate is a surreal experience set in a world that seeks to draw the player into its reality. Spate is a dark, brooding, and beautifully crafted emotional journey that is seen through the eyes of a struggling addict. Created by former Disney & Jim Henson artist Eric Provan, this artistic game is a story about one man's struggle and descent into madness. Fuelled by absinthe hallucinations and haunting memories, Spate delivers a deliciously eerie adventure as the main character deals with the tragic loss and grim reality of the death of his daughter.' (Steam)*

Playdead. (2011). *Limbo.* [Video Game]. Playdead.

> *'Limbo is a 2D sidescroller, incorporating the physics system Box2D to govern environmental objects and the player character. The player guides an unnamed boy through dangerous environments and traps as he searches for his sister. The developer built the game's puzzles expecting the player to fail before finding the correct solution. Playdead called the style of play "trial and death", and used gruesome imagery for the boy's deaths to steer the player from unworkable solutions. The game is presented in black-and-white tones, using lighting, film*

grain effects and minimal ambient sounds to create an eerie atmosphere often associated with the horror genre.' (Wikipedia)

DONTNOD Entertainment. (2013). *Remember Me.* [Video Game]. Capcom.
'Neo-Paris. 2084. Personal memories can now be digitised, bought, sold and traded. The last remnants of privacy and intimacy have been swept away in what appears to be a logical progression of the explosive growth of social networks at the beginning of the 21st century. The citizens themselves have accepted this surveillance society in exchange for the comfort only smart technology can provide. This memory economy gives immense power over society to just a handful of people.' (Steam)