An Investigation of the Digital Sublime in Video Game Production

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Abstract

This research project examines how video games can be programmed to generate the sense of the digital sublime. The digital sublime is a term proposed by this research to describe experiences where the combination of code and art produces games that appear boundless and autonomous. The definition of this term is arrived at by building on various texts and literature such as the work of Kant, Deleuze and Wark and on video games such as *Proteus*, *Minecraft* and *Love*. The research is based on the investigative practice of my work as an artist-programmer and demonstrates how games can be produced to encourage digitally sublime scenarios. In the three games developed for this thesis I employ computer code as an artistic medium, to generate games that explore permutational complexity and present experiences that walk the margins between confusion and control.

The structure of this thesis begins with a reading of the Kantian sublime, which I introduce as the foundation for my definition of the digital sublime. I then combine this reading with elements of contemporary philosophy and computational theory to establish a definition applicable to the medium of digital games. This definition is used to guide my art practice in the development of three games that examine different aspects of the digital sublime such as autonomy, abstraction, complexity and permutation. The production of these games is at the core of my research methodology and their development and analysis is used to produce contributions in the following areas.

1. New models for artist-led game design. This includes methods that re-contextualise existing aesthetic forms such as futurism, synaesthesia and romantic landscape through game design and coding. It also presents techniques that merge visuals and mechanics into a format developed for artistic and philosophical enquiry.

2. The development of new procedural and generative techniques in the programming of video games. This includes the implementation of a real-time marching cubes algorithm that generates fractal noise filtered terrain. It also includes a versatile three-dimensional space packing architectural construction algorithm.

3. A new reading of the digital sublime. This reading draws from the Kantian sublime and the writings of Deleuze, Wark and De Landa in order to present an understanding of the digital sublime specific to the domain of art practice within video games.

These contributions are evidenced in the writing of this thesis and in the construction of the associated portfolio of games.

Acknowlegements

I must first thank Professor Steve Swindells for his attentive supervision, mentorship and insights, helping me overcome the various issues that inevitably punctuate any long-term research. I have benefited greatly from his open mind, artistic sensibility and academic rigour. I must also thank both Derek Hales and Professor Monty Adkins, my co-supervisors, both of who provided me with many hours of valuable discussion and argument. They both supplied an ongoing stream of encouragement and literary resources which helped to keep the research process fresh and relevant.

I must also thank my peers from the world of game design, discussions with Ed Key, Jim Rossignol, David Kanaga and Professor Dan Pinchbeck have helped me to verbalise aspects of game design and philosophy that would have been impossible otherwise. In addition I would like to thank the wider independent game community for events such as Wild Rumpus (27th Sept 2014, San Franciso), Indievelopment (25th April 2013, Amsterdam) and Game City (18th October 2013, Nottingham). These occasions provided me with the opportunity to engage with gamers and designers in playful and thought-provoking surroundings.

Both Jonathan Pilcher and Noel Murphy deserve special recognition for the music they contributed to the games and their willingness to work within the odd constraints I set them.

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1. Introduction

1.1 Personal Rationale

This research is an artistic investigation of the digital sublime in video games. It uses concepts from literature (Kant, 1951; De Landa, 2011; Deleuze & Guattari, 2004) and games (Key & Kanaga, 2013; Steenberg, 2010a; Persson, 2009) to create a definition of the digital sublime and then explores this definition through the artistic production of three video game projects. This research is an auto-ethnographic activity, based on self-observation and reflexive investigation (Maréchal, 2010). It does not attempt to provide philosophical proof of the digital sublime, rather it presents new concepts and methods to developers and artists in order to extend the creative palette of game design through the consideration of code as an artistic and philosophical medium. The conclusion of this research shows that although the existing barriers within game design and game culture can make the communication of philosophical concepts difficult, using code and video games as a medium for such concepts has enormous potential for both designers and artists.

The research operates from the perspective of an established art practitioner and experienced programmer, and the lines of enquiry I am pursuing reflect this cross-disciplinary position. The hybrid form of artist-programmer practice is a growing field (C. A. McLean, 2011) and the results of this thesis will aid other artists and designers working in this cross-disciplinary zone. This aid will be presented in the form of new design methods, new programming techniques and software demonstrations.

As an artist-programmer[1], code is my creative medium, and although my work is often formal and computational its aim is to create artistic experiences rather than engineering solutions. It is important to note that this thesis is not driven by player feedback or industry requirements. Instead this research is focused on the development of digital games as an artistic medium and seeks to develop new and innovative creative coding techniques. I have already established a significant reputation in these areas[2] and my work has been reviewed in multiple publications (Greene, 2004;

1 An artist-programmer is someone who creates art through the medium of computer code; see section 4 for a more detailed discussion of this term.

2 See Appendix D for a list of relevant exhibitions, performances and presentations.

Bittanti & Quaranta, 2009; Reas, 2010).

My practice has always focused on procedural[3] and generative[4] processes (Angelides, 2013). These processes are built around algorithmic techniques that generate digital forms using mathematical functions (see section 4 for more detail). The results of my work have always reflected qualities that could be considered sublime, particularly when presenting digital art work where the virtual forms become too complex or abstract to be properly understood. This research presents me with the opportunity to investigate these scenarios and examine what the digital sublime might mean in the context of my practice. The resulting definition of the digital sublime can then be used to guide the development of video games designed to engage with this phenomenon.

I use algorithms to create abstract, escapist game-worlds, audiovisual spaces and generative art. My criteria for success in these creations is measured by the degree to which they lead me into a state of sublime immersion. To me this sensation is the most desirable element of digital games, it makes the experience transcend the normal logical interactions of play. This experience is something that I try to demonstrate in my work and the starting point for my investigation of the digital sublime. It could even be argued that by being an artist-programmer I am operating implicitly within the digital sublime, it is the immersive digital space I inhabit while coding, thinking and playing. In my work I frequently experience seductive sensations that could be attributed to the sublime; states of immersion, transfixion, dizziness or confusion. However, I have never analysed these phenomena in a critical or philosophical manner. Why are these sensations desirable? How are they engendered? And what techniques can encourage them? This research is the opportunity to address these questions and provide insight into the creative process of game design when it is undertaken for the purpose of artistic enquiry. It also enables me to contribute my experience and findings to a broader group of practitioners and researchers. With this in mind, this research will identify, analyse and develop elements of my practice with the goal of furthering the understanding of the digital sublime in my own work and in the field of digital games.

1.2 Thesis Structure

This document is structured into in nine sections which follow the chronological path of my research. My practice work is generally produced in a modular and formal structure, and the

3 Procedural programming involves producing complex content from mathematical functions. It is broadly similar to generative approaches but involves less focus on evolution or random emergence.

4 Generative programming (or art) is an approach to coding where the computer systems are designed to produce a range of formal results that can vary and evolve over time, based on mathematical equations and elements of randomness.

organisation of my research reflects this approach. The diagram below illustrates how the sections of this thesis are arranged.

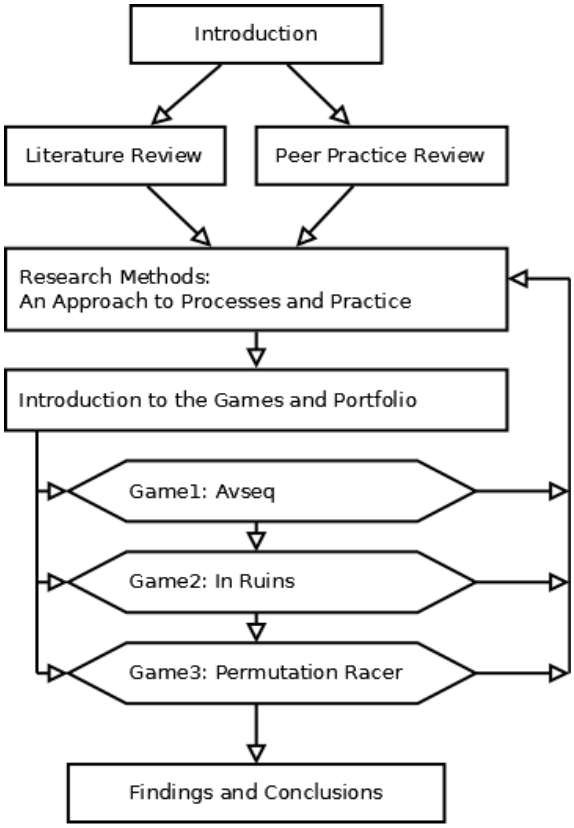


Figure 1.1: Thesis structure

The *Introduction* (1) outlines the context for the research, its aims and objectives and a brief description of the project stages. The *Literature Review* (2) defines a number of precedents and conceptual frameworks that will underpin the work by examining literature. The *Peer Practice Review* (3) examines a number of contemporary digital games in order to identify current practices and techniques. These first two sections provide a definition of the digital sublime in the context of game design. *Research Methods: An Approach to Processes and Practice* (4) describes the development of methods designed to address the research question from the perspective of an individual art practice. The following section *Introduction to the Games and Portfolio* (5) outlines the collective goals of the research games and the associated portfolio. Sections 6, 7and 8 then describe each game in detail, examining the design, production and outcome of each project. Finally *Findings and Conclusions* (9) provides a summary of my results and conclusions.

In addition to the main structure of the thesis there is also a detailed appendix, which provides extra documentation on the games developed and expands on the topics discussed in the main text. A digital portfolio is also included, comprising three research games and additional supporting media. This portfolio includes examples of the prototyping processes, variations of design, recorded user feedback, associated papers and presentations, and publicity documents.

The thesis uses terminology that refers to specific areas of game design or programming that may be outside the experience of the reader. For this reason there is a glossary provided at the end of the thesis. Whenever a term that appears in the glossary is first used it is accompanied with an initial footnote giving the glossary definition. From that point on the term will be not be footnoted and the glossary can be referred to.

The three research games are examined in chronological order, and the results from one are used to inform the development of the next. This sequence of development is important and key concepts are re-examined and refined throughout the series, each game offering a different perspective on the subject of the digital sublime. In keeping with this idea of multiple avenues of enquiry, readers are encouraged to refer to portfolio and appendix material alongside the main text. Just as my practice work explores concepts through permutation and recursion the writing in this document will often return to key concepts and quotes in order to identify connections with the different areas of my practice. This reflects my approach of finding answers through confluence and agglutination rather than developing singular statements of proof.

It is important to note that the while the writing component of this thesis is designed to follow the formal framework described above, the practice component operates in a more rhizomatic and experimental manner. This represents a deliberate separation of the two strands of investigation. Earlier drafts of the thesis incorporated a writing style that was more experimental and non-linear, but this approach proved problematic as it eroded the critical distance that a formal thesis structure provides. Maintaining a reflective distance between practice and writing is important in this research in order to to provide clarity and perspective on an investigation that could otherwise become too nebulous. The formal structure of the writing allows the research to objectively observe and analyse a paradigm that the practice is fully immersed in. The observation of a critical distance also mirrors the post production evaluation that occurs within the practice component of the research (see section 4). In addition, by utilising both interactive practice and formal text the contributions of the research can be disseminated via two different channels of communication to

reach a broader audience.

1.3 Cultural Context

Digital games are still a young medium, yet in the last few decades they have invaded the media landscape, increasing in cultural and economic significance (Herz, 1997; Poole, 2001; Dyer-Witheford & Peuter, 2009). Their unique interactive nature allows users to engage with content in ways that traditional media does not. Games are non-linear, participatory art forms and bring with them new aesthetics drawn from aspects of code, computer graphics and interaction design (Juul, 2005; Bogost, 2006). In a parallel to Film or TV, video games are becoming an established medium for cultural and artistic expression (Bogost, 2007; Wark, 2007b; Galloway, 2006).

Critical research around digital games is generally split into two areas.

I) Ludic Systems and Mechanics

The study of games as ludic systems is connected to the fields of mathematics, computer science and economics (Binmore, 2007; Castronova, 2005). It examines games as enclosed systems focusing on mechanics, rule-sets and applications. Within this area the design of game mechanics and game code is an increasing field of research (Salen & Zimmerman, 2003; Sweetser, 2008). The study of ludic systems also connects with my own specialist area of procedural and generative programming, particularly where such methods offer solutions to the increasing complexity required in contemporary video games (Angelides, 2013).

II) Socio-Cultural Systems

The study of games as a new territory for narrative, politics or identity comes from an extension of traditional media studies (Galloway, 2006)[5]. Theorists in this field such as Ian Bogost and Mckenzie Wark focus on the socio-cultural aspects of games and game culture. In this area of study, games are considered as vectors for cultural messages or social interactions and the underlying mechanics are often only discussed when they contribute to this communication. This area of exchange, between mechanics and meaning has been called procedural rhetoric by Ian Bogost; however I will refer to this area as system-driven rhetoric, in order to avoid confusion with the branches of procedural and

5 Galloway deliberately reconfigures aspects of film theory in order to apply similar critical interrogation to games and gaming.

generative coding referred to through this thesis.

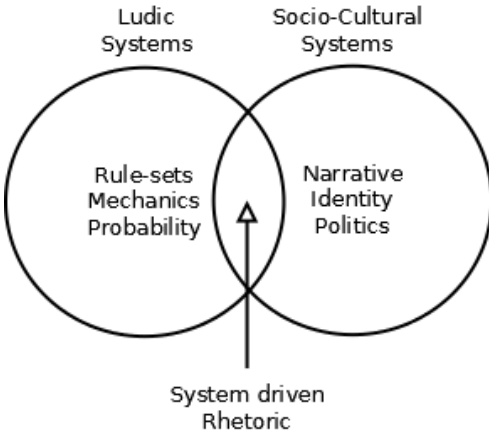


Figure 1.2: Game study areas

My research engages with both these systems and with the overlapping region of system-driven rhetoric, but I am also interested in connecting these areas of study with aesthetics and concepts that have emerged from the digital art scene and specifically from generative code-based art (Galanter, 2003; Reas, 2010). The connection between generative art and video games lies mainly in the area of automated content creation. These area is also the focus of procedural game programming and I demonstrate through this research how generative processes used in digital art can be used to encourage elements of the digital sublime in games.

The development of digital art began with the creative use of early computers but expanded rapidly alongside the usage of the world-wide-web (G. D. Taylor, 2014). Throughout the 1990s and 2000s artists found that they could distribute audiovisual work across the web to a large audience, outside of the context of traditional art galleries. This period saw an increase in the popularity of generative artwork by artists such as Lia, JODI and Marius Watz[6] (as documented by Paul, 2008a; Greene, 2004). These artists used algorithms, executing in real-time to produce variable audiovisual experiences. As opposed to game design, this form of digital art often foregrounds visual aesthetics and emergence at the expense of interaction. When displayed in a traditional white cube space digital art occupies an intermediate territory between the user-directed nature of games and the less interactive nature of traditional art (Paul, 2008b). This research applies the aesthetic judgements and emergence of generative art to the design of video games while maintaining the deeper interaction of game design.

6 Lia http://www.liaworks.com/ Jodi http://www.jodi.org Marius Watz http://mariuswatz.com/

The aesthetics of digital games are often described through parallels to cinema or literature (Galloway, 2006). However, video games represent an interactive medium that has developed its own visual styles and tropes (Klevjer, 2001; Myers, 2005). Game designers are also demonstrating an increasing cultural awareness of computer code as a creative tool. The semantic growth of 'code as a medium' has also contributed to new epistemological ideas associated with autonomy, complexity and permutation. These philosophical aspects will be examined in section 2.2.

In summary, games are becoming one of the most popular forms of the creative industry (ESA, 2013; Livingstone, 2011). And although there is much industry-led discussion of digital games and a growing field of media study-based enquiry (see references above and section 2.3), there is still little critical contribution from the artist-programmers who bridge the position between these two disciplines. If artists are to be able to adopt code and games as a medium then those elements should be examined from an artist-programmer perspective. This research adopts a bricolage approach that encompasses digital art, game theory and coding practice from a practice-based perspective. The results of this enquiry will feed back into the cultural context as previously discussed, allowing the increasing number of game designers, digital artists and coders to benefit from these findings.

2. Literature Review

This literature review will generate a definition of the digital sublime that connects the fields of philosophy (Kant, Deleuze), computer science (De Landa) and game design (Caillois, Wark). This definition is then explored through the experience of playing and developing digital games in the following sections of the thesis. (3,4-8). The diagram below illustrates how the areas examined in the literature review contribute towards my definition of the digital sublime.

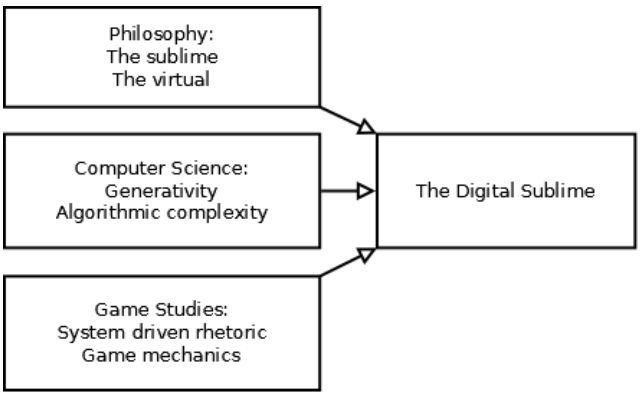


Figure 2.1: The relationship of the areas of the Literature Review

The review is divided into three sections: 2.1 *The Sublime* 2.2, *Digital Complexity* 2.3 and *Game Systems*. These sections introduce the Kantian definition of the sublime and then use the writing of several contemporary philosophers and game theorists to create a description of the digital sublime in games. In more detail, 2.1 examines the writing of Eugénie Shinkle, Sianne Ngai and Steven Shaviro in order to identify how the sublime has evolved from its Kantian foundations to its use in contemporary technological forms. This establishes the conceptual bounds of the sublime, demarcating the territory of 'what is the sublime?' for the purposes of my research. In section 2.2 I connect this definition of the sublime to digital media concepts and computational aesthetics through the work of Gilles Deleuze, Manuel De Landa and McKenzie Wark. This section also identifies the conceptual frameworks I will use to create and analyse my work. Finally section 2.3 examines critical theory from within games culture, identifying writers such as Roger Caillois

whose texts reinforce specific aspects of the definition of the digital sublime.

The concepts examined throughout this review are part of an interwoven set of philosophies that underpin the definition of the digital sublime which this research proposes. Identifying the convergence of concepts from different fields helps to pin down the slippery notion of what we might mean by a digital sublime and forms a conceptual architecture that supports the practice component of my work (see section 4). To this end the literature review aims to identify measurable qualities of the digital sublime. Such qualities include *complexity*, *autonomy*, *permutation* and *abstraction*[7]. Each of these terms represents an axis along which my work can be gauged and developed. The review also identifies conceptual frameworks that I employ in my game design (see section 2.2), including the ideas of *multiplicity*, *topology* and *allegorithm*[8] (a portmanteau that will be explained later). Defining these elements generates a clear conceptual framework within which the design of games can be applied to the research question. Throughout the review glossary references will be included to help clarify the meaning of key terms or words.

It is important to state that this review is intended to be fully comprehensive to the research question – whilst identifying its limits in relation to an expanded research field. In particular the review does not include discussion of Vincent Mosco's book *The Digital Sublime* (Mosco, 2005) which although sharing the same title as this thesis is focused on a historical review of the rise of cyberspace and its cultural impact.

This research focuses on a specific definition of the sublime, there are various interpretations that are not pursued to any great depth, such as the sublime as pleasure-pain principle (Burke, 2008), the sublime as religious epiphany (Morris, 1972), the sublime as advertising concept (Meister & Japp, 2002) or the romantic sublime (Mitchell, 2010). The main reason for these exclusions is that they occur in spaces exterior to virtual environments of games. Physical pain is generally absent in video games and advertising is rare. The romantic sublime does have significant representation in games (see section 3, 3.4) but although it has some place in the research (section 6), it is restricted in this thesis to the discussion of romanticism as an aesthetic framework. Although this research intersects with many different ideas of the sublime (see Bibliography), the aim is to define a version that

7 There are many other ways to describe the qualities of the digital sublime, and each of the chosen words relates to a range of associated concepts. For example when I use the word *permutation* I will also be referring to elements of iteration, recursion and repetition. Similarly c*omplexity* refers to many different types of complexity such as feedback systems, fractal mathematics and non-linear systems. It is too verbose to refer to all of these elements each time a quality is discussed and so the key words chosen are intended as the best representation of those areas.

8 These three terms are described in general terms in Appendix A:Glossary, a more detailed interpretation of each word is developed throughout the course of the Literature Review.

relates specifically to an encounter with digital games. It is also worth stating that to limit this research to a realistic scope I have had to avoid many tangents and associated investigative threads that I would typically have explored in my studio work[9]. To some degree, this enforces a set of artificial boundaries on the subject area of the sublime, but it is necessary to allow focused discussion of the central research issues.

2.1 The Sublime: From Kant to the Digital Age

There are many definitions of the sublime, both in historical texts and in contemporary culture (Shaw, 2006; Hoffmann & Whyte, 2011). This research derives its conceptual framework from Kant's definition of the sublime. Kant's writings provide concepts and definitions that mirror aspects of digital complexity and generative art, and as such, his work forms an ideal foundation for the process of this review. In more detail, Kant's concepts are logical and structured, like programming, yet still allow the space for mystery and poetic expression. His writing mixes the purity of formal terms "the absolute measure than which no greater is possible subjectively" (Kant & Bernard, 1951, p. 90) with the drama of personal experience; "look out into the infinite, which is for it an abyss." (Kant & Bernard, 1951, p. 105). The combination of mechanical logic and experiential awe in Kant's definition of the sublime directs and underpins this research. It is for these reasons that Kant's writing is used as a prism through which the other literature in the review can be examined in order to build up a solid definition of the digital sublime.

The first section of the review begins by examining Kant's *Analytic of the Sublime* (Kant & Bernard, 1951) which allows me to establish a foundation for my definition of the sublime. The following sections then explore how this definition has been altered in the historical transition from pre-industrial society to contemporary digital culture.

In his treatise of 1757, *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful* (Burke, 2008) Edmund Burke became the first philosopher to describe the sublime as an experience other than that of aesthetic appreciation. Burke's claim was that certain experiences lay beyond the comfort zone of beauty or pleasure. Beyond these margins the mind becomes paralysed in a state of awe or confusion, "Infinity has a tendency to fill the mind with that sort of delightful horror, which is the most genuine effect, and truest test of the sublime" (Burke, 2008, p. 129). Burke was also clear that such sensations were not pleasurable in the same way that experiencing

9 Such tangents include investigations that stray away from game design and into the abstraction of pure code or formal mathematical models. But I have also avoided avenues that require excessive production requirements or indeterminate development times.

beauty was described. Instead they may instil a kind of dread, “that state of the soul in which all its motions are suspended, with some degree of horror” (Burke, 2008, p. 95). Burke closely aligned the sensation of pain with the generation of such effects and following this logic pronounced beauty and the sublime as exclusive entities. The beautiful was pleasurable, whereas the sublime was chaotic, disorientating and potentially destructive. This is an important distinction that I am also conscious of in my own work where I often create experiences that are intended to be something other than just aesthetically pleasing[10].

Although Burke's writing had significant impact on the philosophical community it was not until Kant's discussion of the sublime in his *Critique of Judgement* (1786) that it became cemented as a prominent aesthetic and a continuing philosophical concern. This research takes J. H. Bernard's 1951 translation of *Critique of Judgement* as its primary text concerning Kant's definition of the sublime.

2.1.1 Immanuel Kant

Both Burke and Kant were concerned with the causal nature of sublime events, but they had differing opinions on the actual effect of the sublime in the observer. Burke's approach was inclined to examine physiological effects on the individual, whereas Kant's analytical style focused on a more metaphysical interpretation. Ultimately this makes Kant's approach more applicable to the discussion of digital systems, as its definitions and frameworks are more logical, mathematical and modular. Kant asserts that the sublime arises from an overriding complexity of sensation or information, rather than from a direct physiological condition. An external stimulus effect may lead to this situation (the view of a thunderstorm), but equally the surfeit-state can be driven by complex mental processes (thoughts of infinity). Kant describes the desire to experience and perhaps master these sublime states as an inherent quality of our minds.

> There is in our imagination a striving towards infinite progress and in our reason a claim for absolute totality, regarded as a real idea, therefore this very inadequateness for that idea in our faculty for estimating the magnitude of things of sense excites in us the feeling of a supersensible faculty. (Kant & Bernard, 1951, p. 88)

10 In my work I create environments that are both beautiful and disorientating at the same time. Especially when the work employs generative or procedural methods that are allowed a wide range of expression and can therefore produce unusual and alien results.

To Kant the sublime breakdown of comprehension is triggered by the notion that the mind might sense the potential range or complexity of forms a system can take, yet is incapable of imagining or processing those permutations internally "to go beyond the limits of sensibility" (Kant & Bernard, 1951, p. 94) For example a single pebble is easy to understand, but trying to imagine all the pebbles on a beach is impossible. At this point the individual's cognitive modelling is pushed beyond its functional limit and the mind becomes adrift in a boundless space. Kant refers to the sublime as being a state beyond relative sense, triggered by an object which represents a complex system yet itself is only one facet of that system.

> The sublime, on the other hand, is to be found in a formless object, so far as in it or by occasion of it boundlessness is represented, and yet its totality is also present to thought. (Kant & Bernard, 1951, p. 82)

Being an empiricist Kant attempted to understand this breakdown of comprehension in an analytical and logical manner, which led him to developing definitions in a programmatic and taxonomic way. For example, one of Kant's definitions follows a logical declarative format "We may describe the sublime thus : it is an object (of nature) the representation of which determines the mind to think the unattainability of nature regarded as a presentation of ideas." (Kant & Bernard, 1951, p. 108). This statement embodies a recursive and paradoxical logic that is frequently present in computer systems and their associated logic problems. It is particularly interesting that Kant uses formal terms to try to account for phenomena that are considered beyond logical comprehension. This approach includes a sense of inherent contradiction and tension that is itself representative of the sublime (things escaping definition, yet still a result of those definitions). Using formal logical terms to describe the sublime suggests that these scenarios might have parallels in code (because programming is itself a form of complex formal logic), and therefore translated into games.

Kant relates the sublime to experiences where the magnitude of complexity or range of permutations is simply too great for the mind to comprehend. In these scenarios the mind encounters a system of production (natural or mathematical), the output of which it can no longer determine. This gives me two measurements, *complexity* and *permutation*, that can be used to indicate the degree to which an experience might become sublime. These qualities are deliberately built into the composition and coding of my games.

Kant suggests that sublime events are driven by psychological triggers which he divides into two

categories, the mathematical and the dynamic. These are essentially channels of thought or experience that drive the mind towards the sublime. As an artist I experience this process while coding my own projects and in my engagement with other sublime games (section 3). Often when I am pursuing the goal of a complex and elegant algorithmic system (as a designer or player) I find myself entering a form of sublime trance or confusion. Psychologist Mihaly Csikszentmihalyi calls this phenomenon *Flow* by (Csikszentmihalyi, 1991). Identifying how these states and trajectories function is important to my research as I will use them later (4.4) to direct my own game design.

The Mathematical Sublime

Kant describes the mathematical sublime as the complexity and permutation of deterministic systems and structures. This might be demonstrated in physical systems such as the lattice forms of crystals, the fractal geometry of ferns or the permutations of snowflakes. Or it can be found within abstract systems such as predicting chess moves, solving logical paradoxes or calculating prime numbers (Kant & Bernard, 1951, p. 90). Emulating these systems within a digital game-space[11] is core to my artistic practice. When exposed to such systems, Kant says that the mind attempts to follow a mathematical trajectory until it is no longer capable of understanding the results. He describes this type of sublime experience as:

> The absolute measure than which no greater is possible subjectively (for the judging subject), it brings with it the idea of the sublime and produces that emotion which no mathematical estimation of its magnitude by means of numbers can bring about. (Kant & Bernard, 1951, p. 90)

Kant suggests that the step from determinable sequences to the boundless sublime reveals paradoxes inherent in the logical structure of mathematics (and therefore in computation)[12]. When encountering these systems the mind attempts to understand their complexity and "the imagination proceeds of itself to infinity without anything hindering it" (Kant & Bernard, 1951, p. 92). We can demonstrate this effect with reference to classical mathematical examples, where many formal number sequences are infinitely determinable yet practically incalculable. Such sequences are the results of transcendental and irrational numbers, pi(π) being the most familiar example (Beckmann,

11 Game-space is a term used frequently in this thesis to refer to the interactive environment created by a game. It is intended to encompass the space, experience and possibilities available within a game system.

12 The existence of paradoxes in mathematical and philosophical logic is not unique to Kant's critique, most notably Bertrand Russell (Russell, 1996) and Kurt Gödel (Gödel, 1992) demonstrated that paradoxes are at the heart of mathematics.

1976).

Infinite systems of permutation or non-linear process (like pi) are key to the kind of systems that generate the mathematical sublime and the notion of complex mathematical *abstraction* represents another quality that can be used to measure potentially sublime experiences. Later in this review, (as part of my approach to triangulating philosophical concepts) I will demonstrate how these abstract systems are also key elements in the philosophy of Deleuze, De Landa and Wark (see section 2.2).

Kant's definition of the mathematical sublime is invaluable to the practical component of the research because it directly informs the process of designing code to generate the digital sublime (see section 4). The mathematical sublime is aligned with computation and virtual form, separate from the world of sensations and spectacle. In contrast to this, Kant's other definition of the sublime, the dynamically sublime, focuses on the effects and experiences of the external world.

The Dynamically Sublime

Kant describes the dynamically sublime as resulting from experiences of nature in states of great chaos, impossible scale or complexity. He references specific examples of natural phenomena such as:

> Threatening rocks; clouds piled up in the sky, moving with lightning flashes and thunder peals; volcanoes in all their violence of destruction; hurricanes with their track of devastation; the boundless ocean in a state of tumult; the lofty waterfall of a mighty river. (Kant & Bernard, 1951, p. 100)

In technical terms we can see the dynamically sublime occurring in emergent natural processes such as weather systems, plant growth, fluid dynamics and avian flocking (see illustration below). These examples can still be mathematically modelled but are described as 'chaotic' in that they include so many variables and possibilities that they cannot be totally predicted. In my game design such dynamic systems are deliberately introduced in order to encourage the emergence of autonomous behaviour and novel emergent interactions.

Figure 2.2: Starlings exhibiting complex flocking behaviour

However, unlike the mental aesthetics of mathematical structures, the dynamic sublime represents a more tangible and embodied experience. It is often one of observation and reflection rather than pure introspection. When describing the natural events that trigger the dynamically sublime Kant's wording pre-empts the aesthetics of nineteenth-century Romanticism.

> They raise the energies of the soul above their accustomed height and discover in us a faculty of resistance of a quite different kind, which gives us courage to measure ourselves against the apparent mightiness of nature. (Kant & Bernard, 1951, p. 101)

Rather than the mind challenging internal logic, this scenario sees the participant challenging the complex autonomy of nature. As the dynamic sublime can reflect existing narrative or anthropomorphic tropes (man vs nature, the uncaring storm at sea) it is often more approachable than the mathematical sublime. It can even represent a sense of transcendence, where the participant

has the courage or mental strength to overcome the chaotic *"mightiness of nature"*. This form of the sublime is explored through the second game produced in the research (see section 7).

To conclude, Kant divides the sublime experience into two distinct modes, the mathematical and the dynamic. Both states lead to a sense of boundlessness, beyond comprehension, but each does so in a slightly different manner. The mathematically sublime is reached through the mental processing of paradoxes, infinite permutations and abstract complexity. The dynamically sublime is formed through sensory exposure to the autonomous complexity of external phenomena The diagram below illustrates how these elements can be associated.

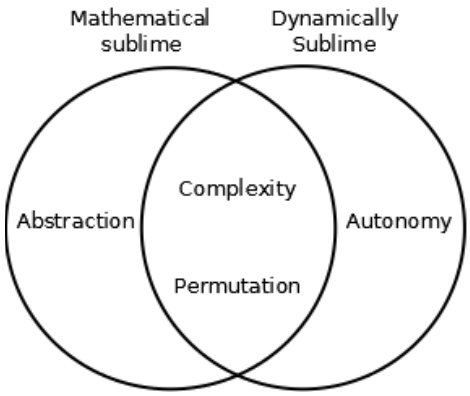


Figure 2.3: Qualities of the sublime within Kant's two forms

The practice component of this research uses both Kants definitions of the sublime to produce experiences that are both alluring and threatening due to the escalating properties described above. Approaching this task within a virtual experience actually brings the two definitions (mathematical and dynamic) much closer together in terms of cause and effect (because a game's mathematical code produces the sensory experience). Kant also provides us with hints as to the kind of qualities that can be used to measure the progress towards a sublime event. *Autonomy*, *abstraction*, *permutation* and *complexity* are key components in Kant's definitions of the sublime and can be incorporated in my game design methodology (see section 4); the diagram below illustrates these findings.

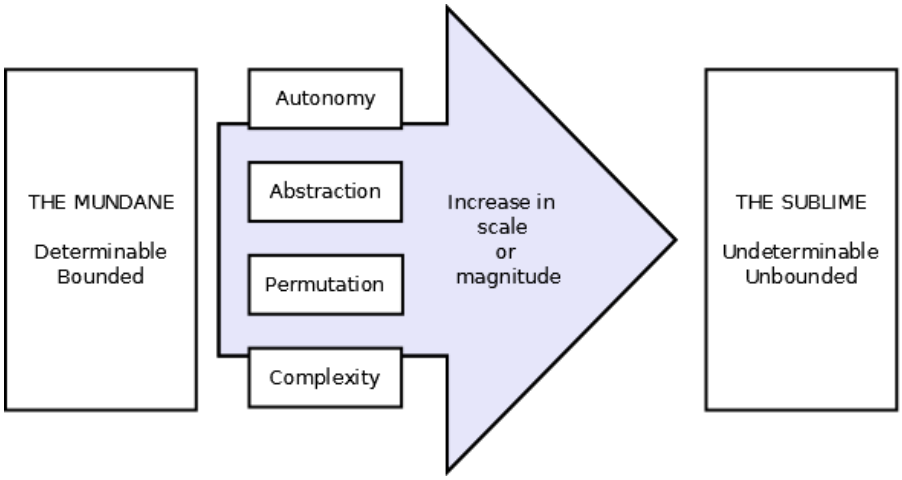


Figure 2.4: The pathway from the mundane to the sublime

Kant's work provides a clear foundation for my own definition of the digital sublime; however, as the research examines the state of the sublime within contemporary video games, it is important to understand how Kantian notions have been re-interpreted in the context of today's digital culture. The next section examines how the digital sublime came to be and how it differs from Kant's definitions.

2.1.2 Eugénie Shinkle

In her short Tate paper *Video Games and the Technological Sublime* Eugénie Shinkle charts a history of the sublime from its Kantian roots to a contemporary interpretation moulded by the cultural impact of technology. She is specifically interested in the transition of the sublime from a self-reflective transcendence into what could be an alienating state of dumb paralysis. Her writing is important as it represents the common perception of the digital sublime as an empty dis-empowering state.

The first significant re-definition that Shinkle introduces is driven by the aesthetics of nineteenth century Romanticism. Shinkle suggests that the romantic ideal altered the notion of the sublime from an experience which was disruptive yet empowering into one which represented alienation and loss. This aesthetic can be observed in many art-works of the romantic period, where human figures are frequently overwhelmed by mysterious vistas or majestic ruins, dwarfed by the terrain and compressed under vast skies. This style of work is typified by the paintings of Caspar David

Friedrich[13].

Figure 2.5: "The Monk by the Sea" by Caspar David Friedrich (1808)

Shinkle reflects on the transition of the sublime into a mode of visual spectacle and alienation.

> While Kant insisted on compensating for this loss by re-asserting the subject's freedom from causal determination and its conformity with moral law, later romantic variants of the sublime welcomed the dissolution of self ... Visual presentation – awe-inspiring size or complexity – came to replace self-reflection as the key dimension of sublime experience. (Shinkle, 2010)

Shinkle introduces a second shift, brought about by the increasing impact of industrial and technological developments throughout the nineteenth century, in both natural and man-made environments, such that, "By the mid-nineteenth century, natural splendour and technological accomplishment were firmly linked to each other." (Shinkle, 2010). The large scale construction

13 This style of romantic landscape is something that I reference in my own work and is the main aesthetic focus of the second game project in this research (see section 7).

projects of railroads, the Eiffel tower, transport bridges replaced wild nature as potential environments for sublime meditation. Even though these new landscapes were man-made they were capable of such complexity and autonomy that they formed a new locus for the sublime to emerge, "the corollary to an expansion of human power and yet simultaneously [as] evoking the sense of individual insignificance and powerlessness. ... as an extension and affirmation of reason or as the expression of a crushing, omnipotent force outside the self" (Nye, 1996, p. 285). Shinkle uses an extension of this phenomenon to identify a contemporary sublime where technology and digital systems are awe-inspiring yet increasingly alienating. She also suggests that attempts to humanise technology through user interfaces only contribute to the alienation, "a cultural moment where depth is replaced by surface and real affects by simulated ones … the now-powerless subject is confronted with a technological artefact – a featureless surface with no relationship to the unimaginably complex workings that it conceals." (Shinkle, 2010)

We have all experienced the frustration and confusion of trying to work out a new computer program or navigate a new digital interface. Shinkle suggests that this increasing dislocation of the user from the system drives the sublime experience into the realm of banality rather than empowerment.

> The dissolution of the technologically enabled self is both catastrophic and utterly banal: marked by a profound sense of rupture and loss, situated in the mundane reality of the post-human everyday. (Shinkle, 2010)

This view suggests that Kant's inspirational disruption has become something much less transcendent. Theorist Sianne Ngai describes this loss of transcendence as "the 'dread' and 'holy awe' eventually superseded by disinterested pleasure" (Ngai, 2005, p. 271). She calls this alternative state *stuplimity*. The stuplime, according to Ngai replaces the (pre-technological) sublime where the triggering scenario embodies the cold abstraction of technology or the digital, rather than the "apparent mightiness of nature" (Kant & Bernard, 1951, p. 101).

> In experiencing the sublime one confronts the infinite and elemental; in stuplimity one confronts the machine or system, the taxonomy or vast combinatory, of which one is a part. (Ngai, 2000)

The implication is that transcendence is replaced by transfixion; rather than staring into the heavens

we are now staring into the heart of the machine. This transition is described in emotive, binary terms. It ignores the notion that Kant's mathematical sublime is already found in systems or combinatories. In addition, the phraseology adds a sense of authenticity to the “natural” sublime and paints the technological equivalent (the stuplime) in much more mundane terms. The words “elemental” and “infinite” have connotations of transcendence and imply a primal authenticity, in a way that “machine” or “taxonomy” do not. It is easy to overlook the associations that specific terminology can bring to a concept such as the sublime. Is the digital sublime less authentic than the natural sublime? Steven Shaviro presents an alternative perspective.

> Each time we extend ourselves technologically, some part of the real gives way to the virtual. This is why every cultural innovation is attended by an ambivalent sense of loss. And this is also why we tend to equate virtual with disembodied, even though it would be more accurate to use it as an equivalent for prosthetic. (Steven Shaviro, 2003, p. 141)

I would argue that the sense of loss associated with an increasingly technological culture is related to a general nostalgia for the simpler (non-digital) scenarios of the past. Rather than considering the virtual world as an extension of possibilities, it's easier to complain that the virtual is a usurper that lacks the authenticity of the real. This is a conservative stance that the authors in the following section (2.2) generally oppose. This thesis argues that it has even less validity when applied to the sublime, as the sublime experience is always internal, the triggering matter can be real or virtual, sensory or mental. *“*true sublimity must be sought only in the mind of the [subject] judging, not in the natural object the judgement upon which occasions this state.” (Kant & Bernard, 1951, p. 95)

This research demonstrates the sublime as a state of mind has not changed substantially. However, the perception of what the sublime 'means' when it is triggered through technology is different. Like Shaviro this research questions the assumption that virtual (or digital) experiences are less valid than real ones. In my practice and portfolio the experience of the virtual is just as important as “the real”. Much of the practice consists of software that is as important for its *potential* output as for its *actual* output, the majority of its aesthetic is contained in a virtual space, ready to be actualised[14]. For example; In a collaborative art-work, *Rand()%* (Betts & Gilmore, 2004), we set up a generative radio station which continuously broadcast the audio output of live running software. The appeal of the work was the autonomous nature of the station, the possible combinations it might produce, the

14 See http://www.nullpointer.co.uk/content/rand/ http://www.nullpointer.co.uk/content/form-seq/ http://www.nullpointer.co.uk/content/generative-av/

permutations that were played but went unheard and even the virtual sounds that were contained in the system but never played. I would argue that the virtual (or digital) is not a less authentic platform for sublime experiences, but rather a parallel space, and given the degree to which contemporary culture is operating on virtual channels, understanding digital experiences (and the digital sublime) is vital to understanding cultural production in contemporary culture .

In summary the writing of Shinkle and Ngai examines how Kantian notions of the sublime can be revisited in the context of technological culture. The diagram below illustrates some of the transitional movements that have occurred from Kant's discussion of the sublime to the digital version.

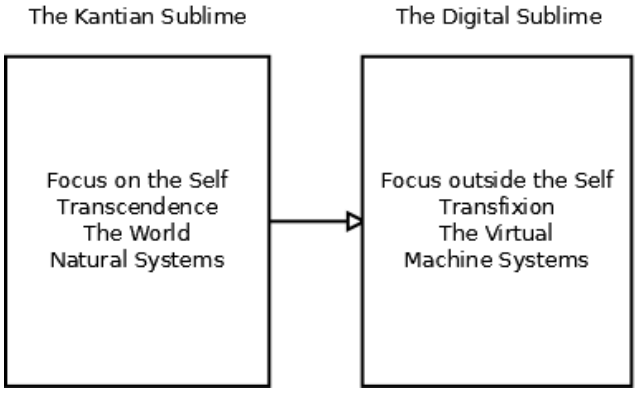


Figure 2.6: The movement from the Kantian to the Digital Sublime

This research proposes that certain aesthetic qualities and value judgements can be associated with the idea of a technological sublime. In Shinkle and Ngai's work these qualities reflect an increased sense of alienation, loss and stupefaction. However there are other perspectives and theorists on the creative and emergent possibilities of the digital and virtual systems who are discussed in the following section. Both perspectives are important to this research, and the games produced for this thesis deliberately include systems that give rise to alienation, bewilderment and stupefaction (as well as sensations of awe and exhilaration). The practice incorporates the confrontation with the machine or system with the belief that even an encounter that baffles or alienates can be an enriching and enlightening experience. A moment of alienation can stop a participant from perceiving digital systems as uncomplicated entertainment or simple tools and prompt them to reconsider their understanding of the digital medium. The games produced for this research offer a body of results that prove a designer can develop mechanisms for creating this experience.

The following section of the review examines the work of three key theorists and introduces conceptual structuring concepts such as topology, allegory, the rhizome and the multiplicity. These concepts are employed as generative foundations in the games designed for this research in order to produce interactive experiences that can encourage the digital sublime.

2.2 Digital Complexity: Topology and Virtual Systems

2.2.1 McKenzie Wark

Mckenzie Wark is a cultural theorist who has spent a significant time exploring the impact of gaming on the philosophical landscape. In *Gamer Theory* (2007a) Wark uses the notions of cartography and mapping as tools to examine the way games and digital culture have effected our perception of the world. In a parallel to Shinkle's chronological history of the sublime, Wark explores the transition between topic, topographic and topological space (as illustrated below).

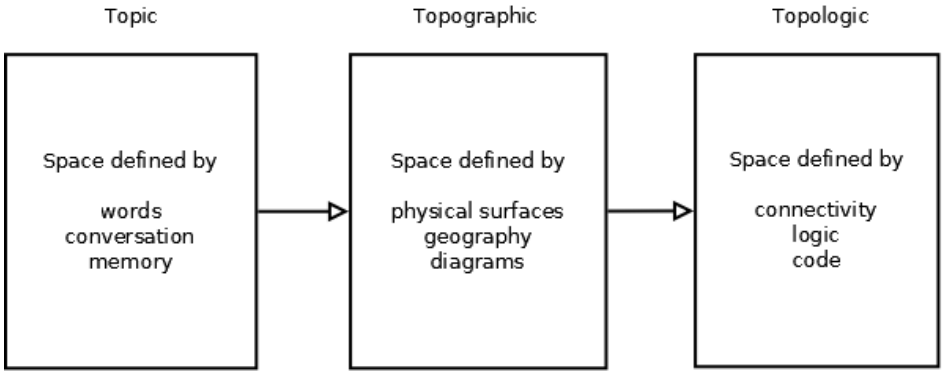


Figure 2.7: The qualities of Topic, Topographic and Topologic spaces

The pre-technological sublime occurs within the topical space, a domain of experience and words. Wark argues that as technology begins to frame society in more numerical and diagrammatic terms the topical space gives way to the topographic blueprint. Finally the impact of digital culture generates the topological network as the final state in this evolutionary sequence.

> The fixed geometry of topography gives way to the variable forms of topology, in which the lines connecting points together lend themselves to transformation without rupture from one shape to another. (Wark, 2007a, p. 42)

Topology is built from logical connections, relationships that are not based on physical proximity or

Euclidean geometry; it is the structure of connectivity and communication in the digital age.

> Where the topographic develops one dimension of telegraphy—its flow of information across space—the topological develops the other—its intricate coding and addressing. Where the topographic is an analog flow, the topological is the digital divide (Wark, 2007a, p. 47)

Digital topology is composed of symbolic links, recursive loops and references, its structures promote a sense of boundlessness and emergence. In games this allows for players and game mechanics to operate in a non-linear exploration of the game-space. The illustration below demonstrates how topology can be used to define symbolic world-space in games.

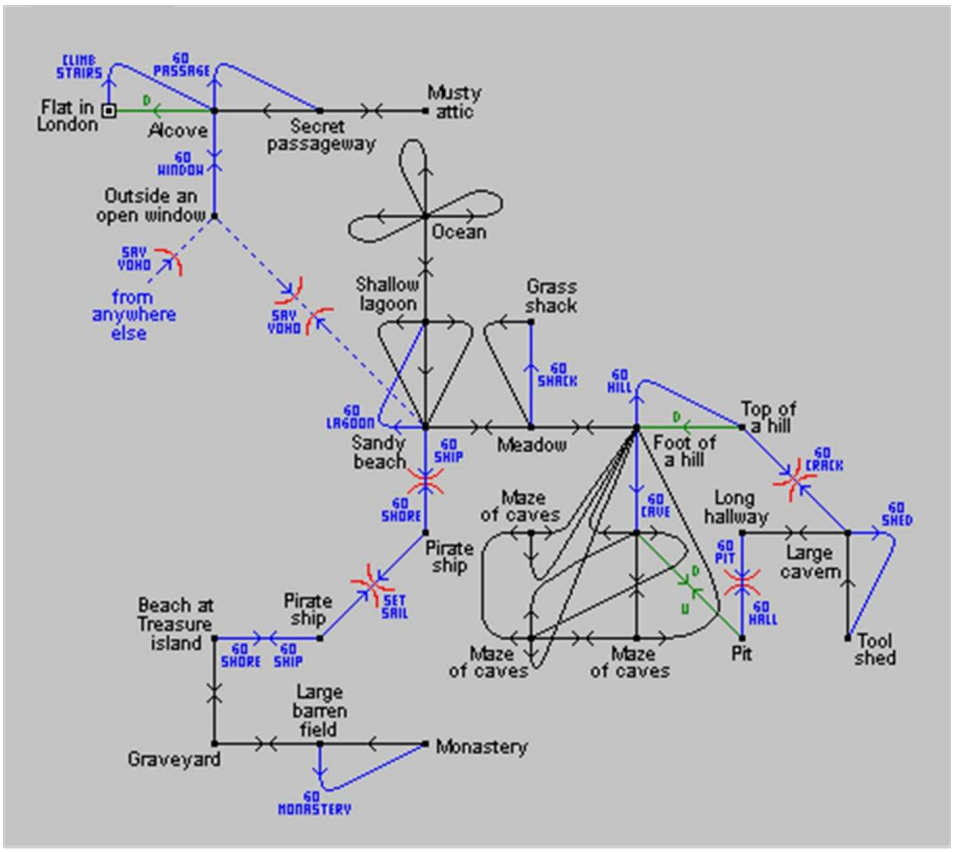


Figure 2.8: A map of the topological world in Pirate Adventure (Vic20, 1984)

For Wark the symbolic connections of the topological network are a unique tool for exploring the co-existence of many possible meanings. Wark describes how this works in relation to game based

narrative.

> It draws the gamer's attention not to the storyline but to the combinations of elements from which any given storyline might be selected (Wark, 2007a, p. 51).

Using topological structures in game design provides multiple threads of interpretation and interaction (as opposed to a linear narrative). When playing through these scenarios the player becomes aware of the expressive range of the system, and understand that the story is transmitted through a combination of narrative framing, game mechanics and player agency (Bateman, 2006). In this context, the algorithms that define the game-world also communicate its message. Wark coins the term *allegorithm* to describe this process.

> Allegory always touches the virtual—which one might define as the possibility of possibility (Wark, 2007a, p. 75). The gamer selects one sequence after another, and gradually learns what they do — that's algorithm. The gamer discovers a relationship between appearances and algorithm in the game... — that's allegorithm. (Wark, 2007a, p. 31)

The diagram below demonstrates the construction of allegorithm in games, showing how both the player and designer read and infer allegorical meaning into the operation of algorithms within the game-space.

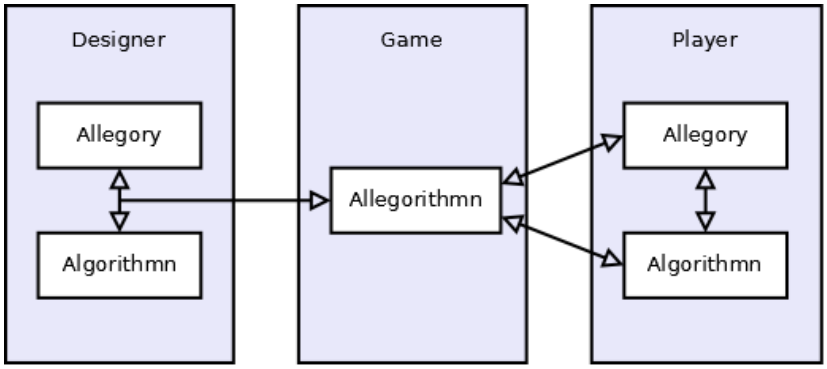


Figure 2.9: Allegorithm: The relationship between code and allegory

The practice component of this research employs Wark's idea of allegorithm to communicate the notion of the digital sublime through the player's interactions with the game-world (see section 7 for

a clear example of this approach).

In summary Wark represents a positive voice for the power of digital games to explore new territories. He sees topological structures as an ideal medium within which to explore the ideas of permutation, possibility and allegory. This sensibility mirrors the approach adopted in the practice component of this research where game environments are designed as interactive, investigative tools. Using topological environments in the practice prompts players to consider game systems as autonomous and rhizomatic objects (the concepts of rhizome and multiplicity will be discussed further in section 2.2.3). In a similar approach, Wark's notion of the allegorithm opposes linear didactic narrative and instead communicates ideas through algorithms and interactions.

2.2.2 Manuel De Landa

Manuel De Landa is an artist and philosopher who combines Deleuzian ontology with modern scientific theory and computer science. Like Wark he explores the terminology and lexicon of technology in order to examine the philosophical possibilities of the digital age. In *Intensive Science and Virtual Philosophy* (2004) De Landa connects ideas from non-linear mathematics, process philosophy and morphogenesis to create a polymath re-reading of Deleuzian philosophy.

Like Wark, De Landa believes that virtual systems are directly representative of our technologically mediated culture, and offer great creative potential and alternative perspectives to existing cultural critique. De Landa uses the term *multiplicity* (inherited from Deleuze) to describe generative systems and their results. The multiplicity is an autonomous, complex and recursive entity, capable of many permutations. Multiplicities are a shifting set of expressions, rather than a definitive object, and thrive in rhizomatic networks that are effectively the same medium as Wark's topological spaces.

> Multiplicity must not designate a combination of the many and the one, but rather an organisation belonging to the many as such, which has no need whatsoever of unity in order to form a system. (De Landa, 2004, p. 4)

> The universality of a multiplicity is typically divergent … there is in principle no end to the set of potential divergent forms it may adopt. (De Landa, 2004, p. 21)

In this research the term multiplicity can be used as to describe the active set of expressions that a

game system might have. This might be the constant variation of terrain in an environment, the re-ordering of narrative structures or the continual remixing of a soundtrack. Thinking of these systems as mutiplicities can be a way to examine and control the range of expressions that the code can produce.

> What is needed is a way of specifying the structure of the space of possibilities that is defined by an entity's tendencies and capacities. (De Landa, 2011, p. 5)

In programming, the "entity" can be considered as a generative code system with the tendencies and capacities representing the permutations it produces. The multiplicity is both the code and its products, including products that are invisible to the player, only existing in a virtual sense.

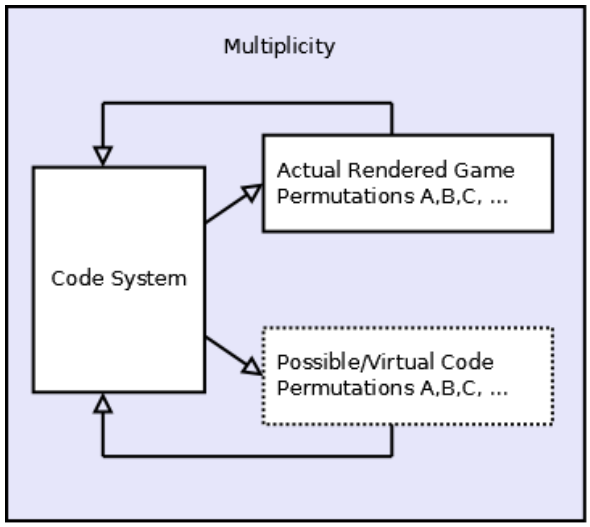


Figure 2.10: The concept of Multiplicity in programming terms

Code systems such as the one above contain feedback loops that can modify the structure of the systems output, further extending its expressive range and potential. Developing generative systems like this (based on the notion of the multiplicity) enables me to embed the possibility for boundless and undeterminable systems into my work.

De Landa describes computer programming and mathematics as important tools for exploring philosophical ideas. In *Philosophy & Simulation: The Emergence of Synthetic Reason* (De Landa, 2011) he states "These questions are not mathematical but philosophical the practice of mathematicians can still provide insights into the answers" (De Landa, 2011, p. 20). The book uses

various programming techniques as tools for exploring Deleuzian ideas (non-linear dynamics, cellular automata, topology) and De Landa specifically celebrates the edge-cases of computer simulation, where unbounded complexity produces unpredictable results that appear as “quasi-species existing in the vicinity of the error threshold” (De Landa, 2011, p. 51).

To conclude, De Landa's approach is important to the research for several reasons. Firstly, his writing combines theories from scientific and philosophical disciplines in order to explore shared underlying principles. This approach promotes the use of coding as philosophical tool, both for investigation and demonstration (De Landa, 2011) and mirrors Wark's concept of the allegorithm as an important element of the research. Finally, De Landa's description of the multiplicity when examined in computational terms helps to focus the development of generative game systems. De Landa's work is critical to the research because it uses scientific concepts as practical descriptions of phenomenon and processes, but also because it considers scientific theories as philosophical and aesthetic trajectories. Rather than using programming to simply solve a problem it points towards the use of code as a medium through which we can explore and communicate ideas.[15]

2.2.3 Gilles Deleuze

Gilles Deleuze is a significant influence in De Landa's philosophy, and although he rarely references digital technology in his work he frequently discusses themes of repetition, permutation, emergence and the virtual; all key elements of this research and associated practice.

In *Difference and Repetition* (Deleuze, 1994) he blurs the boundaries between the production and perception of identity and meaning. In the book he develops an ontology where the structures of difference and repetition are part of a self-reflexive feedback loop which underlies the construction of meaning. Within this recursive cycle there is no predetermined chronology that proceeds logically to a fixed form, all structures of meaning are in flux and consist of mutable connections.

> Destiny never consists in step-by-step deterministic relations between presents which succeed one another according to the order of a represented time. Rather, it implies between successive presents non-localisable connections, actions at a distance, systems of replay, resonance and echoes, objective chances, signs, signals and roles which transcend spatial locations and temporal successions. (Deleuze, 1994, p. 83)

15 For example: In my own work a code experiment based on simulating plant growth might lead to visualisations that produce abstract and unnatural flowers that prompt questions about the concept of beauty in organic symmetry.

In this quote we can see both references to game mechanics (*"systems of replay"*, *"objective chances"*) and similarities to Wark's description of the topological (*"non-localisable connections"* that *"transcend spatial locations"*). Deleuze suggests that a topological system and its permutations can be considered as a single entity, a *multiplicity*, as introduced in the previous section (2.2.2). I have already identified how generative code can represent a multiplicity (2.2.2) but Deleuze extends the expressive range of multiplicities across time and space, through difference and repetition, and across rhizomic networks. The idea of autonomous networks of generative systems recurs throughout his writing, particularly in his work with Félix Guattari *A Thousand Plateaus* (Deleuze & Guattari, 2004) where he discusses them in more topological detail.

> To these centred systems, the authors contrast acentered systems, finite networks of automata in which communication runs from any neighbour to any other, the stems or channels do not pre-exist, and all individuals are interchangeable, defined only by their state at a given moment (Deleuze & Guattari, 2004, p. 17)

In the context of this research, the notion of a rhizomic structure and its multiplicities mirrors the idea of code fragments interacting across a digital network, capable of autonomous permutation and complexity. A shifting network of multiplicities. These fragments of code can be instantiated or destroyed, reconfigured and (re)connected to each other over time and across topological space. But how can such a mutable system maintain a sense of identity or character?

> What we call their noumenal character is constituted by the relations of virtual coexistence between the levels of a pure past, each present being no more than the actualisation or representation of one of these levels. (Deleuze, 1994, p. 83)

In trying to define the "noumenal" character of a system Deleuze includes both the actual outcomes and the unrealised possibilities. The "character" is therefore built up through layers of permutation, through exposure to repeated stages of generation. In programming such a system, the designer can impose thematic control, guiding the expressive range of outputs while still allowing for some autonomy. Experiencing thematic variations encourages the viewer to think of the system as a whole rather than as an individual definitive object. This in turn leads them into imagining what the unrealised permutations may look like and considering the system (the process and its products) in virtual terms (For a more practical example see section 3.2). The virtual or noumenal part of the

system is where the sublime occurs, because it is dislocated from the actual, hinting at boundless possibility and unknowable purpose.

> Deleuze most often describes the virtual as a transcendental field or structure, conditioning and generating the actual. The virtual is a principle of emergence, or of creation. (S. Shaviro, 2007, p. 15)

Deleuze's ontology provides an important framework for the research methods, representing the combination of structuring principles (topological, rhizomatic) and processes (multiplicity, generativity). It also suggests ways in which these combinations can give rise to a sense of the sublime. My role, as an artist-programmer in this research, is to take these mutable conceptual systems and give them an interactive audiovisual form through the medium of code. “What the artist confronts in this way is chaos, the forces of chaos, the forces of raw and untamed matter upon which Forms must be imposed in order to make substances, and Codes in order to make milieus.” (Deleuze & Guattari, 2004, p. 338)

Deleuze's writing is important to the practice component if the research on many levels, primarily due to its celebration of emergent form and virtuality (as discussed above), but also because of its usage of lyrical and poetic metaphors. For example, Deleuze explains how we might deal with the disorientation of the sublime... “Lost, he takes shelter, or orients himself with his little song the best he can. The song is like a rough sketch of a calming and stabilizing, calm and stable, centre in the heart of chaos” (Deleuze & Guattari, 2004, p. 311) With this sort of description Deleuze and Guattari present a fictional frame and environment which acts as an analogue to the philosophical concept he is introducing. In this research, game environments and mechanics express allegorithmic notions through similar fictional frames (see section 7 for a clear example). This sort of theatrical analogue helps to transmit the philosophical concerns of my thesis by providing an additional channel of communication that is less abstract than formal demonstration alone.

To summarise; in this section I have examined the writing of three key theorists whose ideas underpin the practice-based component of this research. Wark defines the topology of the digital world where the sublime might exist. He also introduces the notion of the allegorithm, an experience generated by code that transmits a story or meaning. De Landa's writing can be seen to reinforce the notion that code is a medium of expression. It also suggests that code structures and philosophical structures can be analogous with the multiplicity. Finally my reading of Deleuze ties

these rhizomatic systems together as a generative substrate for the digital sublime. Deleuze also demonstrates how cross-disciplinary metaphors and artistic work are important tools in the investigation of these systems.

The diagram below summarises the qualities and production structures I have identified so far in this review.

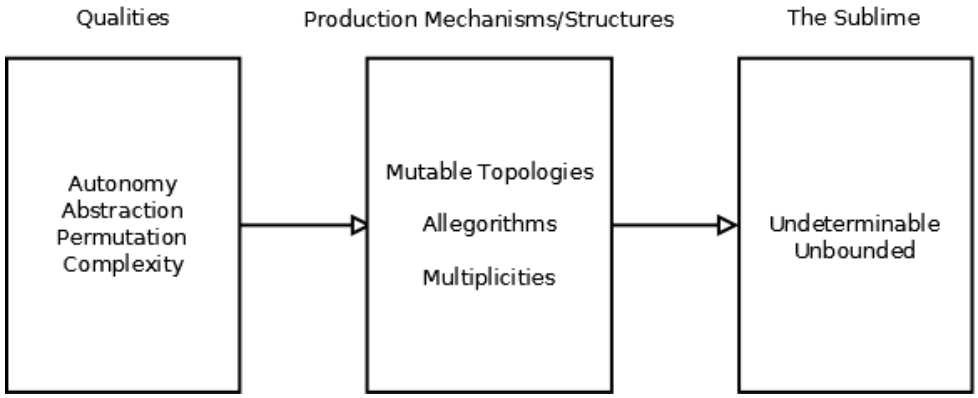


Figure 2.11: Qualities of the sublime and production structures that encourage them

The factors and structures above are used to guide the game design practice in this research. Integrating these elements allows the research to connect the act of coding to the process of philosophical enquiry.

At this point it is important to mention Jon McCormack and Alan Dorin's paper *Art, Emergence, and the Computational Sublime* (2001). This short text presents an overview of generative art as it relates to ideas of emergence. It concludes by suggesting that the results of generative computational art can be considered as a form of the sublime.

> Therefore the concept of the computational sublime is introduced – the instilling of simultaneous feelings of pleasure and fear in the viewer of a process realized in a computing machine. A duality in that even though we cannot comprehend the process directly, we can experience it through the machine – hence we are forced to relinquish control. It is possible to realize processes of this kind in the computer due to the speed and scale of its internal mechanism, and because its operations occur at a rate and in a space vastly different to the realm of our direct perceptual experience. (McCormack & Dorin, 2001)

In agreement with De Landa, McCormack and Dorin envisage the computer as the ideal tool for exploring the new territories of the digital (or computational) sublime[16]. This thesis aims to formulate and test mechanisms for pursuing this exploration.

The previous section of the review has identified some key concepts relating to the sublime in digital and virtual terms, but games also embody a history of cultural context and critique. The next section is a brief overview of this, focusing on theories and observations that have helped me develop my personal game design practice.

2.3 Game Systems: Mechanics and Rhetoric

Until recently digital games have been an under-represented area of academic study. Game systems have frequently been used in the discussion of other logical systems. John von Neumann and Oskar Morgenstern's book *Theory of Games and Economic Behaviour* (Von Neumann & Morgenstern, 2007) examines game theory for economics and Douglas Hofstadter uses game-like mechanics in *Gödel, Esches, Bach : an eternal golden braid* (Hofstadter, 1979) to explore logic and paradoxes. However the study of games for their own sake is rare, with examples being key twentieth century writers such as Johan Huizinga (J. Huizinga & C., 2000) and Roger Caillois (Caillois, 1913) followed by occasional texts such as *The Study of Games* (Avedon & Sutton-Smith, 1971). Of course these titles were produced well before video games had become commercially popular and only discuss non-digital systems. Critical examination of video games did not occur until around the turn of the century and even then the amount of literature was initially sparse.

This scarcity of attention arose from was due several factors; digital games have only existed as a commercial and artistic medium for around thirty years and early games were seriously limited in scope by technological restrictions. However, in the last decade or so video games have become more culturally significant, ranking alongside music, TV and films as a popular pastime and artistic form (Livingstone, 2011). As technology advances, the expressive potential of the medium has vastly increased and the audience has grown from a subculture of enthusiasts to encompass a large sector of the population (ESA, 2013). Computer science research is frequently published concerning games systems, through organisations like SiGGRAPH (ACMSiGGRAPH, 2014), but this output concentrates purely on computational problems. Examples of cultural or socio-political investigations were initially rare but have slowly increased since the early 2000s, with a number of

16 I would distinguish between the use of digital and computational in this context. *Computational* often implies active processes of calculation, whereas *Digital* can also represent inactive and static (yet still boundless) structures.

key theorists such as Ian Bogost (Bogost, 2006) and Jesper Juul (Juul, 2005) helping to build a lexicon of game specific concepts and frameworks. This section of the thesis examines key texts from both the digital and pre-digital era, in order to identify conceptual threads that contribute to the definition of the digital sublime in games.

I will begin the discussion by examining the work of Johan Huizinga and Roger Caillois. Although their writing does not engage with digital systems many of their observations and rubrics are still relevant to the understanding of contemporary video games.

2.3.1 Historical Groundwork: Huizinga and Caillois

Writing in the 1930s Johan Huizinga set out to describe the conceptual space that play occupies in society. In his seminal text *Homo Ludens* (Huizinga, 1998) he claims that play is a primary function of culture and suggests various philosophical categories within which this relationship can be explored. Huizinga first proposed the term 'magic circle' to define the mental enclosure that players enter when playing a game. This phrase has become one of the most common terms in critical game theory, specifically in connection to notions of immersion and player engagement that are often considered desirable traits for contemporary games. Salen and Zimmerman use the term "magic circle" in their book *Rules of Play* (Salen & Zimmerman, 2003), to describe the mental boundary a player crosses when a game begins. This concept is important as it can represent the immersion of the player in a virtual space and help to demarcate the various exit points from that space (into the sublime, or into the stuplime). However, much of the remaining content of *Homo Ludens* is concerned with the importance of games as a socio-cultural phenomenon and although fascinating, is not directly relevant to my questions.

Building on Huizinga's theories, Roger Caillois proposed a set of definitions for play patterns in his 1961 book *Man, Play and Games* (Caillois, 2001). Caillois also examines the social function of games and considers their psychological causes and effects. But arguably the most important contribution were the formal rubrics he proposed. Caillois defined four distinct axes on which to place games; *agon* (competition), *alea* (chance), *mimicry* (simulation), and *ilinx* (vertigo). Even though these terms and associated theories were developed well before the advent of digital technology the definitions and associated theories have been greatly influential to game designers and academics (Juul, 2003; Frasca, 2003; Salen & Zimmerman, 2006). In my research both chance (in terms of permutation) and vertigo (in terms of overwhelming audiovisual stimuli) are potential triggers for the digital sublime.

Since my interests lie in the margins of flow and control it is also interesting to see how Huizinga and Cailois examined states of order and disorder in gameplay. Although both agree a disordered (or rather un-ruled) state can result from unstructured play (paidia) or from unguided role play (mimicry), there is also a suggestion that disorder can also be reached by pushing structured game experiences to a hypnotic or chaotic state through repetition, randomness or over-complexity. Caillois refers to this experience in the rubric of ilinx (or vertigo). He even suggests that sensory and mental overloading is the main goal of certain games and the fulcrum of many modes of play. In some cases the point of transition is also one of empowerment, as Caillois describes… "Somersaults are performed in a state bordering upon hypnosis" (Caillois, 1913, p. 137). But this transformation is not without impact, the player finding themselves "...surrendering to a kind of spasm, seizure, or shock which destroys reality with a sovereign brusqueness" (Caillois, 1913, p. 23). Although Caillois refers to physical or sensory activity as the stimulus for ilinx (the dance of the dervish, the rollercoaster), we can extend the idea of chaotic play into the space of the digital sublime.

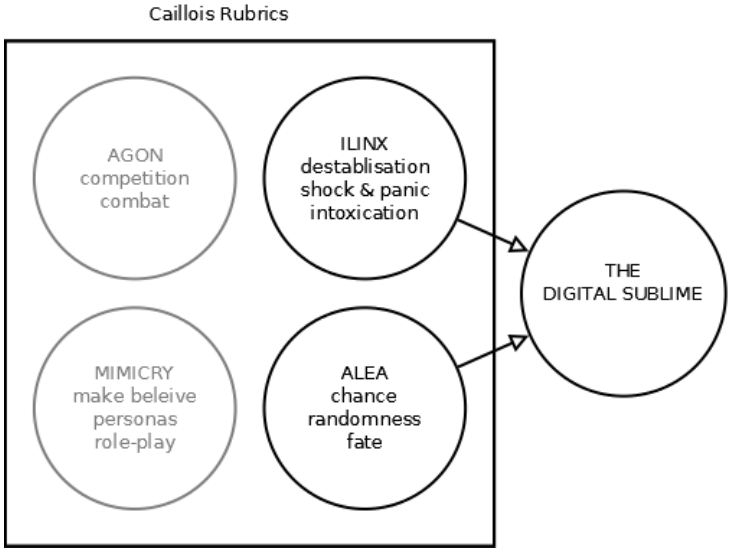


Figure 2.12: Caillois game rubrics and the digital sublime

Huizinga and Caillois are important to my research because they established the idea that games could be transformative events. Games can take the player out of the mundane world and into seductive virtual space[17] (the magic circle) where the battle between order and disorder might give

17 Caillois refers to this seduction as a *"...desire for voluptuous panic"* (Caillois, 1913, p. 65), a phrasing that hints at the hedonistic or enveloping aspect of chaotic games.

way to a sublime experience.

2.3.2 Mechanics to Rhetorics

Caillois' analytic approach can be seen mirrored in several contemporary texts such Raph Koster's *A theory of fun for game design* (Koster, 2005) and Katie Salen & Eric Zimmerman's *Rules of Play* (Salen & Zimmerman, 2003). Both books present informative dissections of game mechanics but are more guides for game designers than philosophical critiques. The area of game mechanics also sees frequent computer science theses presenting new software techniques or algorithmic approaches, such as Penelope Sweetser *An Emergent Approach to Game Design –Development and Play* (Sweetser, 2008).

Other areas that have been the targets of increasing research in recent years include: narrative in games, *The Zone of 'Becoming': Game, Text and Technicity in Videogame Narratives* (Mukherjee, 2009); spatial and architectural concerns, *The Rendered Arena, Modalities of Space in Video and Computer Games* (Stockburger, 2006); virtual economies, *Synthetic worlds: the business and culture of online games* (Castronova, 2005) and digital identity *Play between worlds: exploring online game culture* (T. L. Taylor, 2009).

Ian Bogost has coined the term "procedural rhetoric" to describe the alternative media narrative of digital games. In *Unit Operations* (Bogost, 2006) and *Persuasive Games* (Bogost, 2007) he considers game mechanics as having rich semiotic impact in terms of the values and messages they embody, and also implies that designers have a responsibility to consider the socio-political messages their games project. This move to examining games as rhetorics is interesting, but Bogost's focus on a more political dialogue ultimately limits his usefulness to my research.

McKenzie Wark and Alex Galloway also examine games as rhetoric, but approach the nature of "game-space" from more of an art history perspective. Galloway relates video games to cinema and cybernetics in formal terms in *Gaming* (Galloway, 2006). Whereas Wark (discussed previously) uses games to examine philosophical concerns such as multiplicity, identity and transience. These two authors represent a closer model to my own interests in blending art, code and aesthetics. It is also interesting that prior to hard-copy publishing Wark's book on gaming was written almost entirely in public on a specific website that encouraged readers to comment on the text as it was constructed. (Wark, 2007b)

Indeed it is worth noting that a significant amount of important current writing on games circulates

within the world of online journals and discussion lists long before it reaches traditional publishing. This is inevitably a result of the writers and researchers disseminating their work through the medium that they are studying in. Organisations such as *DIGRA* ("DiGRA - Digital Games Research Association," 2013), *GameStudies.org* ("Game Studies," 2013), the *IEEE* ("IEEE Xplore," 2013) and the *GamesNetwork* ("GamesNetwork," 2013) academic mailing list have been invaluable resources and have also given me the opportunities to publish elements of my own research. In fact, some of the arguments I present in this thesis come from work published through these organisations, for example; *"Pattern Recognition: Gameplay as negotiating procedural form"* (Betts, 2011) and my chapter for the IEEE *"Handbook of digital games"* (Angelides, 2013).

To conclude this literature review it is worth re-iterating the key points that have arisen from my engagement with each group of texts.

2.3.3 Summary

My reading of Kant (1.1) has provided me with a strong historical definition of the sublime. His logical descriptions of the mathematical and dynamically sublime have allowed me to extract specific factors (*complexity*, *permutation*, *autonomy* and *abstraction*) that can be used in my work to measure and encourage the digital sublime. His notion of boundlessness in systems (both natural and mental) has led me to investigate programming approaches that can support boundless digital generation (more detail on this in section 4). Shinkle and Ngai's writing helps to identify how the classical sublime has been modified by technology and suggests that the contemporary sublime may be less about transcendence and awe and more to do with transfixion and stupifaction. Wark, Deleuze and De Landa suggest a more celebratory view of the digital sublime. Their writing identifies important virtual structures of production and organisation such as *topological* and rhizomatic networks, *multiplicities* (generative systems) and the concept of *allegorithm*. It is my intention to use these systems in my work to form a methodological approach to my investigative practice (see section 4). The final section of the literature review (2.3) examined academic critique specific to game design/culture, identifying ludic concepts that reinforce the philosophical framework I am developing in this review. The illustration below demonstrates how all these sections and concepts function together.

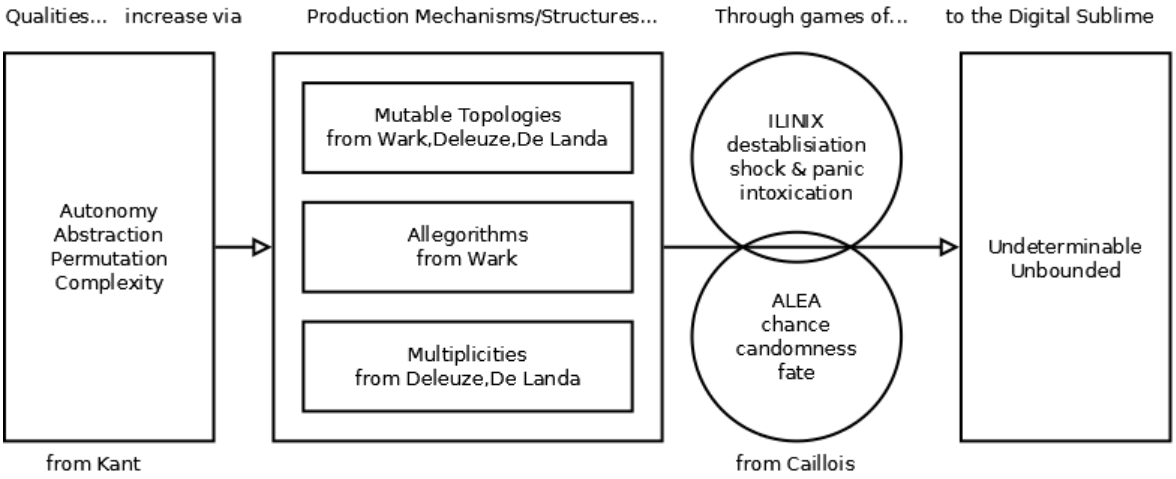


Figure 2.13: A summary of concepts identified in the review

2.4 A Definition of the Digital Sublime

The literature reviewed above has allowed me to identify various qualities, mechanisms and game experiences that contribute to a definition of the digital sublime in video games. The digital sublime exhibits the same core features of its non-digital counterpart and represents a point where human comprehension cannot keep pace with the subject's apprehension of concepts or experience. In other words, the sublime occurs when the subject is faced with ideas or phenomena that are beyond their power to process or determine. Although this point may differ from one individual to the next it can usually be traced through the overwhelming magnitude of certain qualities or concepts.

Although there are many qualities that can increase to the point of sublime boundlessness the ones I have chosen to gauge the digital sublime are *autonomy*, *abstraction*, *permutation* and *complexity*. These terms are applicable to the Kantian sublime but they have also been chosen because of their connections to digital terminology. They form a bridge between notions of the romantic sublime through to the technological sublime informed by the writings of Shinkle, Ngai, and Shaviro.

In the Kantian sublime these qualities increase through systems of logic (the mathematical sublime) or through natural phenomenon (the dynamically sublime). In the digital sublime both the mathematical and dynamic are combined into a computer simulation, but there are still conceptual systems (specific to the medium) through which the qualities of the sublime are increased. I have used the writing of De Landa, Wark and Deleuze to identify the systems of *multiplicity*, *topology* and *allegorithm* and describe their behaviour. Each of these systems can be used in digital games to

encourage a sense of unbounded complexity and the sublime.

Finally the writing of Caillois has enabled me to establish that games employing elements of *chance*, *disorientation*, *vertigo* and *autonomy* are most likely to support and encourage the growth of the qualities and systems listed above.

In summary, when the elements of a digital experience such as autonomy, abstraction, permutation or complexity become undeterminable by the subject the gap between apprehension and comprehension gives rise to the sensation of the digital sublime. Virtual frameworks such as multiplicty, topology and allegorithm encourage this scenario.

Of course for an experience to represent the digital sublime it need not exhibit all the above qualities or mechanisms and may, on occasion, include experiences that are not cleanly enclosed by the terminology presented here[18]. However the definition is broad enough to encompass a wide range of digital experiences while still being sufficiently specific to allow detailed exploration of the individual components.

18 The sublime/digital sublime is always framed by the participants subjective experience and expectations. This means that every individual can find the sublime at different points in the spectrum of qualities and experiences. This does not invalidate the definition of the digital sublime presented here, but it accepts that the concept of the sublime itself must be understood as a multiplicity of experiences that triangulate around that definition.

3. Peer Practice Review

Although literature is an ideal place in which to refine philosophical concepts and develop valuable terminology, digital games are an active medium. “Games are both object and process” writes Espen Aarseth (2001), “they can’t be read as texts or listened to as music, they must be played” It is therefore imperative that any contextual review includes a description and analysis of playing games. The following section is a peer practice review of digital games that represent qualities of the digital sublime (mathematical, generative, romantic) through their mechanics, visuals and code. It must be noted that the games discussed in this review were not designed to demonstrate the digital sublime, they do so because they explore the same qualities and techniques that have been identified as integral to the production of sublime scenarios. The emergence of sublime scenarios in the following games comes through a combination of the designers intentions, aesthetics and the behaviour of the code systems they have used. The games discussed in this section use programming systems that exhibit a significant degree of autonomy, allowing generative algorithms to contribute to the form of the game more than in most mainstream game designs.

To some degree, all games are an expression of their underlying code and data structures; noughts and crosses will always reveal its underlying 3x3 grid (no matter who the winner is), the blocks in *Tetris* (Pajitnov, 1984) will eventually stack up off the screen and the infrastructure of *SimCity* (Wright, 1989) will fail. Tightly-scripted or narrative-driven games tend to suppress the expressive range of their code in order to control exposition and sequence, but non-narrative games often allow their underlying systems greater freedom to promote emergence (Aylett, 1999). The games reviewed in this thesis belong to the second group, where the game-world is a result of autonomous code. My intention is to identify where other developers have approached their designs in a way that engages with and explores the digital sublime.

My own practice has also directed the choice of games examined. My design approach generally begins with the development of code systems that encourage emergent forms and autonomy. These systems are rarely “top-down” (i.e. dictated by a vision of what the final product should be), but rather built from the “bottom-up” to exploit sublime elements that emerge from early prototypes. Several of the games in this review follow the same development approach, for example, *Minecraft*,

or the *Game of Life*. My interests also focus on the development of audiovisual environments that reflect the structure and possibilities of code (see portfolio). This is also true for the games reviewed in this section.

Before examining the key examples it is important to clarify what sort of games are not included in this survey. There are a number of games which are frequently discussed in the context of the sublime, but the interpretation of the word is subtly different from my investigation. Games like *Skyrim* (Bethesda Game Studios, 2011) or *Dear Esther* (Pinchbeck, 2008) are described as sublime because they echo the romantic landscape tradition of Caspar David Friedrich (Friedrich, 1824) or Thomas Cole (Cole, 1843) with a focus on natural awe or meditative vistas[19].

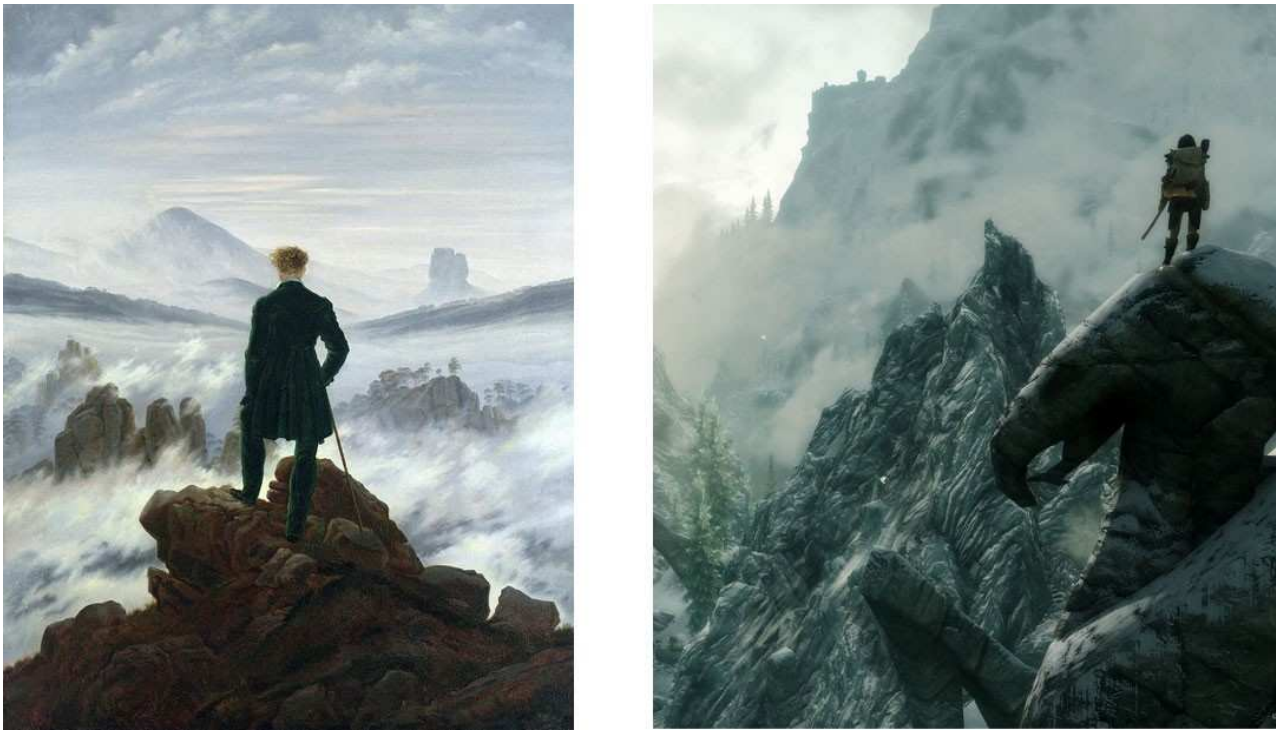


Figure 3.1: Left- The Wanderer above the Mists 1817-18, Caspar David Friedrich. Right- Skyrim 2011, Bethesda Games Studios

These games employ the stylistic approach of romantic landscape painting, which in itself was already a theatrical interpretation of Kant's original descriptions. This is not to say that there is no connection between this sort of artistic vision and my own research, in fact my second game *In Ruins* (section 7) explores this romantic ideal. But it is more interesting and relevant to my research when a romantic aesthetic results from the generative process of the game coupled with a specific

19 Joanne Taylor writes briefly about this relationship in her research notes at http://joannaetaylor.blogspot.co.uk/2012/12/the-modern-sublime-gaming-and-romantic.html

aesthetic treatment. This way the sense of the sublime emerges from the system rather than being "borrowed" from existing imagery.

3.1 The Game of Life

It may seem unusual to introduce *The Game of Life* (abbreviated as *Life* from now on) as the first example in this review since many people would argue that it is not a game at all. There is little or no interaction required and there are no goals or predefined progression. Yet it is a powerful example of an autonomous system that produces complexity in a manner that feels playful and game-like. It clearly demonstrates the sort of emergence and sublime detail that lies at the heart of many modern procedural games.

Life was designed by John Horton Conway in 1970 (Adamatzky, 2010) and is played out across an infinite grid of binary cells that are either alive or dead, (one or zero, full or empty). These cells change state based on a set of simple rules that only takes into account the status of their nearest neighbours. The rules are as follows:

- Any live cell with fewer than two live neighbours dies, as if caused by under-population.
- Any live cell with two or three live neighbours lives on to the next generation.
- Any live cell with more than three live neighbours dies, as if by overcrowding.
- Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

Although these rules operate on cells in a local scale the results generate complex non-linear behaviour across the entire grid. When initially performed by hand in Conway could already see interesting patterns and detailed behaviour emerge. But it was only when computers were able to run the game at greater scales and rates that the true range of complexity and emergence could be explored. *Life* generates bubbling chaotic clouds, static formations, oscillating groups, travelling clusters and even replicating systems (see illustration below). These systems, although primitive in representation mimic Kant's dynamic sublime, with its source material of waterfalls, storms and fires.

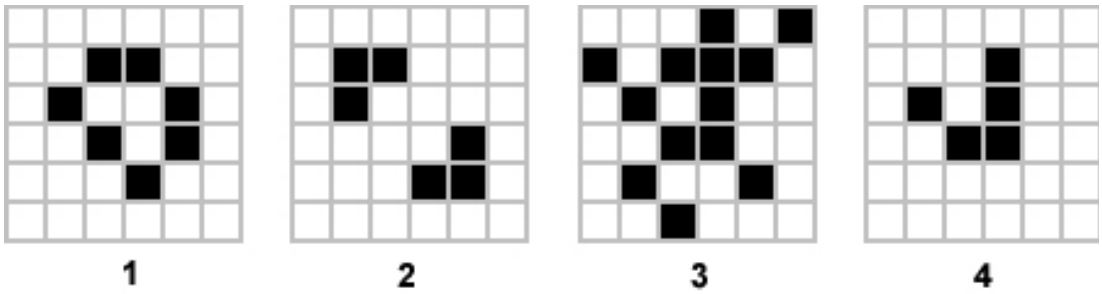


Figure 3.2: Emergent structures in the Game of Life (1 static loaf, 2 oscillator, 3 noisy seed, 4 glider)

Conway's *Life* is a classic example of a simple ruleset that generates procedural form. It is such a clear example of permutational complexity that De Landa devotes an entire chapter in *Philosophy and Simulation* (De Landa, 2011, p. 22) to discussing the range of forms and possibilities it produces. These structures include "glider guns", autonomous systems that can be used to spawn other repeated forms into the game-space[20] (see figure 3.3).

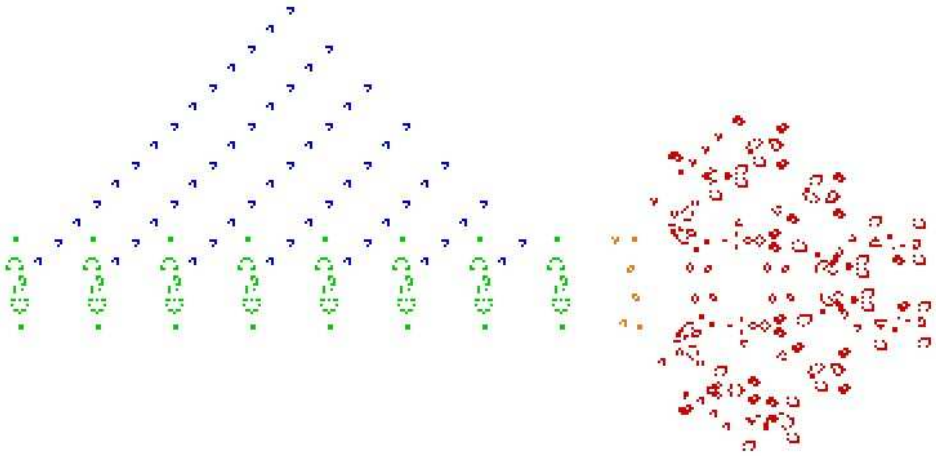


Figure 3.3: A stable "puffer" producing "glider guns"

20 : In this example a puffer-type breeder (red) moves across the grid leaving glider guns (green) in its wake, which in turn create gliders (blue). All these forms exhibit different behaviour but are produced by the same simple rules

Life is a deterministic system (i.e. the same initial state will always lead to the same chain of events) but produces such a wide range of permutations that it seems "alive". It can be seeded with random noise or geometric patterns but in most cases it is impossible to tell what the results will be, the grid could collapse into oscillating but static forms, die out completely, or even migrate across the grid.

Life can appear repetitive and boring, incomprehensible or strangely purposeful. And it is effectively infinite, both in size and permutations, every possible form in *Life* has a determinable outcome at N point in its future, with all those possibilities being directed yet unrealised by the underlying virtual system. This range of algorithmic possibilities indicates how games can bridge the gap between the mathematical and dynamic sublime. And the range of latent, emergent possibilities make it an interesting algorithmic parallel to Deleuze and Guattari's notions of the rhizome and multiplicity.

Not all games represent the permutation and autonomy of code as clearly as *The Game of Life*. Many games use visual design or narrative framing (as in Wark's allegorithm) to communicate the aesthetics of code and permutation. The following games in this section use similar generative systems to create their game-spaces but their stylistic approaches are quite different.

3.2 Minecraft

Minecraft (Persson, 2009) is an open-ended game of exploration and construction, based on a mathematically generated world. Its rapid and unexpected popularity caused a stir in the mainstream games industry, where the game's success was seen as surprising because *Minecraft* is a non-linear game with simplistic graphics, developed by a single programmer. This sort of design approach contrasts sharply with mainstream titles, where games feature hand-crafted content produced by large teams. Unlike these studio-developed games, *Minecraft* has no specific goals, no scripting of events or narrative, and no pre-designed world.

Minecraft is reliant on procedural rules, similar to those in *The Game of Life,* that govern the production of its world and direct the emergent effects of its game systems[21]. The environment is generated from a set of layered algorithmic systems and is effectively infinite. There is no hand-placed content in the entire starting game-space, every element of the landscape is calculated from deterministic rules. This applies to the extent that a world generated from the same numerical seed

21 The world in *Minecraft* incorporates various cellular automata processes to simulate the behaviour of water, fire and plant growth. Together these systems produce emergent effects in gameplay where rivers flood caverns over time or forests grow across mountainsides.

will be identical for every player generating that world. The game is effectively visualising a deterministic sequence, giving a mathematical sequence a virtual 3D form. What is fascinating is how this process conflates Kant's mathematical sublime (the mental/internal) with the dynamically sublime (the experience/external). Of course the representation is thematically constrained, layers of filters are applied to the generated sequence. Algorithms mould the data into rolling hills, cliff-edged islands, deep oceans and vast caves.

Figure 3.4: An unusual geological code feature generated with the seed word "Invisible"

The players negotiation of the worlds produced is essentially the exploration of procedural algorithms drawn in three dimensions and filtered by simple game rules. It is the careful superimposition of these rules on the underlying form that gives purpose and direction to the players interactions. The rarity of different block types, the altitudes at which they occur and the conditions necessary for creatures to spawn all give a wider expressive range to the underlying mathematical world. Players begin by simply negotiating the terrain, becoming familiar with the structures that are possible and the mechanisms for navigating them. Next they learn the distribution of elements and their uses. Finally they understand the construction of the world in such a way that allows them to engage with it on an almost subconscious level, as Isaac Lenhart says:

> The experience of the landscape is similar to an aperiodic tessellation, where the player may see similar aspects to the environment within their exploration of the space, but the features of the landscape are not identical. This semi-paradoxical construction of the space results in an abstract experience of chora, of a space where something can occupy, but not a specific location. It is all just world/region. (Lenhart, 2011, p. 9)

But the world is infinite, limited only by the capacity of the computer's hard drive. Whichever direction the player might wander triggers the system to "realise" that section of the world. The world already exists in some virtual form, within the potential of the code and the generative systems. But until it is visited it has no digitally rendered form. This gives *Minecraft* a great sense of being an eternal frontier, an endless horizon that that is not fixed until it has been seen, explored and mapped. Inevitably this affects the aesthetic of the world and of gameplay.

There is often a feeling of being lost in *Minecraft*. Until players have committed visual landmarks to memory or altered the terrain themselves they can feel disorientated and isolated. The game never ends, there is always a new part of the infinite plane to be discovered. Sometimes the boundlessness can play tricks in the way the sublime plays tricks. There are unique and magical land forms, near clones of similar areas and things that look like they have more individual intent than should be possible from permutations. Though if the world is infinite, but composed of a finite instruction set, then every *Minecraft* map must meet every other *Minecraft* map somewhere, and every landscape formation you can imagine within that instruction set must also exist, somewhere in the virtual unrealised multiplicity. As much as this can be felt as a sublime effect it can also force players into a more stuplime state, where the permutation and endlessness becomes paralysing, forcing the player to give up, since there is no way to "beat" the system.

Sometimes the sense of the sublime is not brought on by the game's endless expression but by its flaws. Occasionally data corrupts in the system and chunks of the world are distorted or destroyed, resulting in a disruption of continuity that draws attention to the underlying system and its frailty. There are edge cases called the *Far Lands* where the algorithms break down due to the sheer scale of the numbers being processed. Here again the world collapses back from its romantic ideal into a revelation of digital processing. So at the same time *Minecraft* can present the spectacle and vistas of romantic vision it also displays its algorithmic generation through its blocky pixelated style and glitches.

Figure 3.5: A chunk error splits the terrain apart due to corrupted data in Minecraft

Other games such as *Terraria* (Re-Logic, 2011) or *Diablo* (Blizzard, 1996) use procedural generation to create their worlds, offering variation and re-playability, but none of them exposes the world creation and underlying system as clearly as *Minecraft* does. *Minecraft* operates on the basis of cellular automata (the same system as Conway's *Life*), but uses these systems to create an explorable world. Its simplistic rendering of natural structures and processes reveals a complex world of permutation and autonomy. There is an allegorithmic challenge in the gameplay, tasking the player to overcome and master the infinite permutations of this autonomous world.

3.3 Love

Love (Steenberg, 2010a) is a first-person perspective exploration and combat game by Eskil Steenberg. It takes place on a small procedurally generated planet, which is generated anew for every instance of the game[22]. The underlying geometry consists of a small globe, approximately 1km in diameter, which is constructed dynamically from a series of algorithmic functions. These functions dictate types of terrain such as deserts, ice sheets, mountains and forests. Sometimes the

22 Each instance of the game is based on a unique world, held on a remote server. Every server contains a different version of the game-world, which is procedurally generated for that instance of the game.

world is easily circumnavigable in the space of ten minutes but the player is often frustrated by canyons, cliffs and great lakes. All the terrain is generated dynamically, and as with *Minecraft* the geometry often reveals its mathematical nature. Cubic structures and grid-like patches punctuate the world, looking like frozen examples of Conway's *Game of Life* (3.1). But there are also errors, areas where the algorithms do not quite match up, or leave glitches and gaps. Most of the time these errors are unnoticeable amongst the alien abstraction of the general world design. Occasionally the world will generate errors that are too drastic to be incorporated logically, forming inescapable oubliettes or impossible chasms. Here the player is momentarily thrown out of their immersion in the world, becoming aware of their role in this mathematical expression. But these events add to the subconscious feeling that the game is an expression of code, one permutation of countless worlds. Eskil deliberately leverages this effect to create an environment that feels unlike most other games.

Figure 3.6: Procedurally generated causeways connect crystalline columns

Perhaps most striking of all is the fact that the spheres evolve over time, their surfaces changing form over a period of weeks. Server-based algorithms constantly recalculate areas of terrain and drip feed those changes into the active world like a process of shedding and regrowing skin.

> The procedural content is the substance. It makes it possible to do things no other games can do. The “Concept” of how it’s being done doesn’t matter to the player, just the result. (Steenberg, 2010b)

Such changes are rarely noticed (Eskil claims that the rate of substitution is so slow that a player would be lucky to notice even one chunk of the terrain change in real time) but they slowly shift the world from one possible expression to another. And this is not always a smooth process, often the path of substitution leads to corrupt geometry as the world sheds its old form. In fact it seems that the longer a world runs for, the more likely it is to become error-prone.

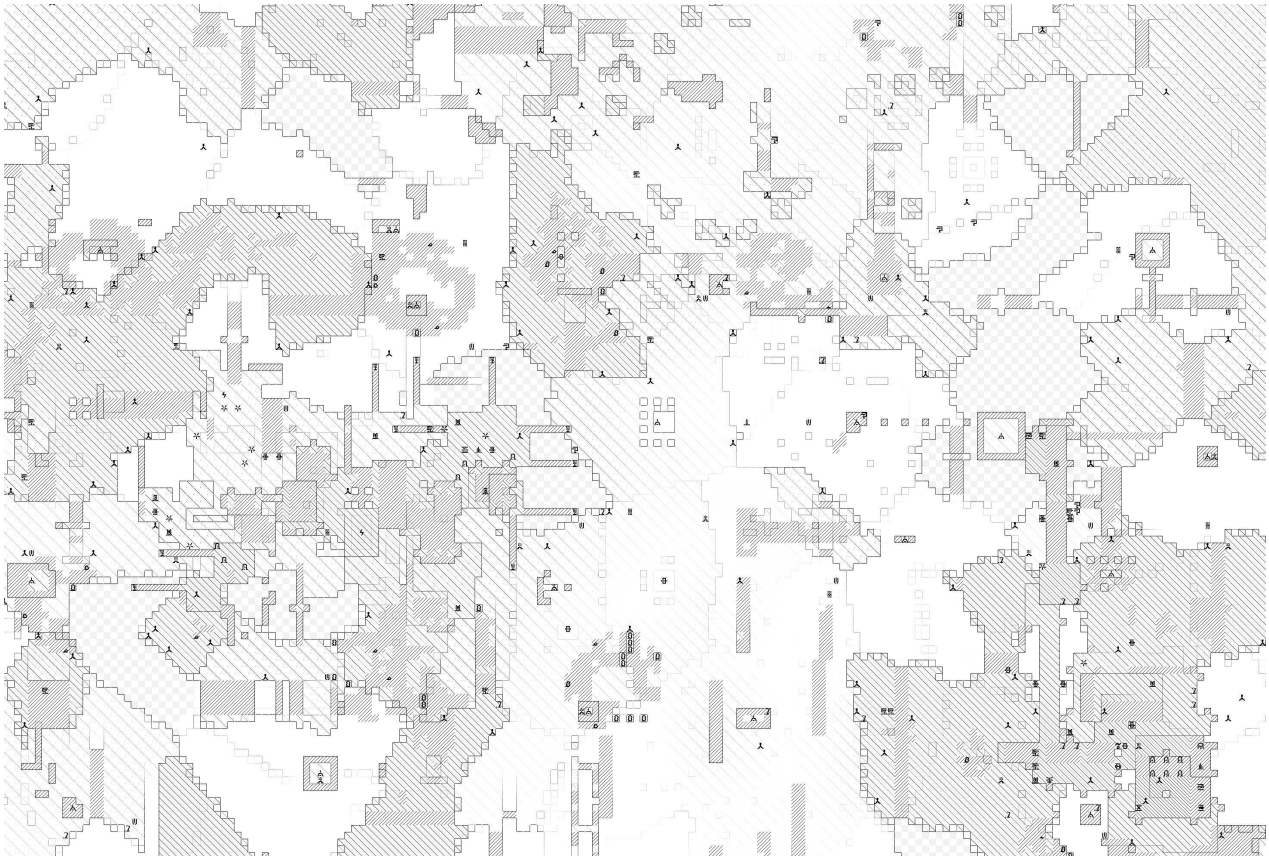


Figure 3.7: A detail of the generated underlying map data

The visuals of *Love* are also unique, even though the underlying geometry is coarse, the game-world is drawn with an abstract painterly flourish, where colours on forms bleed into the surrounding air. Crystalline cliffs recombine above oscillating seas punctuated with wandering plumes of smoke. The cubist-like aesthetic of *Love* supports the sensations of permutation and autonomy.

Love failed on a gameplay and commercial level because it took this aesthetic experience of exploration and wonder and attempted to integrate it with an overly complex multiplayer mechanic. I spoke to the developer during its development and attempted to persuade him to capitalize on the

sense of wonder and alienation that the world generated, but the project developed differently. I think a better experience could have been built around those elements, with simpler mechanics that tied into the fascinating world model (something I attempt to explore in my own research games).

In summary, *Love* represents a game-system that engages with the key factors of the digital sublime. Its many worlds demonstrate the notion of permutation and the intersections of its landscape types leads to an unpredictable level of complexity. The constant modification of the world through coded tectonic changes gives the game a sense of alien autonomy and the graphical treatment of the environment creates an abstract rendering that itself implies a sense of the digital sublime. The final game reviewed, *Proteus*, also combines the aesthetics of procedural code with visual tropes of the sublime, but it in contrast to *Love* it focuses the game experience entirely on this environment by featuring almost no game mechanics or traditional objectives.

3.4 Proteus

Proteus (Key & Kanaga, 2013) is a game of audio-visual exploration and discovery by Ed Key and David Kanaga. The title refers to the myth of a Greek changeling god who would adopt different forms to avoid answering questions. *Proteus* itself embodies this narrative by presenting an almost goalless game-space, where there is no real narrative or guidance.

In common with both *Minecraft* and *Love*, *Proteus* adopts a low-fi visual style which supports a wider range of interpretation and representation than photo-realistic representation would. The visuals never pretend to be anything other than a digital abstraction of the natural world, a pastoral terrain defined in a hypnotic 8bit aesthetic. As such, it is difficult to criticise the game through comparison to real environments. This is an important aesthetic decision which allows the players to engage with the software on its own terms, within Huizinga's magic circle (J. Huizinga & C., 2000, p. 9), and is a technique I also employ (none of my work is photorealistic). The game-world consists of a procedurally generated island, populated with autonomous creatures and organic ambient flora. This environment is coupled with David Kanaga's tumbling melodies, each musical interaction tied to specific entity in the world. Trees shed clouds of square cherry blossom in forests of swirling notes and cubic frogs hop away from the approaching player accompanied by percussive refrains. There is a feeling of autonomy and mystery within the islands, where the permutations of sound and spaces create different, yet familiar interactions with each play-through.

Figure 3.8: The pixellated terrain of springtime

Unlike *Love*, the mechanics of interaction in *Proteus* are minimal. Your avatar has only basic movement controls, there are no dangers, no skills to learn or challenges to overcome. This intentional restraint enables the player to focus on the meditative nature of exploration. The environment is also restrained in its complexity, there are no overhangs or cliffs, no caverns or ravines than might hinder the progress of the player. This version of the digital sublime is a safe space of unhurried wandering. Its only in the final section of the game that a sense of menace or disturbance is inferred. The minimalism of design also reduces the likelihood of generational errors occurring in the game. In *Minecraft* or *Love* broken geometry draws attention to the underlying processes by revealing chinks in the fabric of the world. These glitches happen rarely in *Proteus*, and when they do the result is less jarring.

Figure 3.9: A generational error in the sea

Indeed, the overall aesthetic of the game is of a carefully curated sublime, reminiscent of nineteenth-century romantic landscape painting or Jorge Luis Borges' (Borges, Yates & Irby, 2000) meditative mind-to-world spaces. Whereas *Minecraft* or *The Game of Life* are obviously digital, *Proteus* references an analogue aesthetic. Key's rolling hillsides are a visual contrast to the cubic worlds of *Minecraft* or *Love* and Kanaga's un-quantized soundtrack sounds more like pre-digital psychedelia than contemporary digital beats. And while the audio references early synthesiser music, the visuals reflect the aesthetics of early computer graphics.

> It is nostalgic, in a sense that you have references to the low color graphics that you might remember from early games with their pixellated worlds. As a child you would load up these games and wander around, there was a great sense of discovery and mystery. Sometimes the over-representation of things can spoil that sense of wonder. (Key, 2013)

I agree with the use of looser representation as a medium for encouraging engagement. But Key's highly curated world may be too comfortable when examined under my research criteria. It lacks the disturbances or threatening unknowns that can come from more unbounded complex systems.

Key is a dedicated amateur botanist and forager and the distribution of flora and fauna in *Proteus* reflects these interests. Plants are scattered across the generated terrain, according to how well the environment suits their requirements (heat, light, moisture). Key refers to this sort of generative process as a system "answering its own questions", and he relates this to the way that the natural landscape is colonised by ecosystems, there is no single definitive pattern for things to follow but a series of environmental questions and possibilities of solution. Allowing the player to sense this process is important to Key "You don't necessarily know what the question is.. but you know that the system is trying to find an answer and not one that is directly dictated by human hands" (Key, 2013). This approach seems to walk the line between the abstraction of digital systems and the taming of the sublime in a Romantic-era framework. It's one of the reasons that *Proteus* is so approachable, it uses notions of nature and the organic purpose to give its generative spaces a soulful rather than alienating atmosphere. There is a sense of Wark's allegorithm in the way the player interacts with the world and its inhabitants.

What about the range of permutation in *Proteus*? Key explains that he sees the range of islands possible in the context of multiverse theory, where there are many worlds that might overlap in terms of shared properties or territories. In *Proteus*, all the islands exist in close virtual proximity, forming a curated range of possible expressions within a broadly defined search space. This closely reflects Deleuze's notion of the multiplicity.

In summary, *Proteus* demonstrates how careful aesthetic design and setting can encourage players to engage with systems that might otherwise seem too alien or abstract. It is also a useful example of how existing notions of the sublime (the Romantic Landscape ideal) can provide context and even purpose to players.

The games examined above all use procedural rules and emergent form to create a sense of wonder and mystery. They balance the potential chaos and complexity of non-linear systems to generate virtual environments that feel autonomous and purposeful, yet incorporate a sense of alienation or abstraction. This core notion of games as emergent virtual system, expressed via mechanics and environments is the basic foundation for my own research practice The following section shows how these findings were used to build a specific model of game design thinking.

4. Research Methods: An Approach to Processes and Practice

This research is an artistic investigation of the digital sublime in video games. It uses the literature of Kant, De Landa, Wark and others to form an understanding of the digital sublime (see section 2) and then explores the resulting definition through the artistic production of three video game projects. This chapter describes the research methods used in the production and analysis of these three games.

4.1 The Artist-Programmer

Throughout this thesis I refer to myself as an artist-programmer, someone who uses the medium of code to create art. Alex Mclean describes practitioners like myself as "artists who get directly involved with computer languages as environments in which to create. They are end-user programmers, in that they create software not for others to use as tools, but as a means to realise their own work. We refer to such people as artist-programmers."(C. A. McLean, 2011, p. 14) As an artist-programmer I have been creating software for over fifteen years, producing a wide range of work; from data-visualisation in *Webtracer* (Betts, 2000) through experimental game design in *Endless Fire* (Betts, 2005) to audiovisual performances in *pdhp/sltr/lessbar* (Betts, 2013). My work frequently explores aspects of the digital sublime such as autonomy, abstraction and complexity. It deliberately allows users to engage with these phenomena, presenting encounters with generative forms in works such as *QQQ* (Betts, 2002), infinite permutations in *Rand()%* (Betts & Gilmore, 2004) or chaotic iteration in *CCTEX* (Betts, 2004).

These projects combine the aesthetics of artistic enquiry with the formal investigation of computer science. This is a reflection of my general practice methodology which employs both the problem-solving objectives of computer programming and the subjective judgements of artistic design. In this section I will explain how these two disciplines function together, and how they can become intertwined. I will also explain how I have used this research opportunity to extend my existing practice methods in order to focus on the investigation of the digital sublime.

When writing my software I generally follow a *scientific experimental* methodology (Maxion,

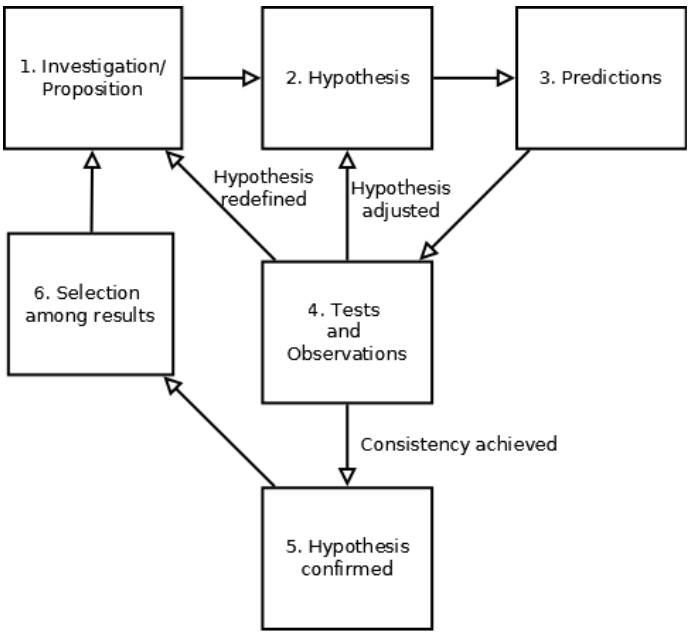
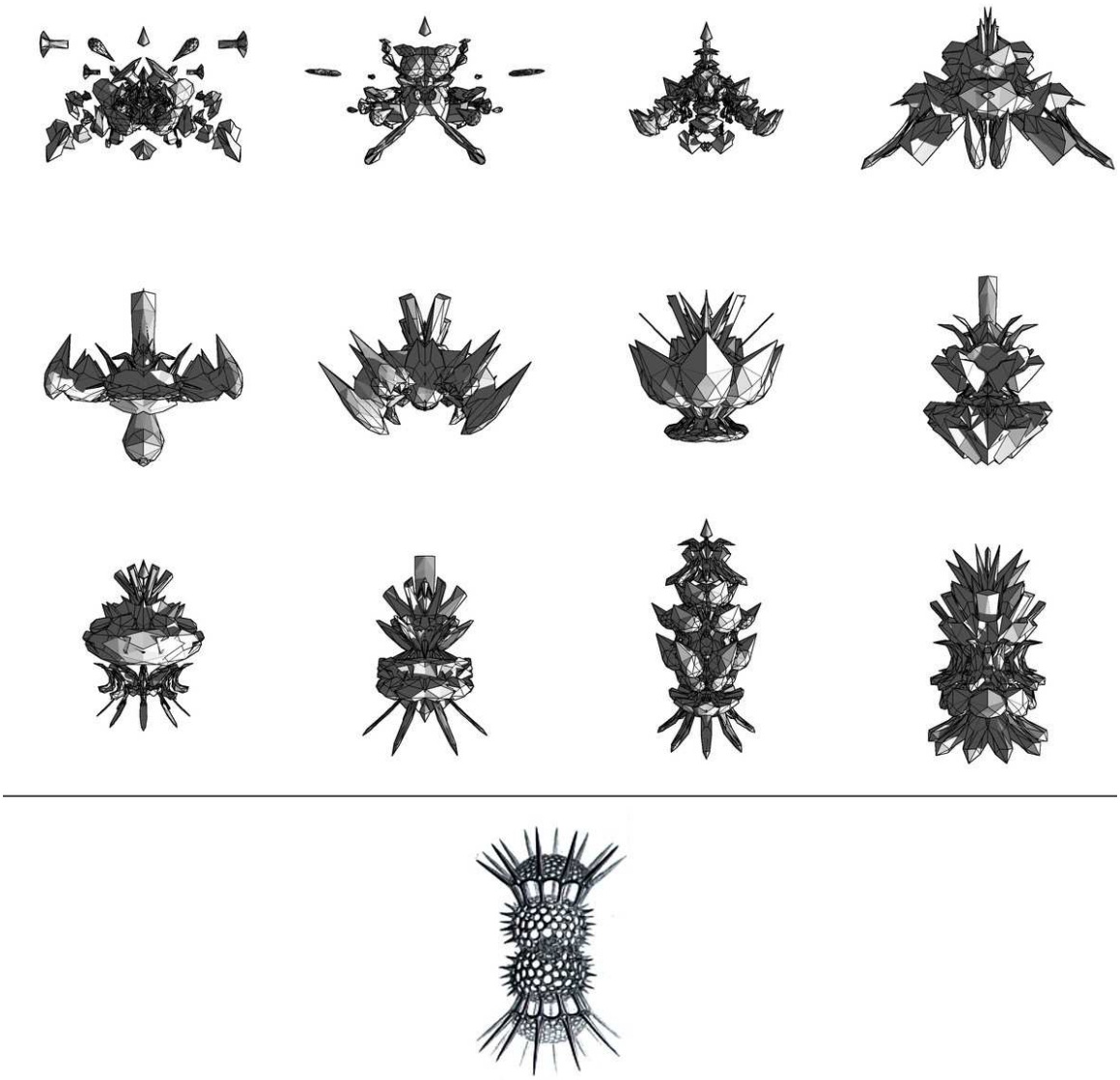


Figure 4.1 : Scientific Experimental methodology (adapted from Dodig-Crnkovic 2002)

2009), the process of which is outlined in the figure below. This approach begins with an investigative proposition (1), which is used to identify specific objectives for my programming to fulfil (2). Then I produce a series of prototypes and tests, which are modified and refined through multiple cycles of feedback and adjustment (3,4). Once the code is working as intended and the hypothesis is confirmed (5) I can identify (and eliminate) elements beyond the scope of the desired result (6) and end up with a final version of the system.

The results of this process often prompt a subsequent investigation that explores or extends a related aspect of the system. In this way the methodology is cyclical and rhizomic[23], with each experiment providing material for other interconnected experiments. As Dodig-Crnkovic states, "It is crucial to understand that the Logic of science is recursive." (Dodig-Crnkovic, 2002).

23 I mention these terms here to draw a connection from my chosen approach to the concepts of the rhizome and the multiplicity identified in section 2. This is to show that the structure of my practice methods can also follow aesthetic and philosophical guidelines.



4.2: Iterations of a form generation system. Working towards an appoximation of the target image from Ernst Haeckel: Kunstformen der Natur, each iteration has successors based on personal aesthetic evaluation

A practical example of the experimental method in my work might be the production of a system to generate specific visual forms based on mathematical formulae. I will identify a target result for the system to produce (for example, the Ernst Haeckel drawing in the figure above[24]) and then repeatedly evaluate and modify the program code until it produces results within a tolerable threshold to the target image. In some projects I will re-evaluate the system mathematically,

24 This figure shows a selection of results from a form generation program I wrote as a prototype. Each iteration is assessed visually for its likeness to the target image (at the base of the figure) and the program is adjusted and re-run. This demonstrates the processes of both of algorithmic refinement and of artistic guidance criteria.

producing hundreds of variations until the desired criteria are met (for example; a precise number of polygons in the forms of figure 4.2). But often the judgement of each generation of forms is performed by eye, with the aim of encouraging a specific visual form.

It is important to note that there are also points where the artistic evaluation of a program's output can lead to a redefinition of the core proposal or suggest a modification to the judgement criteria. For example, the visual results of one iteration of the system might present a novel direction for the program as a whole and require a re-writing of code or evaluation criteria. This sort of reactive flexibility is a key element in the artist-programmer's methodology, where scientific investigation intersects with artistic sensibility and "self-reflexive practice describes an inquiry process that is directed by personal interest and creative insight, yet it is informed by discipline knowledge and research expertise." (Sullivan, 2010, p. 110). In this way the two disciplines interact with one another and become combined.

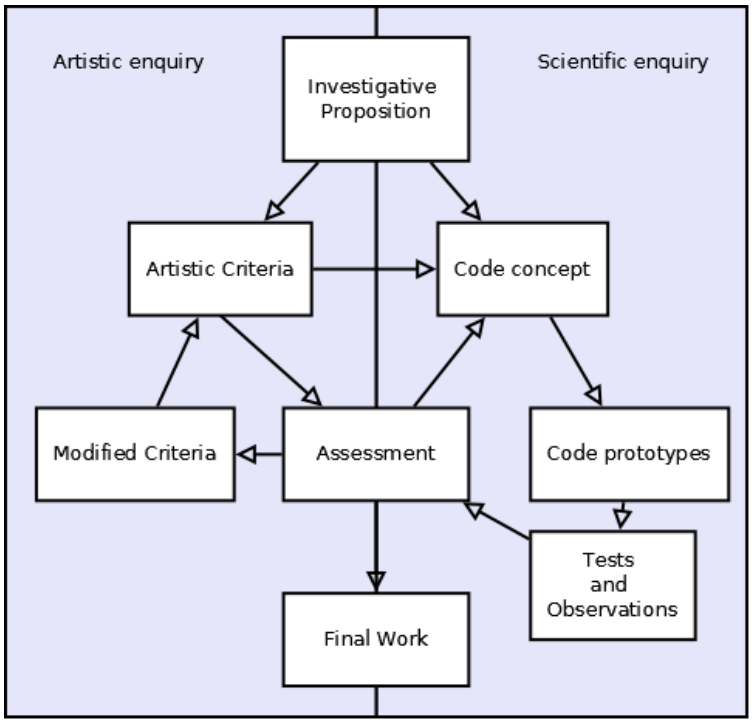


Figure 4.3: The combination of scientific and artistic approaches

In fact, the two disciplines are intertwined on many levels. There are subtle interplays between programming and artistic assessment that occur even within the typing and structuring of code. As McLean points out, "there is a tendency for computer artists and their audiences to focus on

processes as disembodied, autonomous activity. By exposing the activity of programming, perhaps we can adjust the balance towards focus on human interaction rather than autonomous processes" (C. A. McLean, 2011, p. 17). Programming is not just a black box that brings ideas to life, instead the artist-programmer uses code as an artistic tool and is embodied in the interplay between traditional art practice and experimental computer science.

The combination of these two disciplines provides many investigative avenues to the artist-programmer, especially when the differences between the two areas are viewed as "bridges, not barriers" (Sullivan, 2010, p. 100). The table below compares some of the key differences between the two approaches I use in my practice.

Scientific approach	Artistic approach
Test hypothesis by experimentation (answering)	Products as problematics (questioning)
Outcomes as proofs of concept	Outcomes as indefinite/aesthetic artefacts
Use of traditional frameworks & protocols	Use of playful and alternative strategies
Focus on programming/process	Focus on form of outcome
Use pre-existing knowledge appropriately	Apply pre-existing knowledge laterally
Peer judgement	Personal judgement

4.4: A comparison of scientific and artistic methods

As an artist-programmer I use elements from both approaches. In one project I might use existing software techniques to solve a specific problem, but in another project I might employ the same techniques improperly to deliberately generate broken but aesthetically interesting results. Often I will even combine the two by using the output of code both as a proof of concept and as an aesthetic artefact. By selecting the appropriate approach for the task in hand the artist-programmer uses techniques from both disciplines to navigate through the creative options available. In either case the actual work is produced using programming where the computer code acts as the medium for

artistic expression.

4.2 Code as a Medium

Modern computer code is an increasingly expressive set of languages that have their own dialects and even performative attitudes (C. A. McLean, 2011). As an artist-programmer I feel that a significant parallel can be drawn between the construction of meaning via code and the construction of meaning through other mediums such as text or image. In each case the style and semiotic structure of the language (code, words, graphics) affects the output and the "reading" by an audience. It is beyond the scope of this text to investigate what this means within the broad discipline of programming, but it is important to understand that the choice of language and style of code can affect the tone and form of a software project. McLean states "the programs that spring forth from fingers at keyboard have a trace of analogue relations in conceptual space, as well as high level, structural reflections cast from the language of the mind." (C. A. McLean, 2011, p. 150) As my aim is to investigate ideas of permutation, autonomy and complexity then certain programming models and conceptual approaches will support this enquiry more than others.

In general, my use of code and choice of programming techniques reflects my artistic concerns in formalism and complexity. Computer code is a digital medium, which in its early forms was seriously limited in its expressive range (Ceruzzi, 2012). However, modern languages are now much more complex and provide many dialects and conceptual frameworks (even incorporating meta languages that link and extend existing languages). The design of programming languages and code is tied to structural aesthetics and analogies where "Metaphor permeates our understanding of programming" (A. McLean & Wiggins, 2010).

Object Orientated Programming (OOP) considers the elements of a program to be atomic constituents that maintain their own state and interact with their environment through interfaces.

Functional Programming (FP), on the other hand, focuses on operations which pass data around, eschewing the idea of global states or objects.

This leads to programming being capable of representing a philosophical stance and it is worth mentioning that some philosophical movements explore concepts familiar to specific coding paradigms, *Object Orientated Ontology* (Harman, 2013) being perhaps the most obvious example[25].

25 The connections between programming concepts and philosophical approaches is a complex topic that is unfortunately outside the scope of this thesis. For now it is simply worth identifying that the two practices have significant points of overlap when concerning the use and structure of language.

Different programming approaches, such as OOP or FP all have their own stylistic flourishes, linguistic tropes and guidelines about what is well structured or elegant code (Watt, 2004). The diagram below demonstrates some of the differences between these two programming paradigms.[26]

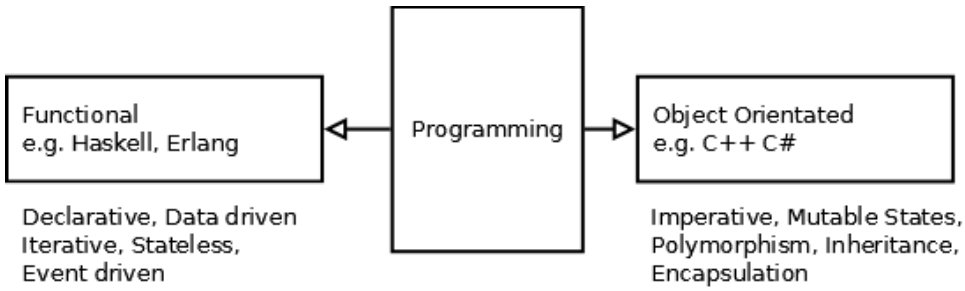


Figure 4.5: Conceptual differences in two specific programming paradigms

Using code as a medium to create art inevitably means that some of these underlying structures and conceptual approaches influence the final work. For my research I needed a language and approach that was both practical (I.e. capable of producing games) and conceptually aligned to the philosophical frameworks of the digital sublime. I chose the language C# and adopted a style that combines both a component-based design pattern and procedural (or generative) techniques.

C# is a common modern language (inherited from C) which along with C++ is one of the most popular languages for games programming (Schuller, 2010; Murray, 2014). It is object-orientated, which allows for a degree of autonomy within code and also supports inheritance, where objects can be extended and varied based on simple base designs.

The component-based approach is a system where many elements of an object or function can operate independently and be added to or removed from a process with ease. This means that a program can modify the behaviour or form of a object multiple times and in different orders by attaching and ordering components.

Finally, procedural techniques are language agnostic methods for producing complex forms using mathematical functions. Procedural methods allow the programmer to produce a wide range of possible variations of a system or form and even automate that process.

26 Haskell and Erlang are functional programming languages that focus on iterative procedures and nested execution, whereas C++ and C# are object-orientated languages that focus on mutability and inheritance. Unfortunately a deeper explanation of these terms is beyond the scope of this thesis; if readers wish to find out more, David A Watt's "Programming language design concepts" (2004) is a good source.

I have already used many of these processes in my existing art practice, and have developed a significant level of understanding and expertise with these systems[27]. The programming styles listed above support the production of complex autonomous objects and as such provide a strong framework for the development of code intended to investigate the factors of the digital sublime. However, the adoption of any particular programming paradigm must be combined with key elements of design and production in order to produce a piece of digital art or video game.

4.4 Game Design Process

There are many different approaches to software design and prototyping. In mainstream software development processes such as UML (Unified Modelling Language)[28], Design Pattern application[29] and Unit testing[30] are used to produce extensible, re-useable and stable code. These practices are invaluable in the development of business software and when working with collaborative groups on large code bases. However, such techniques are less applicable to game design, especially when the project is developed by a single author with artistic goals rather than commercial ones.

Commercial software development has predetermined objectives and many applications are simply improvements or iterations on previous designs. In contrast game design is a much more organic process, including many phases of prototyping, code branching and experimentation. As a solo developer there is less pressure to produce code that is universally transferable or systematically organised to work with multiple collaborators. This allows a single developer to be more agile than a larger team, but it can also lead to badly structured code and inefficient working methods. Most developers avoid these pitfalls by evolving their own design patterns over time and being aware of their limitations and expectations. I have developed a series of design patterns and processes that fit both the objectives of my artistic practice and the associated programming tasks. These patterns and processes are implemented in projects through the chronological stages of prototyping, production, presentation and analysis. The figure below describes these stages in more detail, also showing where stages of development feed back into associated tasks (as described in section 4.1).

27 Other programming languages or paradigms may also be able to produce a similar working environment and results, but the models and approaches chosen here are the most suitable for my practice and for addressing the research.

28 UML is an abstracted diagrammatic planning schema that allows designers to plan software development in a non-language -pecific environment. The diagrams in this thesis share many similarities with UML style schema.

29 Design Patterns are reusable approaches for solving common design problems such as managing object lists or extending functionality of objects.

30 Unit testing is the practice of simulating small aspects of a program's functionality with dummy data, in order to test their stability in isolation.

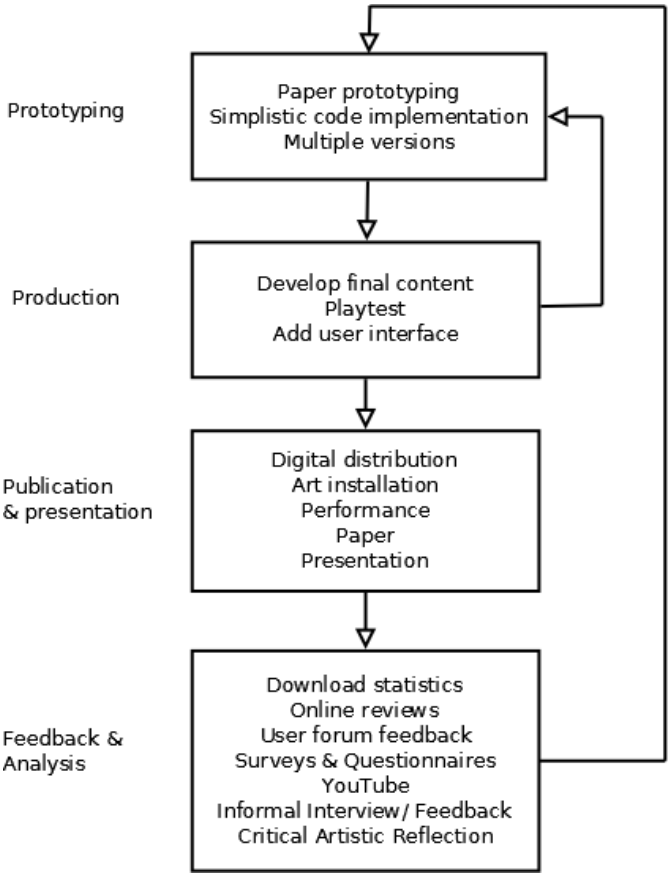


Figure 4.6 The stages of production for game development

4.5.1 Prototyping

Much of my game design happens away from the computer. Whenever an idea arises I will record the concept in text, diagrams and drawings in a notebook. If the idea seems feasible then I will proceed to write up some possible implementation details, often outlining programming structures in pseudocode[31]. This process is much quicker than prototyping directly on the computer and also allows me to conclude issues or eliminate problems before beginning programming. It also means that the beginning of the design process is not immediately digital and is comparable to the classic artist's sketchbook, where material and inspiration found outside the studio is collected and sifted before it is incorporated into on-site work[32]. Working outside of a programming environment during

31 Pseudocode is a language agnostic style of coding. It is not meant to be executed, but offers an easily read, generic example of how an algorithm might be composed; readers can then implement a version of the solution within their chosen programming language.

32 Marcel Duchamp's *Green Box* is a good example of this practice, particularly in this case as it contains sketches, notes, poems and mathematical calculations. http://www.tate.org.uk/art/artworks/duchamp-the-bride-stripped-bare-by-her-bachelors-even-the-green-box-t07744

the initial stages of prototyping allows the process to be more fluid and less constrained by software protocols.

The next phase of prototyping involves producing various iterations of the concept on computer (see the experimental method discussion in section 4.1). While prototyping these systems I maintain flexible structural definitions and coding conventions, and often work on multiple versions of the same program with different elements removed or extended. I also create back-ups of the whole project in order to protect the development and allow me to step back to earlier iterations. Often I begin working in 2D and then extend the calculations to three dimensions later in the prototype[33].

Once I have a working framework for generating content I refine the structure and output of the code through many iterations of programming and testing. At this stage my interactions with the project become game-like themselves as I enter into a looping phase of tweaking algorithms, exploring the results and then revising the code (as discussed in 4.1). During this stage I explore a much wider range of permutations and interpretations than feature in the final product. I then begin a sifting process in order to narrow down the range of designs to the target form. I generally have a specific mood or tone I am attempting to create (the thrill of vertigo, a confusion overcomplexity etc.), and I shape the output of the code in order to achieve the most appropriate result. This is a common approach for artists dealing with generative systems, Brian Eno describes it as "...more like the work of a gardener. The gardener takes his seeds and scatters them, knowing what he is planting but not quite what will grow where and when". (Eno, With, 2011)

Once I have a stable game environment and useful methods of interaction, I start to implement the project's game mechanics and interfaces. It is at this stage where I invite peers to playtest the systems and offer informal feedback. I may place demonstration versions on the internet or post images and recordings of the work in progress. If there is a definitive goal for the product publication (installation, performance, presentation, public release) I will also be experimenting with the type of contextual framing the project might need by testing various styles of graphical information design or implementing different methods of game feedback. This enables me to begin thinking about issues of presentation and communication early in the design process. Although prototyping of certain elements will continue until the game is finished there is always a stage where the core of the game is established and the next task is one of production and refinement.

33 Working in 2D reduces the amount of work and complexity involved in prototyping and therefore increases the speed with which an idea can be tested.

4.5.2 Production

The production phase of game development generally focuses on the creation and incorporation of the assets and content that are produced externally to the main game code. In my work the majority of the content is algorithmically created and as such there is much less external content design needed. However there are still a significant number of graphical and audio elements that need to be produced to enhance and frame the procedural work to ensure the software is readable and usable. Production tasks may consist of synthesising hundreds of audio clips (as in *AvSeq*), developing ambient audio and atmospherics (*In Ruins*) or planning out logical level progression (*Permutation Racer*).

This is one of the more difficult stages of work, mainly due to the fact that refinement and consolidation is rarely as exciting as the novel results of prototyping. However, good production aims to convert an interesting prototype into a coherent game with immersive feedback, appropriate contextual framing and polish. Steve Swink refers to this stage of production as creating "Game Feel" something which consists of "real-time control, spatial simulation and polish" (Swink, 2009, p. 9). However, It is also important not to overproduce a project; there is often a temptation to keep adding content or additional mechanics to the core idea. This is only beneficial up to a certain point, after which it becomes a distraction from the core game experience and can dilute the intended message or overwhelm it. This is especially true when designing the games for this research, where each project must maintain its focus on the investigation of the digital sublime.

4.5.3 Publication and Presentation

There are multiple options available when considering how to present or publish a video game. Most mainstream studios still publish through traditional retail outlets, but the majority of developers now use digital distribution systems such as Steam ("Steam," 2014). Mobile games are placed on Apple's "App Store" or "Google Play", depending on their target hardware. Digital distribution systems have grown rapidly in the last few years and now represent the main retail channel for PC games. Outside of these publisher-driven platforms many independent developers also distribute their work via personal websites and smaller curated digital shopfronts[34]. Placing a game online independently of a traditional publisher context also allows the software to exist outside the commercial expectations associated with mainstream media. This is the method I have chosen to release the games produced in this research.

34 For example http://www.showmethegames.com/ and https://www.humblebundle.com/

Online distribution is easy to accomplish and is accessible to a wide audience. The server costs for hosting downloadable software are negligible and the games can be made available for years to come. In addition, hosting systems can also track the number of downloads and allow access to software from many different sites and users at once. Equally, the process of downloading software is now understood by most computer users and is especially familiar to those who play games.

Each time a game is released I try to generate some press interest. I will contact journalists and website editors, providing a copy of the game and a description of the project. I also support awareness of the game by producing documentary videos and image galleries to act as further publicity. These media assets are posted on public forums and social network sites like Flickr or YouTube where more people will encounter them, leading to increased traffic and downloads. I also do email/online interviews whenever possible and engage in forum discussions in order to raise awareness of the project. These tasks are not primary intended to make more players download the game, but are done in the hope that they will prompt interesting discussions or reflections that I can use in the production and analysis of the projects. In addition to managing an online profile for the work, I also present my work at international conferences and events; the following section describes some of this activity, but a more detailed list of research outputs is available in the appendices.

During this research project I have given artist-programmer talks at various industry festivals and academic conferences including Indievelopment (NL), Eurogamer/Rezzed (UK), Unite/Nordic Game Festival (SE), Game Developers Conference (USA) and DIGRA (NL).

In association with these events I have contributed papers to conferences (DIGRA) (GDC) and produced a book chapter for the IEEE (Angelides, 2013).

I have run workshops and training sessions where I use my own projects as demonstration material, encouraging participants to explore elements of procedural programming and digital art. (“Real-Time-Visuals,” Culture Lab ,2013) (“London Unity Usergroup 10,” 2012) (“MetaCritic,” 2013)

Several of the projects have also been shown in gallery spaces (Phoenix Square, 2010), (“Real-Time-Visuals,” Culture Lab, 2013) and I have performed audiovisual shows with game system prototypes in locations such as Culture Lab (UK) and the Brighton Digital Festival (UK).

All of the events above have provided me with the opportunity to discuss my work, disseminate the results of my research and publicise the project games themselves. Showing my work in a range of contexts is a way to broaden the potential audience for the research and examine how different

display environments might influence my approach to design and presentation style. Indeed, the presentational frame that surrounds a game when it is played is of great importance, especially when the software is intended to communicate specific ideas or concepts to the player[35]. The range of opportunities discussed above allows me to test out what kinds of presentation approaches are most appropriate for the games and their settings.

It is worth stating that the public release of these games is not the primary goal for this research. Publication provides deadlines to work towards and allows me to finalise projects as they are released. However the success of each game is not gauged with player ratings or download statistics. Instead the methods of publication and presentation listed above provide different perspectives from which to observe, analyse and reflect on the progress of my research.

4.5.4 Feedback and Analysis

When gathering feedback on a games performance or reception, designers can make use of both quantitative and qualitative data.

In most mainstream studios quantitative data based on the number of downloads a game attains and the aggregated review scores it has received ("Metacritic," 2014) are the main statistics used to analyse a games' commercial performance. It is also relatively easy to assess the success of a design by measuring player progression throughout the gameplay experience. If players are failing to proceed beyond the initial stages of a game or only experiencing a very small fraction of its content then most developers would consider re-designing the experience. On the other hand recording a player's emotional or aesthetic response to a game is slightly more difficult.

Qualitative feedback can be gathered through questionnaires, surveys and informal interviews. In addition to this, an increasing amount of feedback can be gleaned from online reviews, video commentaries and forum discussions. User play-testing can also provide a a range of feedback, where designers can observe players interacting with the game and ask them directly about their experiences. Although my research is not dependent on validation through user feedback, it is useful to gather and analyse a range of players responses to the games, in order to consider a spectrum of different perspectives in the development of my work.

The games produced in this research were all presented in different formats and resulted in different forms of feedback and commentary. The majority of this feedback was informal, consisting of my

35 See sections 6-9 for discussion of how presentation concerns were addressed for the individual games in this research.

own observations and reflections provoked by discussions with players and their responses to the work. The following section describes a few examples of how this operates in the development of my games.

The installation of *AvSeq* at Phoenix Square and at the ICMC, gave me the opportunity to watch gallery visitors playing the games in a traditional white cube space. It also allowed me to observe and discuss the work in a fine-art context. This process was key to the production and evaluation of the first research game *AvSeq* (see section 6) and the results directly affected the development of the subsequent two games.

Presenting my work at conferences (Game Developers Conference (USA), DIGRA (NL)) provided me with direct audience feedback, interaction with peer practitioners and the opportunity to forge ongoing discussions with other designers and programmers. These events were a valuable opportunity to establish relationships with a wider community of researchers and artists. Some of the discussions initiated at these events have continued throughout the entire research process[36].

Online reviews and YouTube "Lets Play" videos[37] discussing the games have provided me with hours of unsolicited commentary. "Lets Play" videos are online recordings produced by gamers and amateur reviewers who play the game in question while discussing their experience in a live voice-over. And, in an associated channel of feedback, individuals' blog-posts offered more personal reactions to the games. This range of unsolicited responses allowed me to gather opinions that I could examine in order to identify any consensus of thought amongst players. They also pointed towards individual experiences of the projects where the experience of the digital sublime seemed best communicated.

In addition to the informal feedback channels described above the games in this research programme have been made continuously available online and simple statistical tracking shows that they have been downloaded and played by thousands of users over the space of the research.[38]

36 Perhaps the most important of these ongoing conversations was with the designer of *Proteus*, Ed Key (see section 3.4).

37 These streams are a useful source of potentially unbiased feedback, but it is important to bear in mind that they represent a particular sort of player, generally someone who is happy to broadcast their opinions into a public arena. However, having access to an unmoderated ten-minute commentated play-through can result in some valuable user feedback. Players seem much more likely to express emotions in unsolicited recordings than in test conditions (computer lab, installation), and even though some degree of "performance" is present in a YouTube broadcast it's cynical to assume that every broadcaster is "acting".

38 Exact figures are available in the individual project sections 6,7 and 8.

All these channels of feedback have fed into my own critical reflection on the research, and although these channels are by no means definitive proof, together they help to point towards commonalities in the player experience of the digital sublime. The phenomenon I am investigating is highly subjective and hard to articulate or delineate in a statistical format, so I use feedback to help indicate weaknesses in my work or prompt alternative strategies. In this way, the channels described above serve to augment the core process of my own artistic analysis and critique.

It is also important at this point to distinguish between use of the words “gamer” and “player” in the research since the two terms are often used interchangeably. For the purposes of my writing a “gamer” is someone who identifies as an individual that plays games; this may be as a hobby, or even as part of their work. They take an active interest in the commercial and cultural aspects of the games industry and often focus on specific game genres or play styles. A “player” is simply someone who is playing a game. They might be broadly familiar with video games but do not have any specific allegiances to genres or play styles. Individual players who engage with my work might also be gamers, but the term “player” allows the development and discussion of my research to begin on more neutral territory.[39]

The processes described in the previous section represent a combination of traditional game design techniques and my own artistic practice. It is this approach that I used in the production of the three games developed for this thesis. The next section examines how these games can be designed to investigate the digital sublime.

4.2 Designing Code to Investigate the Digital Sublime

De Landa suggests that for complexity and emergence to occur in a digital system, “what is needed is a way of specifying the structure of the space of possibilities that is defined by an entity’s tendencies and capacities” (De Landa, 2011, p. 6). This is an idea that can be modelled in code through the use of a highly parametricised objects. The expressive range of these parameters defines De Landa's space of possibilities. For instance the illustration below shows how the construction of a form can be varied along two axes via parameters.

39 Gamers can often bring their own ideals to the critique of a video game. Although these discussions can be interesting they can potentially divert the research question into tackling irrelevant tangents.

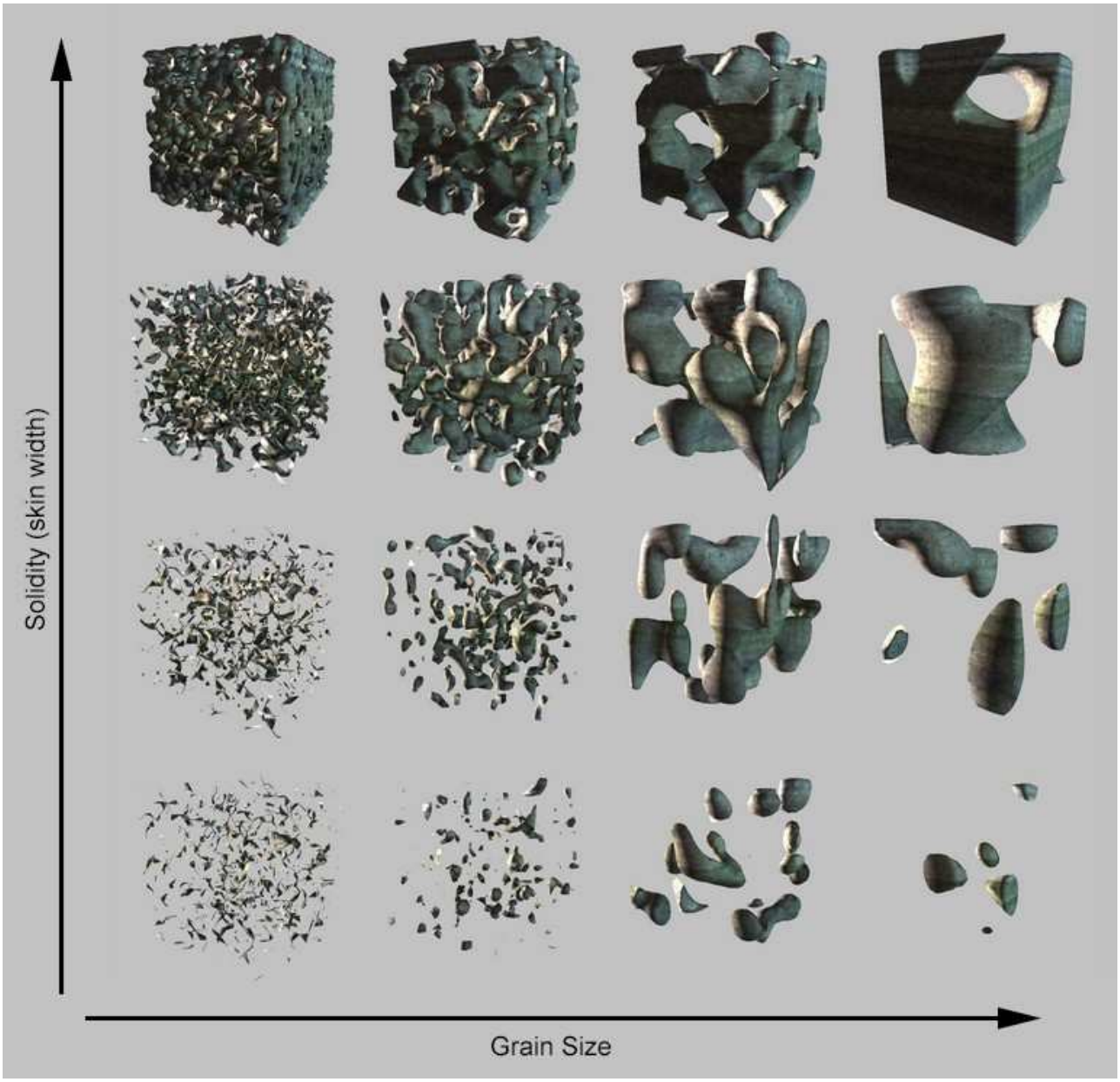


Figure 4.7: 16 permutations of a voxel cube

This example is taken from some of my prototype work, produced for this research. In the image one axis represents the scale, or granular frequency of the underlying form, and the second axis represents the "skin size" or "bulk" of the form. The samples displayed only represent specific intervals across this matrix, revealing the results of the parameters at those exact intersections. The number of possible forms, between and beyond those depicted, is infinitely variable and only limited by computer processing power. It is reminiscent of Sol Lewitts *Open Cubes* series (Lewitt, 1974) but with an infinite permutation space. Ngai reflects on this strategy as used by practitioners

working in digital systems.

> Though repetition, permutation, and seriality figure prominently as devices in aesthetic uses of tedium, practitioners have achieved the same effect through a strategy of agglutination— the mass adhesion or coagulation of data particles or signifying units. Here tedium resides not so much in the syntactic overdetermination of a minimalist lexicon, as in Robert Ryman's white paintings, but in the stupendous proliferation of discrete quanta held together by a fairly simple syntax or organizing principle. (Ngai, 2005, p. 263)

It is important to note that Ngai equates the generation of aesthetic tedium in digital systems to the same effect in minimalist art. She also implies that the digital experience is machinic, cold and "stuplime" (see section 2.1.2 for a more detailed description of the stuplime).

> In experiencing the sublime one confronts the infinite and elemental; in stuplimity one confronts the machine or system, the taxonomy or vast combinatory, of which one is a part. (Ngai, 2005, p. 263)

I have already stated my disagreement with Ngai's judgement of the digital sublime in this quote (see 2.1.2), but the description is still accurate. My work does aim to create vast combinatory systems through code, but I believe these systems can still represent the sublime through the act of visualising and exploring complex permutation.

Returning to the example image, in programming terms each cube generated is an object that constructs itself based on a set of parameters. These values represent its location in the entire generation space, its own spatial bounds, its resolution and any other component that might be filtering the underlying form. In the illustration these cube objects are instructed to generate themselves based on fixed positions in formal space, but in the research games, *Permutation Racer* in particular (see section 8), the generating objects can autonomously re-write their own parameters, mutating and moving across the possibility space.

The illustration above demonstrates how a module of my game code might function in relationship to the concepts I am exploring. Locating the permutation matrix of these objects in a 2 or 3 dimensional virtual space is a deliberate application of topological thinking (see Wark in section

2.2.1). And allowing the entities within this space to divert from their positions and follow new paths is a concept that mirrors Deleuze's and DeLanda's ideas of rhizomatic structures and changing multiplicities. My software art has always been designed with certain conceptual or philosophical ideas in mind, but within this research process the connections can be made more explicit.

4.3 Designing Game Mechanics to Investigate the Digital Sublime

The programming paradigms outlined above are important to the conceptual design of code, but within my games, user experience and game objectives also need careful construction. This part of game design requires using rule-sets and mechanics to generate player goals within an appropriate virtual environment. How can these elements be developed to encourage the sense of the digital sublime?

I started to answer this question by examining the elements of the digital sublime I have already established, autonomy, complexity, permutation and abstract topography. Digital games are already good examples of autonomous systems. They employ rule-sets that automatically generate a wide range of experiences for each player and each play-through. Design templates can vary from deliberately random systems with unpredictable results, to static worlds offering little space for emergence or novelty. In most commercial games the balance between these extremes is carefully controlled. Too much freedom in the system can lead to unpredictable results, confusing the player or breaking the game logic. Conversely too much control or stasis leads to a restricted system that is dull to explore. The type of autonomy in a game is often linked to the game's objectives and challenges. In many games the players task is to impose order on an increasingly complex or chaotic system. Players are frequently wrestling to reach some formal goal (end the level, beat the score, solve the puzzle) in the face of destabilising or destructive elements (random puzzle pieces, increasing complexity, increasing speed). And even when the goal is reached, another state or level appears, needing another solution. This repeating state reflects Deleuze's notion of the milieu “milieus swing between a stratum state and a movement of destratification” (Deleuze & Guatarri, 2004, p. 337), and the multiplicity, each virtual states of being and becoming, in constant flux between order and disorder.

Autonomy in game design can be used to drive complexity and permutation in an emergent way that reinforces the sense of flux and multiplicity. Experiencing a game in this state (repeatedly at the edge of manageable ordering) forces the player to constantly anticipate the possibilities in the system. Kant refers to this as the process of forming comprehension from apprehension (to judge

and predict the outcome of phenomena), and where that process fails, and the possibilities appear boundless, the sublime can occur. Ideally then, my games should be designed to encourage this scenario, by using systems that hint at unbounded emergence or permutation.

My software generates game-spaces that walk the margin between confusion and control. This entails a fluid design approach where the game-code and the environments it produces expose permutational complexity within a virtual topographical space. Balancing generative systems to create this sort of experience is a difficult task, but can produce the sort of games that will elicit the digital sublime.

An example here is an older project prototype I produced called *Endless Fire* (Betts, 2005) It is a game based on the "shmup" (shoot-em up) genre (which is itself a descendant of *Space Invaders*).

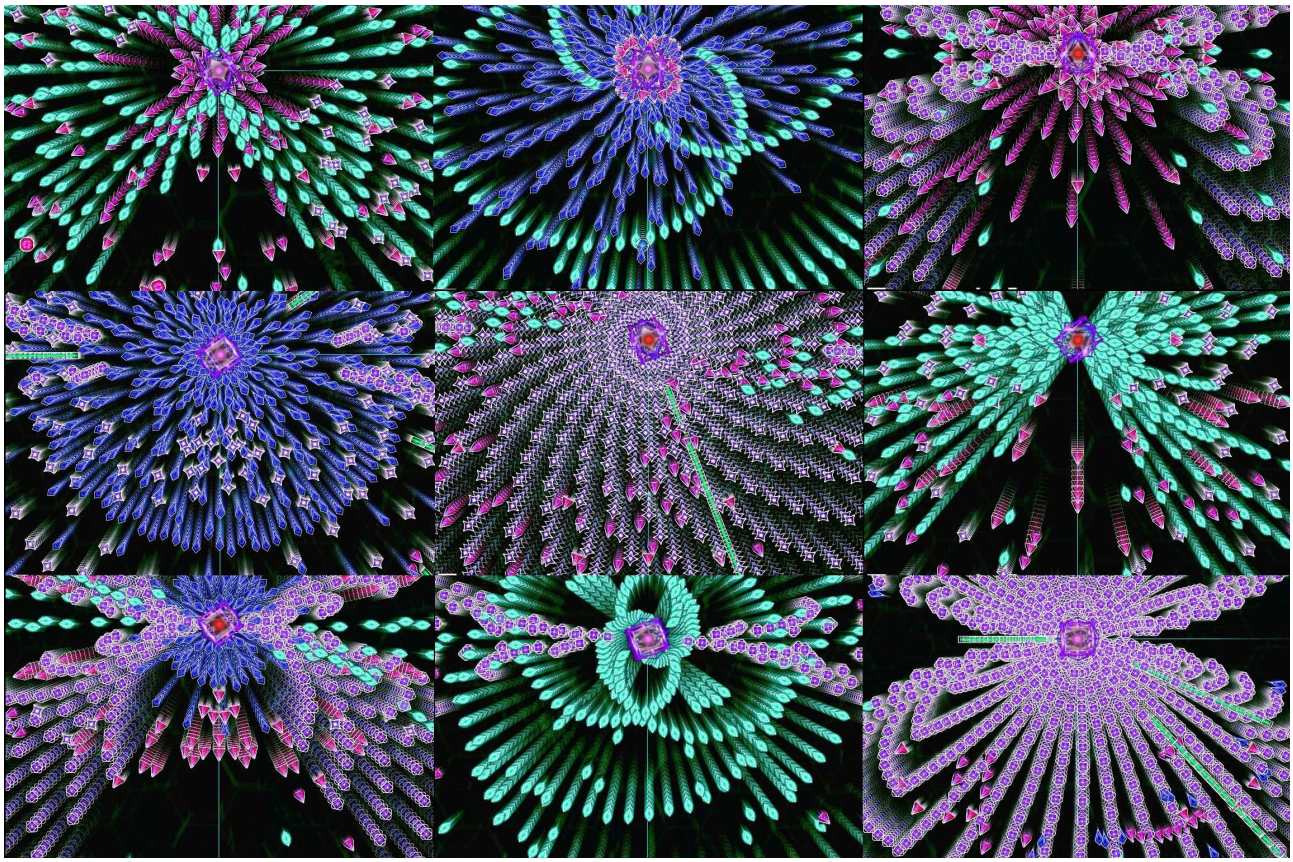


Figure 4.8: Examples of procedural patterns in gameplay

In the game, the player has to negotiate a space filled with moving patterns of particles; contact with any of these spinning shapes means the player loses a life. Rather than manually defining the formations for these hazards I wrote a system of evolving algorithms that vary and extend the

particle patterns. The underlying system employs trigonometry functions that are used in the production of mandalas, Islamic art and children's Spirograph toys (Abas & Salman, 1994). The initial patterns are meditative and hypnotic, but as the game progresses the complexity and unpredictability of the shapes becomes almost impossible to navigate, ultimately leading to the end of the player's run. Whereas the code approach (defined in section 4.2) explains how permutation and autonomy can be built into game design; the example of *Endless Fire* shows how these internal patterns can be used as active game mechanics and visual material.

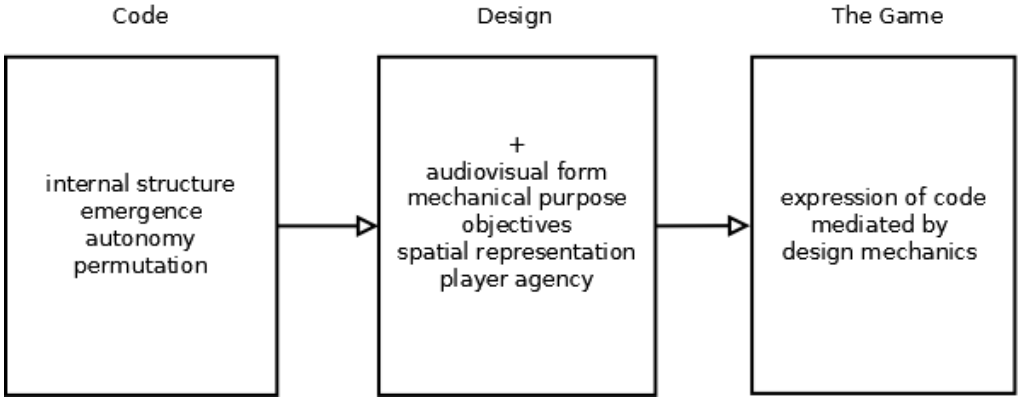


Figure 4.9: The relationship between code, design and game

It is crucial that both the mechanics and their audiovisual counterpart should allure the player, attracting them towards an engagement with the systems and digital sublime.

> Allure is properly a sublime experience, because it stretches the observer to the point where it reaches the limits of its power, or where its apprehensions break down. To be allured is to be beckoned into a realm that cannot ever be reached. (Bryant, Srnicek, & Harman, 2011, p. 289)

To entice and allure a player in such a way, it is important to present them with an inviting theme or trajectory that they can engage with. This can provide both an aesthetic frame for the design of the game-world and help define the progression mechanics of gameplay.

5. Introduction to the Games and the Portfolio

This section describes how the conceptual frameworks identified in the review have informed the development process of the research games. The software produced for this thesis is designed to encourage digitally sublime scenarios by exposing players to game-systems that demonstrate the elements of the digital sublime defined in section 2.4. To demonstrate these elements the games use procedural and generative systems to create complex interactive environments that are repeatedly re-constructed and re-organised, in order to represent the potentially undeterminable systems at their core. In addition to this formal exposition the games also employ specific audiovisual treatments in order to communicate the sense of the digital sublime through re-interpretations of established visual tropes[40]. The games further differentiate themselves by exploring specific trajectories to the digital sublime. These trajectories will be described in section 5.2, but first it is important to explain how the games themselves are designed as re-playable content generators that deliver their scenarios through a layering of code-driven permutations over multiple play-throughs.

5.1 Games as Multiplicities

My focus on the use of permutation and procedurality to explore the digital sublime means my work is poorly represented by any single instance of audiovisual output. Each game and prototype is designed to be run repeated times, with every execution adding to the expressive range of the project. In particular *AvSeq* (game 1) and *Permutation Racer* (game 3) have time limits on their gameplay. This forces users to replay sections repeatedly in order to progress. Replaying sections means game code is re-run, creating more variations of the possible game-space. The images below show how this iteration builds up the aesthetic of a game through repeated generation of the world [41].

40 Sections 6.3, 7.3 and 8.3 describe the specific visual treatments of each game and their aesthetic connotations.

41 The use of the term "aesthetic" in this research refers to a style or form of audiovisual treatment. In other words the first game in the following chapter could be described as utilising the aesthetics of synaesthesia, whereas the final project adopts the aesthetics of futurism. I am using the word aesthetics rather than style because it has a closer connection with philosophical ideals attached to the production of particular work (such as the conceptual ideals behind the aesthetics of impressionism).

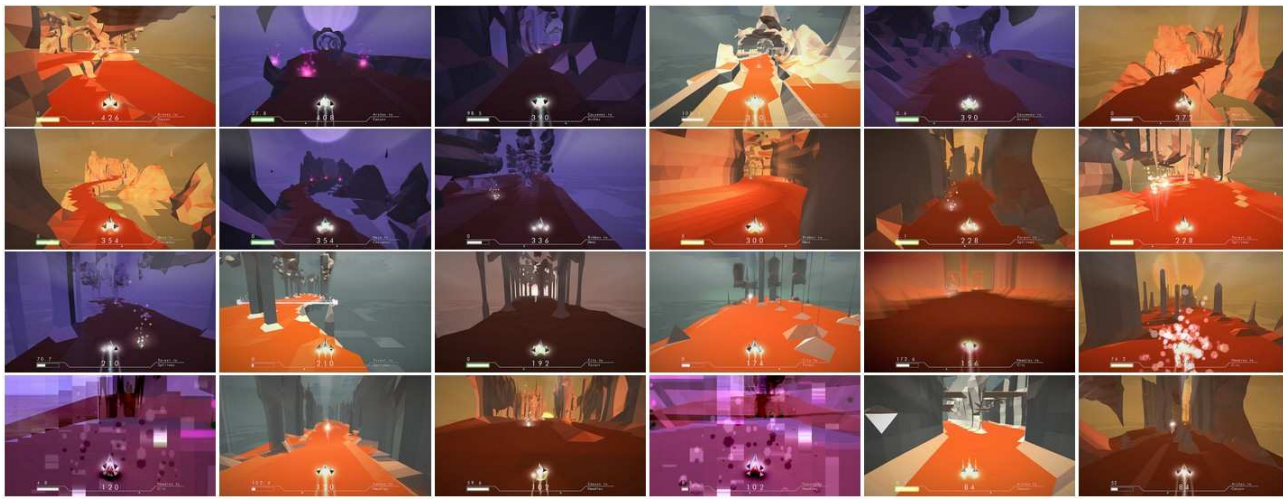


Figure 5.1: Multiple iterations of world generation in Permutation Racer

In this way, the aesthetic space explored by each piece of software is revealed through the gradual consensus of forms and experiences emerging from multiple play-throughs (in what Ngai might term "*agglutination"* (Ngai, 2005)). This means that a single play-through or generated entity is never a fair representation of the game or system. A single play-through is unlikely to produce enough permutations to show the range of expression possible in the system. It is also not enough for the player to begin to sense the thematic range and idiosyncrasies of the game system. It is through experiencing these multiple expressions that the player can begin to try and project their imagination about what lies in the next iteration or beyond the current boundaries.

Figure 5.2: Repeated generations of world lead the player into predicting the algorithms

The next three sections of the thesis describe the development and results of each game, and are accompanied by portfolio documentation consisting of digital software, image booklets, video documentation on disk, associated publicity and feedback documents. It is important to note that because of the significance of multiplicity and permutation in my work (see the definitions in section 2), the portfolio deliberately contains a large number of images for each game. This is not

sufficient to demonstrate the full expressive range of the systems involved, but it is the best approximation possible in print – it is only possible to really experience this range by playing the actual games.

So how many variations constitute a fair representation of a systems expressive range? This is debatable. Simple rule-sets such as Sol Le Witt's *Open Cubes* (Lewitt, 1974) have a precise and realisable number of permutations, whereas Conway's *Game of Life* is effectively infinite in its range of possible worlds (Adamatzky, 2010). We can judge the range of outputs mathematically, as a probabilistic set of results, but this might not be appropriate when examining systems for aesthetic forms rather than numerical range. With the three games produced for this research (*Avseq, In Ruins, Permutation Racer*) I have tried to include enough imagery to demonstrate both the scope and the aesthetic of each game, and I have also included output from the prototype phases of these games in order to demonstrate the development of these aesthetics and constructions.

In addition to these projects the portfolio contains information on a number of associated prototypes and experiments that were produced alongside the main three games. This includes items such as audiovisual performance work performed at CultureLab ("Real-Time-Visuals," 2013), prototypes of generative form shown at Plexus at the Bartlett ("PLEXUS 04," 2013) and studies for permutation-based art prints (Betts, 2012).

5.2 Trajectories and Themes

The previous sections have described a set of qualities (*permutation*, *abstraction*, *autonomy*, *complexity*) that can be measured and encouraged in order to locate the digital sublime. I have also identified a number of conceptual frameworks (*topology*, *allegorithm*, *multiplicity*) that I can employ in order to structure my game design. However I wanted each game to explore a specific trajectory or theme, in order to examine different gameplay paths to the digital sublime and give some sense of direction to the player. Most genres of video-game are built around specific trajectories like this. For example; racing games such as *Wipeout* (Psygnosis, 1995) focus on the theme of acceleration and speed, strategy games like *Sim City* (Wright, 1989) progress in scale and complexity and puzzle games drive the player to solve increasingly complex problems at a faster pace, as in *Tetris* (Alexey, 1984). These trajectories are signposts that direct player actions and thoughts towards future game-states of greater complexity and permutation.

We can relate these trajectories to Kant's descriptions of experiences leading to the sublime. For

Kant, increasing magnitudes of scale (the sea), movement (the storm) or structure (mathematical infinity) act as pathways to the sublime. They are sensory and conceptual channels which most people can understand and engage with. It seems logical to try and encourage similar trajectories within my games, so there are recognisable axes (from the perspective of both programmers and players) along which the qualities of the sublime can increase.

Based on these ideas, the research has identified three individual trajectories to be explored within the research projects, broadly defined as experiences in time, space and speed (see illustration below). These may seem like grandiose terms, but they are generous enough to encompass a wide range of different scenarios while still being limited enough to allow focus. When applied as a theme for developing game mechanics they become functional guidelines rather than metaphorical terms. Core game systems can be designed to engage with one or more of these themes in a direct mechanical sense (as in 4.2). Game environments can also be designed with audiovisual triggers in place that encourage the player to think along the same trajectory as the core mechanic investigates (as in 4.3). These development strands cover both the mental or internal model (the game mechanics), and the phenomenological or external model (the game environment). In addition, each of the chosen themes already offers a considerable set of pre-existing philosophical notions and aesthetic tropes (from art and literature). Many of these existing tropes will be familiar to players and can be used to help frame their game experience.

All three trajectories are seeking to increase qualities of the sublime along a specific axis. Each game design will use the conceptual frameworks described above in order to produce an experience that combines theme, production concepts and qualities to generate the digital sublime. The association of these elements is outlined in the table below. The final games, their prototype stages and any associated software experiments form a body of practice material that serves as both the investigative tools and subject matter for the research of the digital sublime

Theme/Trajectory	Game	Exploring
Time	1. Avseq: An audiovisual music game	Multiplicity: repetition, trance and the synaesthetic sublime
Space	2. In Ruins: A meditative exploration game	Allegorithm: disorientation, dreamlike states and the romantic sublime
Speed	3. Permutation Racer: A infinite racing game	Topology: vertigo, procedural form and the mathematical sublime

Figure 5.3: Investigative trajectories and the elements they explore

The following sections describe the research underpinning the three games and discuss how each project implements mechanics and concepts in order to explore a specific trajectory to the digital sublime. The games were developed over a four year period from 2010 to 2014 and are presented in the chronological order of their development. Although they share a design methodology (described in section 4 and 5) they represent a individual projects created to investigate the points listed in the table above. In the following sections I will describe how each project was designed and produced and how my reflections on each game were used to inform the development of the next. It is important to note that these sections are presented from the perspective of an artist-programmer and reflect a subtle shift in writing style to a more auto-ethnographic tone, using first person perspective and personal narrative. This shift is in keeping with the research methods introduced in section 4 and helps support a detailed self-reflexive analysis of the games.

6. Game 1: AvSeq

AvSeq is the first of the three games designed and developed for this research. It also represents the first example of my existing art practice being adapted for the purposes of academic research. In this respect the thinking and design underpinning *AvSeq* was specifically framed by the research question, and the games development was continuously informed by the reading conducted during the literature review. This process has allowed me to re-contextualise my existing practice, and establish a conceptual framework appropriate for the production of my games as investigative tools.

Like all the games in this research, *AvSeq* uses ideas of complexity, autonomy, permutation and abstraction to create a game which explores the notion of the digital sublime. In this case I employ code as a medium to leverage repetition, trance and the synaesthesia[42] as gameplay elements in a project which communicates the digital sublime through audio-visual multiplicity.

The design process for *AvSeq* began with a reflection on my existing art practice prompted by the research question (see section 4). This led to the process of identifying an existing game genre which shared elements of my own work and had the potential to examine the investigative points listed above. In the case of *AvSeq* the most appropriate genre was that of the music puzzle game as typified by *AudioSurf* (Fitterer, 2008), *Lumines* (Q Entertainment, 2004) and *Rez* (United Game Artists, 2001). The following sections explain the format of the game, the aspects of the digital sublime it explores, the development process and the resulting observations.

6.1 Game Description

AvSeq is an experimental puzzle game that asks players to complete patterns within an increasingly complex audiovisual environment. It uses generative procedures, structural emergence and entropy to create an evolving music sequence which the player has to protect from chaotic and destructive elements. By solving simple puzzles the player must the audiovisual loop running in order to complete each timed level of the game. There are several versions of the software for different audiences, each variation exploring slightly different interface methodology and user experience. The game has been published online through several forms of digital distribution ("*AvSeq* | Big

42 A condition in which one type of stimulation evokes the sensation of another, as when the hearing of a sound produces the visualisation of a colour.

Robot," 2014; "Steam," 2014), it has been part of a successful software bundle ("The Fall Bundle," 2012), and has been exhibited as an installation at a commercial gallery (Phoenix Square, 2010) and an academic conference ("ICMC 2011", 2011).

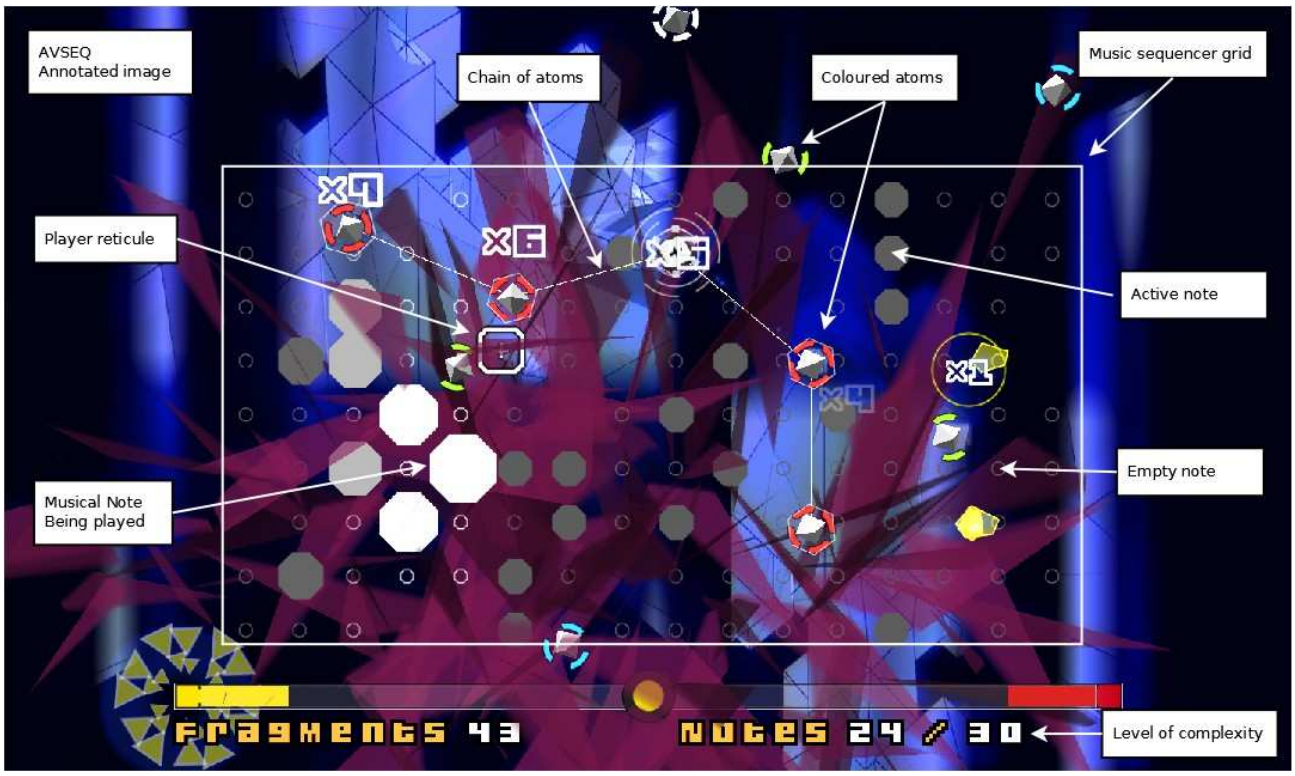


Figure 6.1: Gameplay elements in AvSeq

The structural basis for *AvSeq* is outlined in the illustration above. It consist of a grid-based 16-beat step-sequencer with nine audio channels. A step-sequencer operates much like a traditional piano roll and is a scoring method used frequently in music production. Each channel consists of a row of cells that represent active notes, these are triggered when a moving "play-head" reaches a filled cell on that row. This play-head is an invisible bar that highlights the appropriate column of notes for each beat of the cycle. When triggered, each note flashes briefly and produces a melodic or percussive sound.

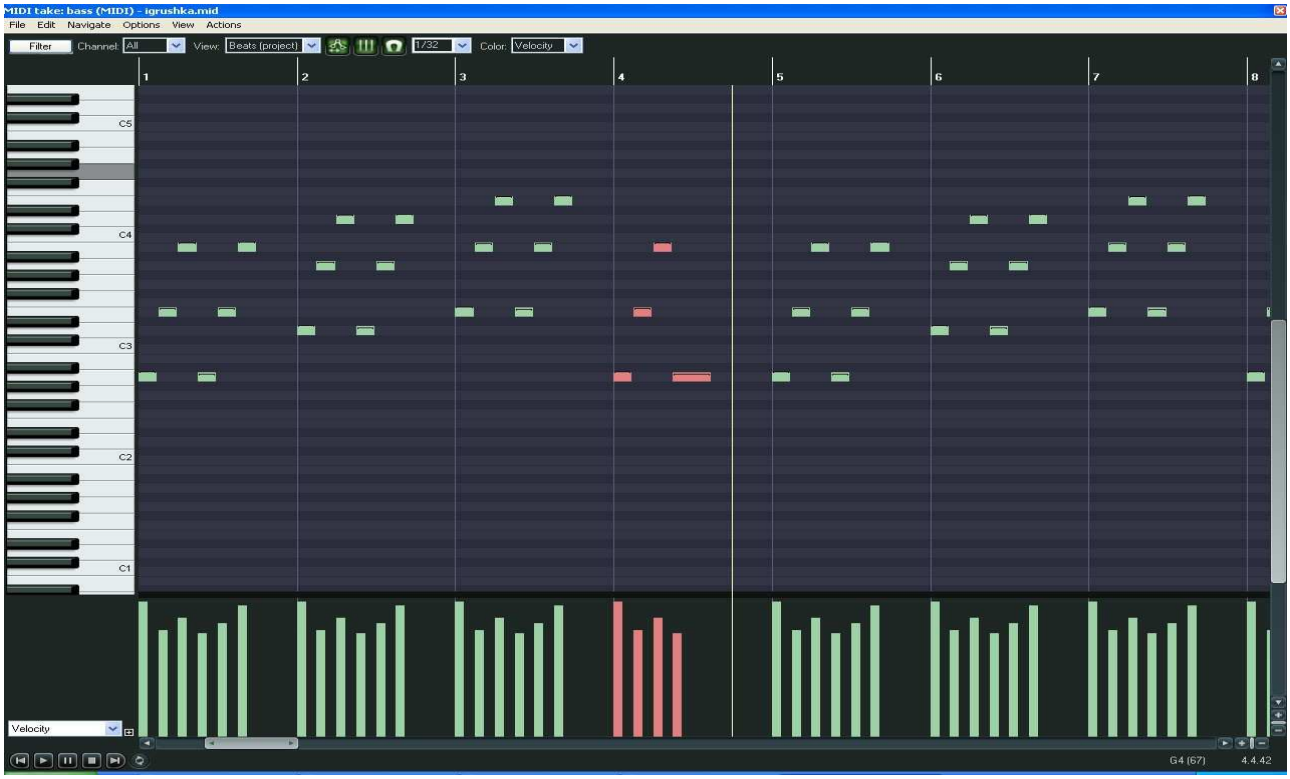


Figure 6.2: A "piano-roll'"step-sequencer showing the play-head, which has just triggered the 4 red notes

Approximately half of the channels hold melodic samples and the remaining hold rhythmic sound clips. The melodic samples are selected to fit within specific chord sets so that most combinations will sound harmonious. This structural format supports a vast number of musical sequences, the result of calculating 16 beats to the power of 9 channels equals a total of 68,719,476,736 permutations.

The musical grid forms the background play-space of the game across which coloured atoms fall. The user can move a targeting reticule with the mouse in order to click and select falling atoms of the same colour. Clicking on same-colour atoms connects them with a line and allows the player to form long chains. Clicking the right mouse button causes the chain to detonate, atom by atom, with explosions and audio that is quantized (in synch) to the current tempo/beat. For each detonation the player scores points and on reaching a specific scoring threshold a new note is added to the underlying step-sequencer grid, by visually filling in a cell. Longer chains score more points and drop more notes into the grid, but present a risk/reward balance as any atoms reaching the bottom of the screen destroy a proportion of the notes already placed on the grid. When notes are removed from the sequence the target complexity score is less likely to be reached within the current stage's

time limit.

As more notes are added, the complexity of the audio increases and the game introduces other elements, such as additional musical accompaniment or tempo manipulation objects that change the pace of the game and music for short periods. As the sequence is populated with more notes, additional visual effects are also introduced, reflecting the complexity of the music and presenting the player with an increasingly synaesthetic environment. There are 11 game stages in total, with each one utilising a specific tempo (increasing the difficulty level of each stage) and thematic set of audio samples, visual effects and colour schemes. A stage is completed when the musical grid has reached a specific level of complexity, due to the player connecting enough chains of atoms, the player only has a limited time to achieve this goal, otherwise the stage is considered failed. After the player has completed a stage they can then replay that level in "infinite" mode, with the pressure of a time limit removed, this allows them an alternative method of play, where they can explore the audiovisual interactions in a more relaxed state.

6.2 Investigative Points

AvSeq is designed to explore the digital sublime in a game that deals with structures in time, processing these structures through themes of repetition, multiplicity and synaesthesia. This section describes how these qualities informed the design of the game. In order to examine how *AvSeq* uses repetition as a core mechanic it is important to understand how time works in the context of gameplay experiences. As identified in the literature review ludic historians frequently describe games as experiences that stand outside of everyday time (see section 2.3.1). Games invite the player to enter a *"magic circle of play"* (J. Huizinga & C., 2000), within which the perception of time is altered. Games allow us to temporarily ignore real-life schedules, and the ebb and flow of mental and physical challenge in games alters a participant's sense of chronology and pacing (Csikszentmihalyi, 1996, p. 111). This sense of altered time is often provoked through recurring gameplay scenarios where players are required to perform a repeating cycle of interactions or adopt muscle memory patterns as seen in titles such as *Super Hexagon* (Cavanagh, 2013) and *Tetris* (Pajitnov, 1984). The ritual patterns of such games can be meditative or transcendent in the same way that chants, drumming or dancing is (Woodside, Kumar, & Pekala, 1997). This sort of behaviour is particularly prominent in puzzle games which focus on audio and music as a key element of design; see *Lumines* (Q Entertainment, 2004), *Fractal* (Cipher Prime, 2013) and *Circadia* (Simple Machine, 2013). Indeed, games based on musical sequences are inherently

cyclical and durational, and combine the execution of mathematical solutions with the sense of improvising or "jamming", Caillois describes this as a key element of play "the search for repetition and symmetry or, inversely, the joy of improvising, inventing, or diversifying solutions infinitely"(Caillois, 1913, p. 65).

Support for performance and virtuosity is beneficial to the genre of audio/puzzle games. Expert players can read puzzles and improvise solutions with great skill and speed, and successful games designs encourage this by providing opportunities for risk-taking and reward. *Tetris* is a prime example of this approach, where a skilled player's performance can echo the dexterity of a practised musician or the finesse of a table magician[43]. The opportunity for improvisation and mastery also improves player immersion and is something I wanted to incorporate into *AvSeq*.

This phenomenon has been studied in the context of Csikszentmihalyi's notion of *Flow* (Chen, 2007), a psychological state where the participant is fully immersed in a task because it represents a perfect balance of skill versus challenge. In *Flow*, "real" time becomes superseded by the time frame of the activity at hand.

> The objective, external duration we measure with reference to outside events like night and day, or the orderly progression of clocks, is rendered irrelevant by the rhythms dictated by the activity. (Mihaly Csikszentmihalyi, 1996, p. 75)

However, *Flow* represents a comfortable mastery of control and in my definition the digital sublime relies partly on the disorientation that occurs when the mastery of a system falters. When a player loses control of the game-world, either manually or in terms of their comprehension, they sense the undeterminable and sublime space beyond. To generate this state a game must be capable of increasing its complexity autonomously, until at some point it pushes players outside the comfort zone of *Flow* (Csikszentmihalyi, 1991). The transition to confusion or uncontrol is more effective when it occurs from a previous state of mastery, as the contrast makes the event more jarring *"...it does violence to the internal sense"* (Kant & Bernard, 1951, p. 98). With *AvSeq* I wanted players to be able to master the system, but then have this mastery disrupted by gradually accelerating the complexity and tempo of the task. This entailed programming the game so that it would produce an increasingly complex and varied game-states for the player to encounter. This is done through the procedural code at the heart of the game, producing a unique soundtrack and visual score for each

43 See the (*Tetris - Guiness world record*, 2010) for an example of such virtuosity.

play-through. These are examples of Deleuze's multiplicities, with each play-through presenting fluctuating levels of abstraction and complexity which the player must try to control.

Deleuze refers to this task of forming order from chaos in his ideas of "territorialization". Territorialization is the construction of bounded space against the boundlessness of generative systems. In the context of player action, territorialization is the repeated act of problem solving (connecting the correct chains of atoms), a process which removes chaos from the game and establishes order and control.

> Territorialization is an act of rhythm that has become expressive, or of milieu components that have become qualitative. The marking of a territory is dimensional, but it is not a meter, it is a rhythm (Deleuze & Guattari, 2004, p. 315)

But Deleuze points out such acts of territorialization are only ways of placing temporary reliable structure in place, but are not themselves permanent. He implies there is a cycle or rhythm to this sort of structuring process, taking randomness and ordering it over and over again. "Stratification is like the creation of the world from chaos, a continual, renewed creation" (Deleuze & Guattari, 2004, p. 502). *AvSeq* takes this trance-like cycle of creation and decay and uses it as a trajectory to usher in the digital sublime. Like the accelerating dance of the dervish, with "Somersaults are performed in a state bordering upon hypnosis" (Caillois, 1913, p. 137), the player might be caught in a loop until the tempo pushes them out of control and into the digital sublime.

6.3 Aesthetic Design

AvSeq is an investigation into the digital sublime that uses repetition and multiplicity in audiovisual forms. When designing the graphics for *AvSeq* I sought out visual references that might connect these elements together in a way that could enhance the experience of these qualities. In my art practice I draw on historical and contemporary aesthetic styles when designing games, taking cues from stylistic approaches that are intended to communicate concepts or propose ideas. In this case I drew inspiration from synaesthestic art. This concept reflects a neurological condition where stimulus in one sensory domain gives rise to its representation in another, sound represented as shape or smell as colour. There is a rich thread of synaesthesia running though games and art work, ranging from Kandinsky's abstract score-like compositions; *Composition 8* (Kandinsky, 1923), *Horizontale* (Kandinsky, 1924), through the interactive installations of Toshio Iwai; *Resonance of 4*

(Iwai, 1994), *Composition on the Table* (Iwai, 1998) to contemporary audiovisual games like *Rez* (United Game Artists, 2001) and *Lumines* (Q Entertainment, 2004)[44].

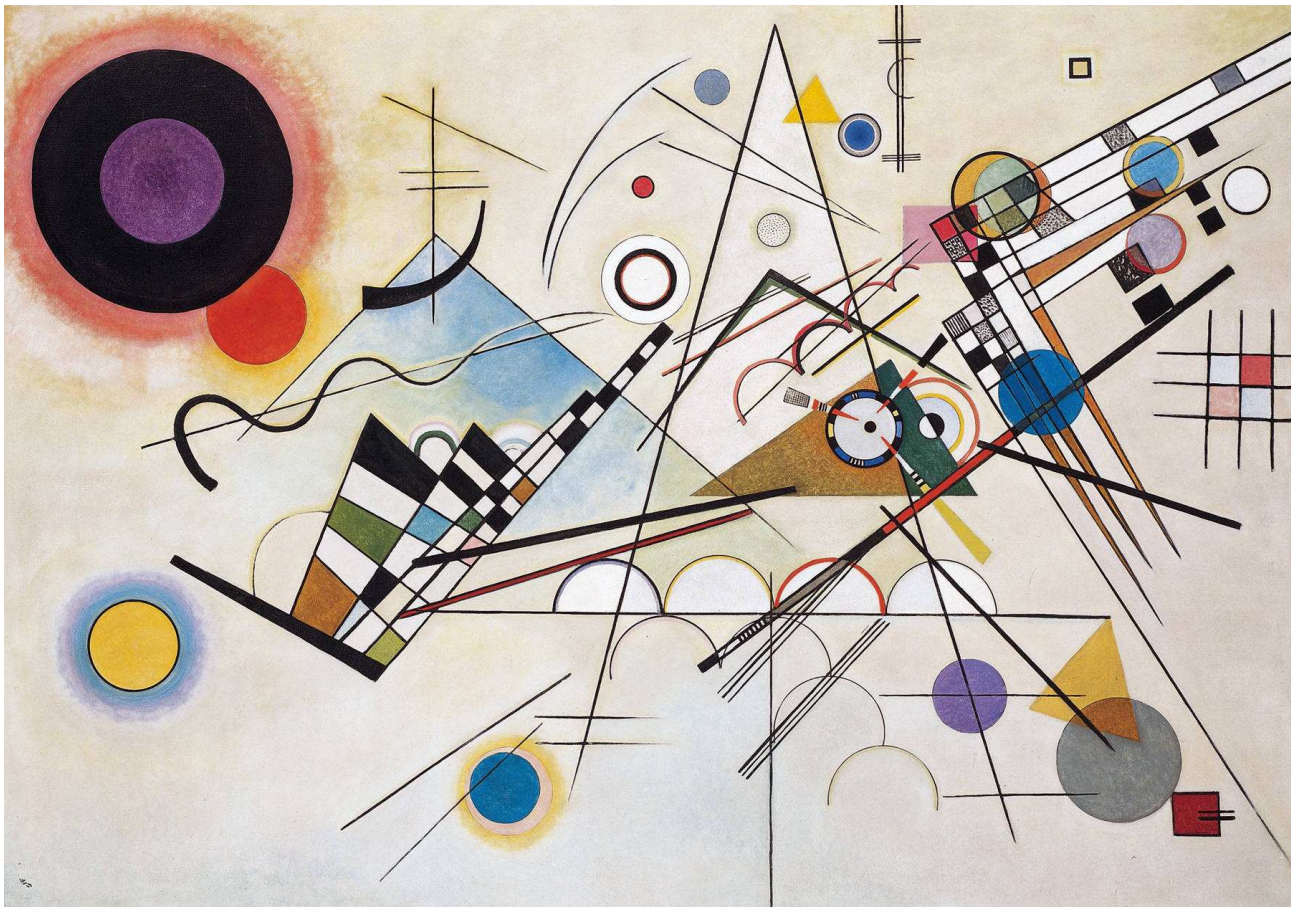


Figure 6.3: Composition 8 (Kandinsky, 1923)

By examining these projects I realised that the experience I was trying to generate already had a well-established visual aesthetic. The use of multi-coloured icons, matrices and scored lines are all common graphic elements in the history of synaesthetic art (Baron-Cohen & Harrison, 1997). By using similar imagery in *AvSeq* it was possible to contextually frame the intentions of the work, without having to express these concerns too literally. I did not want to present the player with an explicit statement describing the sort of experience I hoped they would encounter. Instead I hoped that the combination of gameplay, visuals and audio would communicate the sense of the digital sublime without the project having to resort to didactic narrative. This reflects my own experience of the digital sublime, which seems to result from a mental attempt to "join the dots" between the

44 Each of these game examples really demands its own review, but unfortunately the appropriate detail is beyond the scope of this thesis.

different elements of an emergent game system (audio, visual, mechanics).

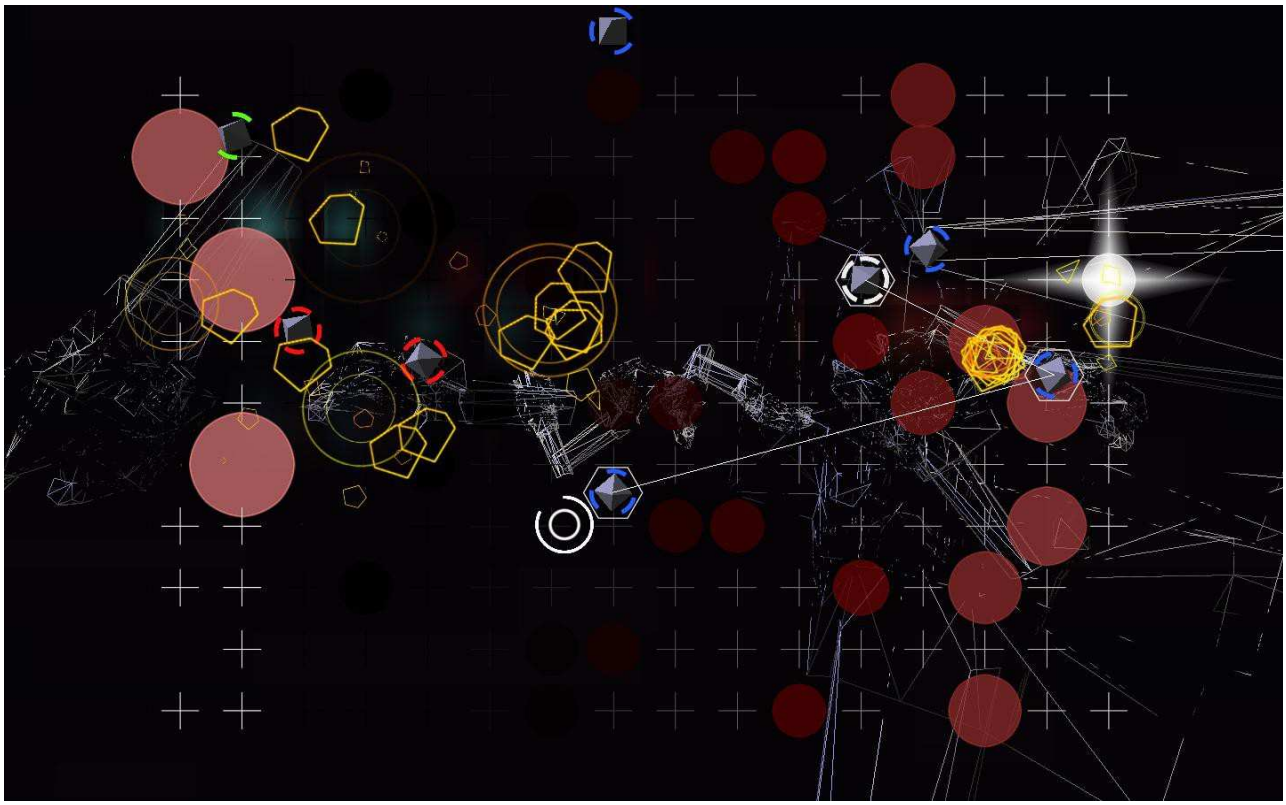


Figure 6.4: Screenshot from AvSeq

With this in mind *AvSeq* also employs the graphical language of musical scores and the imagery of electronic synthesis. These influences were chosen in order to reinforce the notion that some internal logic is at work in the game, working towards some sort of structural objective. The visuals employ "retro styled" wireframe graphics and mimic cathode ray tube effects such as noise and video feedback in order to reference the classic audiovisual imagery of oscilloscopes and graphic equalisers.

It also references software and hardware sequencer layouts such as the *Monome* (Monome, 2014) and *Cubase* (Steinberg, 2014) as well as visual scores like Brian Enos *"Music for Airports"* (Eno, 1978).

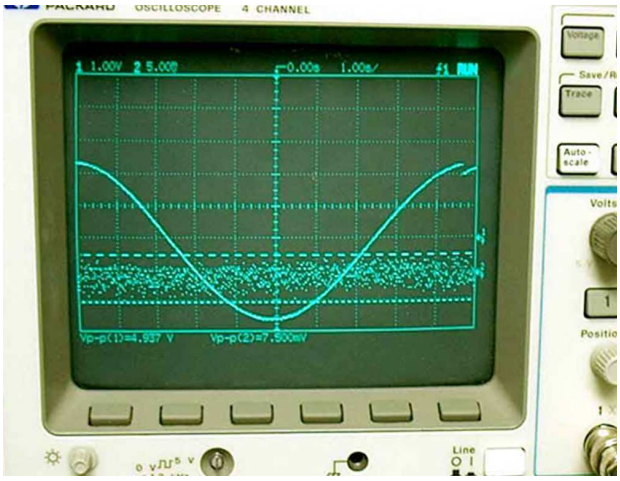


Figure 6.5: a CRT oscilloscope

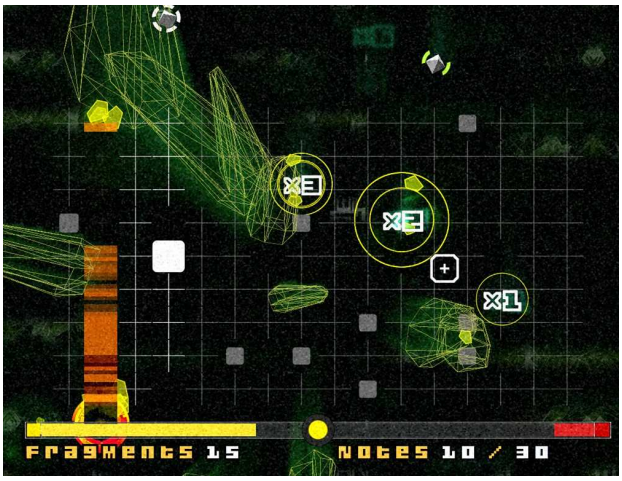


Figure 6.6: Screenshot from AvSeq

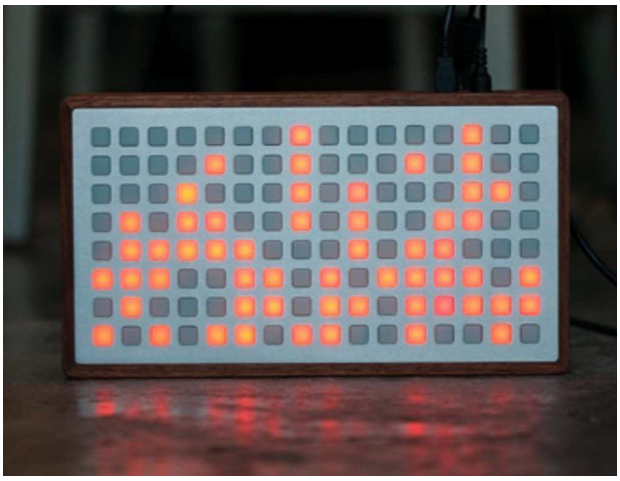


Figure 6.7: The Monome hardware sequencer

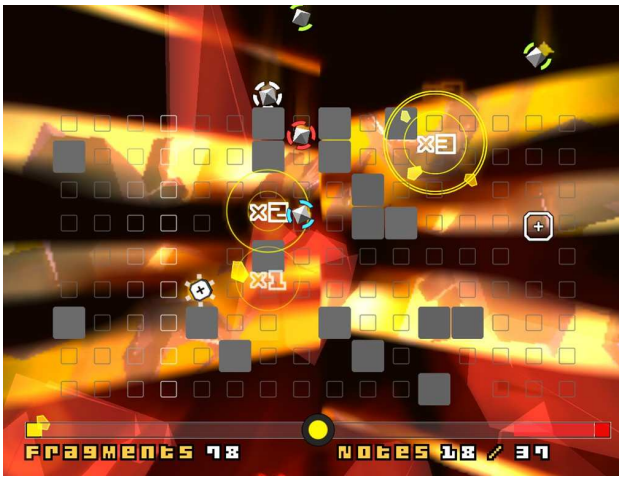


Figure 6.8: Screenshot from AvSeq

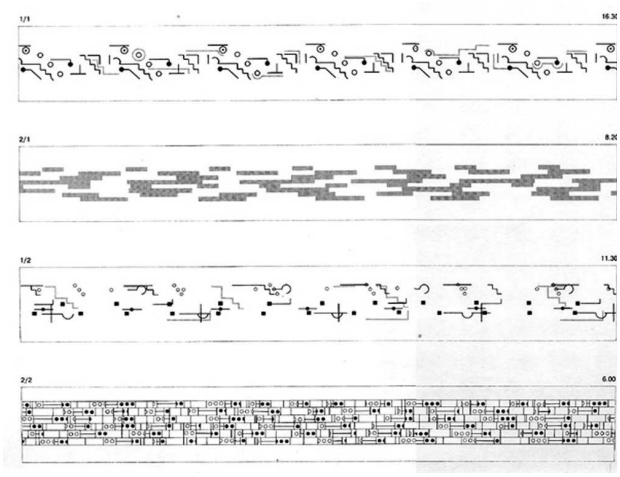


Figure 6.9: Brian Eno's score from "Music for Airports"

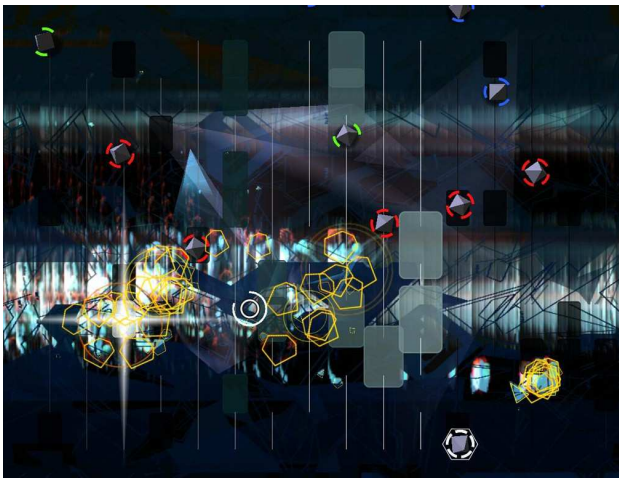


Figure 6.10: Screenshot from AvSeq

The puzzle elements themselves are designed to mimic atoms and molecular forms, and reference network diagrams and webs (a reference to Wark's topological structures). The player is constantly trying to impose structure, on both the puzzle elements and the music, while the game mechanics drive the system towards chaos or entropy (accompanied by appropriate visual effects). These various visual cues and references were constantly redesigned in order to find a balance between a level of readability that is functional for gameplay and a level of abstraction that creates the intended audiovisual environment.

Early designs were highly symmetrical in layout but this compromised the actual game mechanics and was eventually evolved to a more readable background grid that supported better gameplay. The audiovisual design of the project changed far more than the mechanical design across the development cycle[45]. This happened across all the projects and highlights the importance (and workload) of audiovisual framing and communication within the game design of the research projects. This is because the games need to represent the notion of sublime structures and also provide a usable interface for players; often these two elements contradict each other. For instance in one prototype I had no text to indicate a player's progress, the resulting game looked more "pure" visually (it wasn't cluttered with mundane score reports or instructions), but was very difficult for most players to navigate or engage with. The final aesthetic style was a result of various stages of design and followed a formal and synaesthetic look that is common to my generative work and is intended to "set the stage" for a gameplay experience that explores the digital sublime.

6.4 Development

In developing *AvSeq* I had to create a system that would compose structured music without demanding musical knowledge from the player. Requiring compositional skills from participants would drastically reduce the potential audience and also move the project into the off-topic field of music software. This goal was achieved by designing the construction of the audio track to proceed alongside the player's performance, but not be directly controlled by them. It was important to let the player feel a sense of their involvement in a complex generative audio system, but also to give them a sense of that system's autonomy. This fulfils two important functions; firstly it provides a collaborative or competitive feel (with the system) and secondly it removes some of the responsibility for game progress from the player themselves (a player does not need to micromanage every element of the system). In *AvSeq* the line between control and chaos gradually

45 This was mainly due to the difficulty in communicating the nature of core gameplay mechanics while also allowing for audiovisual complexity and synaesthetic effects to provoke a sense of the digital sublime.

shifts as the game increases in complexity and tempo. This progress is measured and matched by the music sequencer as shown in the images below, where the changing musical structure is presented as a black notes on a white grid.

Figure 6.11: Visual interpretation of the complexity of the sequencer grid over time

The image above shows how notes can become active on the sequencer grid over the period of a single level. All the audio samples for the game (melodies, chords, percussion) were designed by me using a mixture of traditional synthesisers, sampling techniques and sequencing software. This process involved the production of over one hundred sounds arranged in thematic sets which were then assigned to specific stages of the game. The project presented a specific technical challenge in the area of audio timing and synchronisation. The accuracy of timing available in the Unity game engine was insufficient to support a real-time step sequencer. An innovative algorithmic solution was developed to solve this problem and the details of the code were made available online (Betts, 2014)[46].

The rate at which notes are added to the musical score is tied to the skill of the player and the speed of their progress, but the location of those notes (and therefore the syncopation of associated audio samples) is not. What is unusual about this distribution of notes is that the resulting audio almost always sounds coherent and consistent in the terms of a 16-beat electronic composition. There are rarely cases where an asymmetric distribution forms a lopsided rhythm or where a specific beat within the cycle is overloaded compared to its neighbours. Of course this is the nature of random distribution and replicates a simple noise algorithm writing data into a sequence (the distribution over time smooths out discontinuities). It is the human sensation that the music is intentionally structured that is intriguing. When players realise that the music relates to their progress they feel a definite sense of ownership where they believe that they have "written" the track themselves (as if

46 The technical innovations and solutions developed through the research are documented at http://www.nullpointer.co.uk/content/research-hub/

via a more direct method than is actually present). By actively participating in a skill-based challenge players feel rewarded (by audiovisual cues and environmental changes) and relate those rewards directly to their own actions. This sense of integration with the game system helps to highlight the idea that the player is participating in an evolving system that might escape their control. Ideally this sort of immersion should encourage the player to engage with the system in a collaborative *and* competitive sense, where they try to predict the system in order to react to its behaviour. It is this sort of mental trajectory that can elicit the digital sublime.

6.5 Publication and Presentation

The first version of *AvSeq* was exhibited at Phoenix Square, Leicester (Thu 8 Apr – Mon 24 May 2010) and was developed specifically for a gallery setting featuring easy levels of gameplay and a casual difficulty curve. The decision to make the installation version of game easier than the downloadable version was based on a number of factors. For most gallery audiences there exists a common, historically imported notion that there should be a respectful distance between audience and art-object. In the context of an interactive piece this causes considerable problems. Even when people overcome the segregation that a gallery context implies they rarely engage with a work for very long, this may be due to the drive-through mentality of the modern art experience, or simply the uncomfortable sensation of performing for an audience of strangers (Graham, 1997). Either way the general period of gameplay or interaction is much shorter than the same experience would be in a home setting. In retrospect a gallery setting may not have been the best place to garner a useful degree of interaction from participants, but I wanted to examine how the installation frame might effect my development of the work and its reception. Presenting a game in the context of an art work can persuade the visitor to re-assess their preconceptions of the medium. Audiences predisposed to discard games as “low culture” will often give games in galleries more contemplation; this was certainly the case in exhibitions of my previous work *QQQ* (Betts, 2002). The differences of perspective from an 'art' setting to a vernacular setting are something I have experienced many times with my previous art work.

The installation at Phoenix Square took place relatively early in my research programme, while I was still formulating the questions I wanted to investigate. In the following years I developed my thesis and reflected on this initial exhibition. There were elements of the Phoenix Square software and presentation environment that I was unhappy with and wanted to explore further. I felt that the experience might have been compromised by myself making concessions to my idea of art

presentation, perhaps I had made the objectives and interactions too arcane to be understood by many participants (see more on this in section 6.6). So when given the opportunity to exhibit again I re-wrote the software in a cross platform engine with new audiovisual content and a new user interface that provided more contextual gameplay information (in order to make the player experience initially less confusing). I was invited to install the work during the 2011 International Computer Music Conference ("ICMC", 2011) at Huddersfield University. This is an academic conference dedicated to exploring computer-based methods of composition, analysis performance and synthesis and *AvSeq* was exhibited alongside other software demonstrations and performances. The audience was also from a more specific background, consisting of musicians and software designers.

In addition to these two public installations the game was made available via several channels of digital distribution ("*AvSeq* | Big Robot," 2014) ("Steam," 2014). It has been downloaded from the internet approximately 30,000 times (as of 01/06/14) and reviewed across a wide range of video game websites and YouTube channels.

From the presentation opportunities listed above I gathered simple feedback through surveys, game recorded data and informal conversation. I also obtained indirect feedback from game reviews, forum comments and YouTube "Lets Plays". A full listing of these sources is documented in the Appendix E[47] and this information, coupled with my own artistic reflections, helped to guide the "post-mortem" analysis of the project.

6.6 Findings

The development of *AvSeq* was successful from a game design perspective, its mechanics were understandable, it was bug-free[48] and was engaging enough for most players to run through several stages of the gameplay. Playability does not relate directly to the experience of the digital sublime, but it is important that a game does not drive away players due to bad implementation. After various stages of prototyping, the final game did indeed allow players to engage with a generative system that could be used to project aspects of the digital sublime.

The game displayed obvious elements of permutation, autonomy, complexity and abstraction, with each of these factors increasing over time, as the game was played. This increasing difficulty curve

47 It has already been stated in section 4.4 that the measurements for success in each game project are not based on player ratings or quantitative game statistics.

48 A bug is an error in software that can interrupt the proper execution of a program or cause it to stop functioning completely.

allowed different players to face challenges and failures at individual points. It also meant that players could keep replaying the stages to find the sense of challenge and the digital sublime at different points, as their skill increased[49]. Both myself and other players found this balance of skill and complexity gave rise to a sensation identical to Csikszentmihalyi's description of Flow.

> Starting out on a blank playfield, it's pretty easy to lose yourself in the zen-like, metronomic rhythm of alternating gem chain connections and explosions. (Orland, 2012)

But it is difficult to tell when Flow collapses into a more unbounded, sublime state; this is partly because of the difficulty in articulating such an experience. In the final version of the game I still encountered a state of panic or transfixion when complex combinations of atoms and visuals occured. This experience was also expressed by a number of players in the feedback (see Appendix E). However one interesting and unanticipated result was the reaction of a few players who referred to the game as “boring”. Initially I was disappointed with this response, because when players describe something as boring, it means they are generally unstimulated and likely to abandon the game. But I realised that in certain circumstances boredom itself can be hypnotic and transcendent. Ngai refers to this in her notion of the stuplime (see section 2.1), and in playing the game I often felt this sense of numbing yet immersive repetition and complexity.

> Though repetition, permutation, and seriality figure prominently as devices in aesthetic uses of tedium, practitioners have achieved the same effect through a strategy of agglutination— the mass adhesion or coagulation of data particles or signifying units. Here tedium resides not so much in the syntactic overdetermination of a minimalist lexicon, as in Robert Ryman’s white paintings, but in the stupendous proliferation of discrete quanta held together by a fairly simple syntax or organizing principle. (Ngai, 2005, p. 267)

This certainly reflects Ngai's notion of “disinterested pleasure” (Ngai, 2005, p. 271) which she describes as part of the *stuplime* replacement for Kant's *sublime*.

I suspect that the cold abstraction of *AvSeq'*s design might have prompted this sense of numbness or

49 It is interesting to note that in the final version of AvSeq I was myself unable to complete the later stages of the game, finding them too difficult. However, several videos on YouTube proved that some players could master these harder stages with ease.

alienation in players. It expected too much literacy in the understanding of the aesthetic area and in retrospect relied too heavily on expecting players to understand musical scores and sequencing. In reality many players do not have this training and found it hard to recognise significant levels of connectivity and topology between the audio and visual systems. Of course my experience of the game was very different. Even after developing the game for months I still found myself immersed in a trance-like state when playing. I felt a rewarding interplay between my own actions and those of a generative autonomous system. This was obviously enhanced by my knowledge of the system as a whole (as its creator), but it was reassuring to find that I didn't get tired of playing the game, either during development or afterwards. The systematic visuals and audio reflected Kant's notion of the mathematical sublime, but I feel that the game lacked the visual depth, and perhaps narrative, to communicate a sense of the dynamic sublime (which comes associated with embodied ideas of scale, space and environment).

The gap between designer vision and player recognition is a common issue in all game development and something I feel might have been a barrier in *AvSeq*. It is very difficult to provide the right amount of context or adjust for the correct level of player skill when the audience comes from such a wide range of backgrounds and experience. Although I deliberately presented a difficulty curve that would cater for most players, I didn't include any progressive narrative or any initial background information. This was based on my personal interest in exploring games that maintain a sense of mystery and leave interpretation to the player; however, in many games, and specifically in one so abstract, even a vague narrative can help to engage a wider range of players. *AvSeq* would have benefited from more contextualisation, either literally through tutorials and introductory texts, or ambiently through visuals and graphic design. This would have helped to acclimatise players to the gameplay mechanics and also introduce them to the concepts I was trying to explore. Although I did not intend to develop my games in order to appeal to a wide public audience, my analysis of *AvSeq,* through my own experience and that of players, led me to approach the development of the next project with more focus on familiar narrative and visual framing[50].

50 This conclusion does not dictate that *AvSeq* was wrong in its aesthetics of contextual framing, and that the following projects should "fix" those problems. It simply points out alternative avenues for the following games to investigate in terms of generating and communicating the digital sublime.

7. Game 2: In Ruins

In Ruins is the second game produced for this research, and is designed to investigate various aspects of the digital sublime including, notions of dreamlike topology, the romantic landscape and allegorithm.

Although it is a stand-alone project, certain elements of its design occurred as a direct reaction to the conclusions drawn during the development and evaluation of the previous game *AvSeq*. In particular I was concerned that *AvSeq* lacked the visual narrative it needed to communicate its intent and trajectory to the player. It used a predominantly abstract visual aesthetic that generated a complex, hypnotic game-space, which was appropriate for a system that explored audiovisual and synaesthetic complexity. But the abstract diagrammatic presentation created a barrier to players who were unfamiliar with electronic music sequencing or the associated aesthetic.

AvSeq represented a style based on the mathematical sublime (see section 2.1.1). As described in the literature review Kant's mathematical sublime revolves around concepts of numerical complexity, infinity and paradox. This presents a far less approachable experience than his notion of the dynamically sublime which includes far more phenomenological triggers such as “the boundless ocean in a state of tumult” (Kant & Bernard, 1951, p. 100). The metaphorical and romantic associations of the stormy sea are far more sensual and picturesque for most people than the equations of generative audio sequencing. The familiar narratives associated with these emotive elements provide an easier introduction to the subject of the sublime. I wanted to explore this avenue of communication in the second game, utilising the romantic and poetic notions of the dynamically sublime in order to try and eliminate the aesthetic barriers that occurred in *AvSeq*.

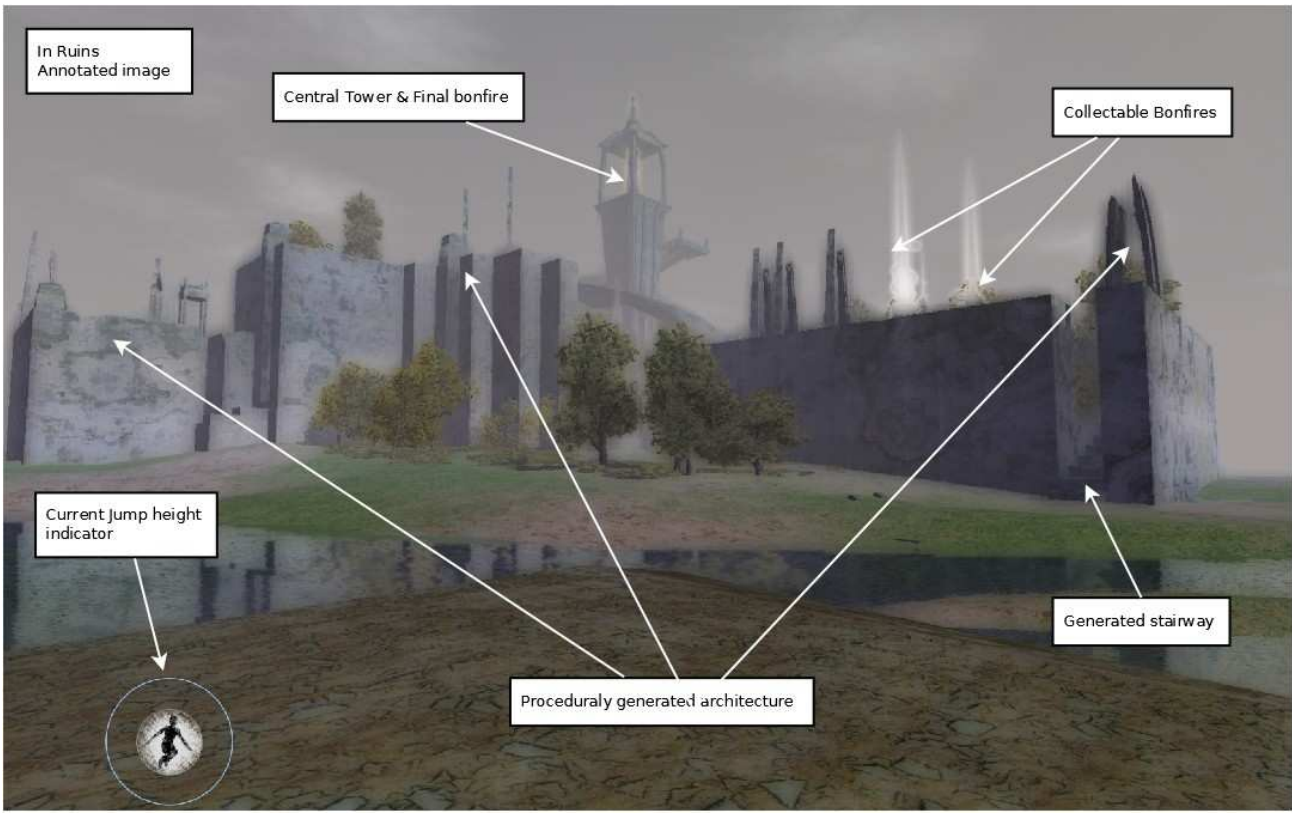


Figure 7.1: Gameplay elements of In Ruins

7.1 Game Description

In Ruins places the player on an abandoned island, the site of a labyrinthine ruined castle as illustrated above. The castle is generated from a simple but expressive set of procedural rules. This code results in a collection of stone plateaus, snaking jetties, suspended stairways, arched causeways and hidden quadrangles. The basic geometry is detailed with both small architectural variations and larger sculptural embellishments. Trees and grass are scattered around reclaiming the stone, and the sky is drawn with ever-changing cloud-cover and an evolving day and night cycle. The player interacts with this space from a first-person[51] perspective, using the mouse and keyboard to walk around the ruins, swim in the surrounding water and jump to climb the stairs and ledges. Dotted around the environment are white crackling bonfires with smoke columns extending into the sky. When the player walks into a bonfire their ability to jump is increased (this is also indicated on a small icon in the screen corner) allowing them to leap higher and reach previously inaccessible areas. This in turn allows them to access more bonfires and increase their exploration range further.

51 First-person perspective is a common camera/control structure in many games. It approximates the player character's vision as if they were embodied in the game-space and is considered one of the more immersive camera perspectives available.

At the centre of the island, and the only constant piece of architecture, is a large tower with a final bonfire located in its belfry. The player can see this destination from almost everywhere on the island but will not be able to make the jump from the highest stair to the belfry until they have visited enough bonfires.

The simple mechanic of "collecting" bonfires is accompanied by a secondary narrative process where accessing each fire also reveals an extract from the Lucretius epic 50BC poem *On the Nature of things* (Lucretius Carus, trans Ellery, 2004). The extracts from this poem are drawn from a pre-selected list of quotes, chosen specifically for their symbolic references to the generative nature of the world. The quotes are revealed in a random order, producing a generative, piecemeal poetic accompaniment.

Once the player reaches the final bonfire they are transported back to their starting position where they can witness a dramatic storm occur while the island slowly sinks into the ocean. After this end-sequence the game begins again, but the player is now given access to optionally adjust many of the generation variables (how many stairways to be generated, how tall might the tallest tower be etc.).

7.2 Investigative Points

In Ruins is an exploration of the digital sublime through virtual space and allegorithm. It examines how the dreamlike aesthetics of the romantic sublime can be re-worked into digital topology. Like *AvSeq*, *In Ruins* is based on ideas of mathematical permutation and complexity, but in this second project the trajectory of the game experience lies in the exploration of space/structure rather than time/structure. This required some changes in perspective and gameplay. For example, in *AvSeq* the underlying permutations are displayed as a two-dimensional audiovisual score, but *In Ruins* presents its procedural forms as explorable three-dimensional spaces. The player is no longer observing the world from "outside" as they do in *AvSeq,* but is instead exploring it from the "inside". Playing the game from a first-person perspective helps with this embodiment. When a player engages with a game environment at a human scale it can make the experience more intimate and personal than when a game is presented as a tactical overview (as in *AvSeq*). It also encourages a personal narrative of exploration (King & Krzywinska, 2003), where users typically ask themselves questions such as, "How did I wander in here? Where did I arrive on the island?". This perspective also instils a sense of mystery, arising from the way the environment obscures information[52] with towers hiding stairways and bonfires lost in recesses. This means players can

52 In *AvSeq* the game-state or compositional structure was never hidden, although it was deliberately obfuscated.

never see the structure of the island in one comprehensive view and instead must create their own topological map of the game-space. Putting the player “inside” the island's procedural forms forces them to engage with these structures from a different perspective, and it is easy to become lost or disorientated. “The question is directly one of perceptual semiotics. It's not easy to see things from the middle” (Deleuze & Guatarri, 2004, p. 23).

Although the environment may be based on familiar romantic themes (see section 7.3) it is generated through procedural methods which create a multiplicity of forms, both logical and illogical. This range of complexity and autonomy creates an odd disconnect with the carefully composed images of romantic painting, and the re-organisation of space with each play-through disrupts any sense of an “original” or “definitive” environment. This reinforces a sense of emergence and autonomy (the same way that the construction/re-construction of audio/structure in *AvSeq* implies autonomy and potential chaos).

The design elements above are intended to encourage the player to reflect on the construction of the game-world and the inclusion of quotes from Lucretius is designed to strengthen this response by punctuating the game with phrases concerning notions of multiplicity, infinity and generativity (see the next section for more details). These quotes work together with the permutations of the ruined architecture to form a kind of allegorithm[53].

7.3 Aesthetic Design

The world of *In Ruins* is generated in the style of a traditional gothic or folklore aesthetic, depicting mystical ruined castles overgrown with gently swaying trees. The buildings form labyrinthine corridors and are decorated with broken arches and tapering spires. The entire scene is post-processed[54] with a painterly effect that softens the natural hard edges of computer graphics. A constant cycle of night and day casts looming shadows across the scene, and reveals stars amongst dynamically created cloudscapes. The environmental audio consists of a general ebb and flow of naturalistic sounds, wind rustling in trees, water lapping, fires crackling. All of these elements are deliberately romanticised. They reference the work of Thomas Cole and Caspar David Friedrich, but are also influenced by games such as Fumito Ueda's *Ico* Series (Ueda, 2001), which were themselves inspired by Giorgio de Chirico.

53 See section 2.2 for more information about this term.

54 Post Processing is a technique used in film and digital media where visuals are filtered with various effects (motion blur, sepia toning, highlighting) to affect the final aesthetic of the images.

Figure 7.2 : The Abbey in the Oakwood (Friedrich, 1809)

Figure 7.3 : Ruine Eldena (Friedrich, 1825)

Figure 7.4: Screenshot from Ico *(Ueda, 2001)*

Figure 7.5: Screenshot from In Ruins

The dreamlike spaces generated are also a reference to Jorge Luis Borges' writing, where the exploration of mazelike spaces is presented as a parallel to the exploration of abstract thought. In Borges story *The Garden of Forking Paths* the narrator states that “all possible outcomes occur; each one is the point of departure for other forkings. Sometimes, the paths of this labyrinth converge: for example, you arrive at this house, but in one of the possible pasts you are my enemy, in another, my friend.” (Borges et al., 2000). This sense of multiple permutations of space and story are reminiscent of Deleuze's multiplicities and reflected in the near-infinite number of possible ruins in the game. In fact even the repetition of certain modular elements reinforces this aesthetic as the re-appearance of forms suggests the world is itself a remix of elements. This is something that was also common in the romantic landscape art of the Friedrich and others (the two images above share an almost identical arched opening).

The quotes (from Lucretius) that are revealed to the player as they progress are also selected to represent the sublime subtext of the generative world. Phrases such as “And the primordial germs of things unfold.”, “Through aeons and infinity of time. For the replenishment of wasted worlds.” and “Possess those properties required of generative stuff–divers connections, whereby things forevermore have being and go on.”, hint at themes of autonomy and recursion, suggesting that the game is exploring similar ideas through its ability to endlessly generate the virtual world. Other quotes are directed more toward the appearance of the ruined world and the players experience within it, “When salt seas eat under beetling crags.”, “There's place intangible, a void and room.” and “By matter eternal, shackled through its parts, Now more, now less. A touch might be enough to cause destruction.” The full list of these quotes is available in Appendix C.

When the player completes a game cycle by reaching the top of the central tower the ruined world sinks slowly into the sea under a violent storm and a final quote from Lucretius is shown, “From that slight swervement of the elements. In no fixed line of space, in no fixed time. Repeat the movement as the foot keeps time.” I felt that this quote summed up much of the game's theme, reminding the player of the recursion of the world, the deviations that make each cycle different, and the role of the player in their movement through the game.

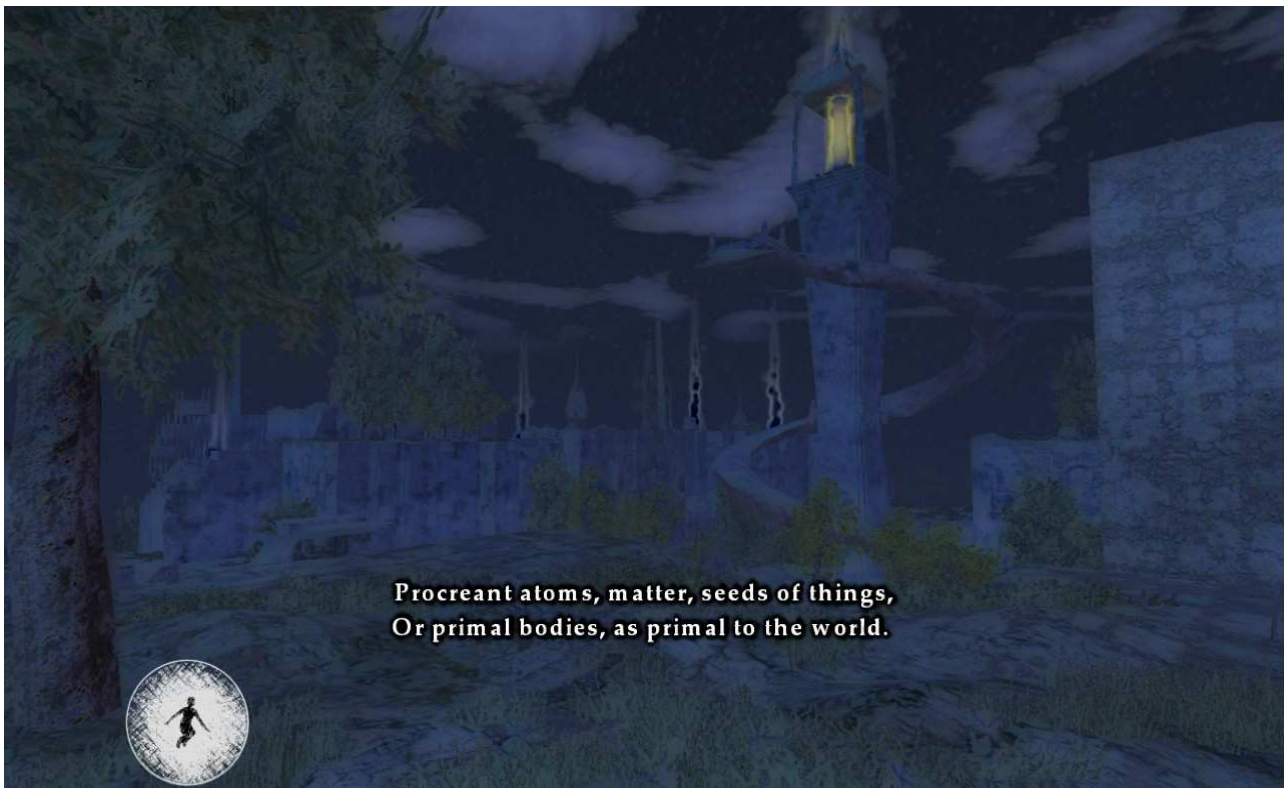


Figure 7.6: Screenshot from In Ruins *showing a Lucretius quote*

7.4 Development

In Ruins began as an experiment in architectural design, based on the genre of "rogue-like" or "dungeon-crawler" games. This design trope is typified by the use of maze-like game-spaces through which the player has to progress to reach an exit (leading to the next level). "Rogue-likes" are one of the earliest genres to employ procedural generation and have a well-documented history of associated algorithmic techniques (Togelius, Yannakakis, Stanley, & Browne, 2011). I wanted to experiment with code that could generate human architecture, but was capable of producing more chaotic structures when modified. It was also interesting to use architectural structures as an environment rather than landscapes because buildings are constructed with human use in mind and imply a sense of purpose that players want to decipher[55]. Writing code to generate architecture rather than terrain is a difficult task. In some cases it may be viable to scatter simple huts across a tundra-like terrain, but anything more complex (like a ruined castle) requires the local juxtaposition of architectural elements to demonstrate more logic.

Because of the concerns above, designing procedural code to generate architectural spaces presents specific problems. Both the internal structure of buildings and the external layout of settlements needs to take into account the functionality of those elements and their strategic location. To address this I used a variation on a method called room-packing (where random points are expanded to fill intervening space), mixed with a pathfinding function that connects doors and gateways with a system of corridors. The initial prototypes already showed the ability to produce a wide range of variable architectural layouts. However, the resulting environment was too enclosed and dungeon-like. It had little verticality or open spaces that could enhance the sense of scale I wanted to explore.

To remedy this I inverted some of the primary architectural structures, selected rooms became open plateaus and many corridors became causeways. This increased both the sense of exposure and the opportunity for open views across the environment. After fine tuning several iterations of the process I arrived at a set of rules that produced an interesting mix of enclosed spaces and open mesas. This combination of spaces accentuates the idea of scale, but also aids gameplay by and making bonfire targets easier to locate and navigate to. A selection of generated layouts is shown in figure 7.7; this image also displays some of the interface sliders that I programmed to vary the architectural generation. After building these options into my prototypes I chose to allow players access to the same parameters from the main menu of the game after they had completed it. This

55 This same sense of purpose can be disturbed by allowing procedural generation to create architecture that seems illogical or alien in design, something that can help point players in the direction of the digital sublime.

meant that they could then experiment and influence with the range of architectural permutations available before entering the ruins again. The details of this innovative generation system were made available online alongside the game itself (Betts, 2014)[56].

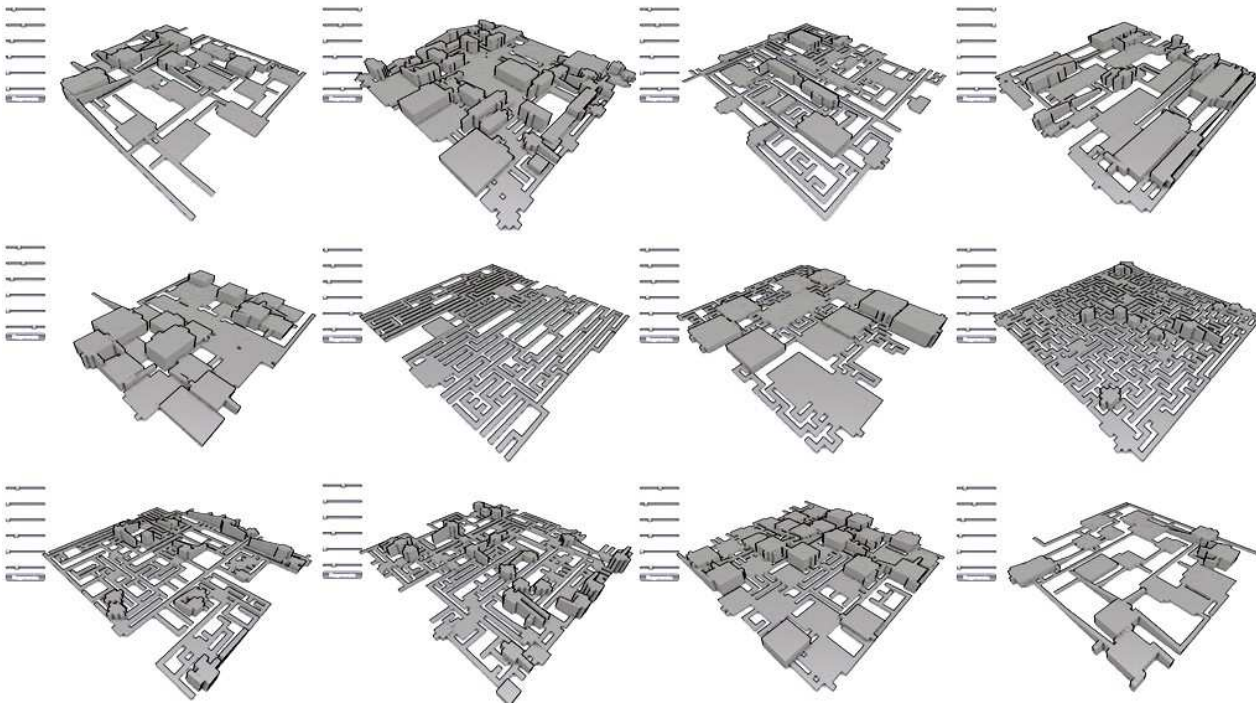


Figure 7.7: Selection of generative architecture produced for In Ruins

In addition to the game's environmental audio (waves, wind, crackling fires) there is a semi-generative soundtrack produced from the phasing combination of ambient melodic loops. These sonic layers consist of simple drones, sparse piano chords and slow echoing melodies. The individual sounds were produced by Jonathan Pilcher[57] a musician with whom I had collaborated with on my previous work as *Weevil* (as discussed in section 6). The intention was to create a subtle, shifting background layer of minimal music that reflected the aesthetics of permutation in the game.

7.5 Publication and Presentation

In Ruins was first shown during the Brighton Digital Festival at an evening of digital art presentations ("BDF12 Gong Show," 2012) . This event allowed me to demonstrate and discuss the game with an audience of artists and digital practitioners. The game was also formed part of a

56 The technical innovations and solutions developed through the research are documented at http://www.nullpointer.co.uk/content/research-hub/

57 See http://www.jonnypilcher.com/jonny1.html for more details of Jonathan's work.

presentation I gave at the GAME12 ("Game12," 2012) academic conference at Imperial College London[58]. I also delivered a detailed technical talk describing the methods developed for the project at the London Unity Users Group ("London Unity Usergroup 10," 2012). Continuing this strand of technical dissemination, a selection of prototypes was made available on my website during the development of the project and the associated algorithmic techniques were documented on my blog[59]. Additionally a short technical review of *In Ruins* was used in *The Handbook of Digital Games* (Angelides, 2013) as an example of innovative procedural design.

In contrast to *AvSeq*, *In Ruins* was not exhibited as an art piece; this was a deliberate decision for several reasons. I felt that I had already investigated the effects of producing games for an art gallery context via the two previous *AvSeq* installations. Although these installations had been useful in terms of providing alternative perspectives on the work, the impersonal setting of a public exhibition space is at odds with the introspective atmosphere that *In Ruins* engenders. In addition, the play-time of *In Ruins* is around twenty minutes for an average session, as opposed to five to ten minutes for *AvSeq,* and this meant that the game required a longer attention window than is usual in exhibition contexts. I decided that allowing players to download the game and experience it at their own pace was the best method of presenting the work. The final public version of the game was made available online during the summer of 2012.

In Ruins has since been downloaded over 2,000 times[60] and received generally favourable feedback. Key elements of this feedback are discussed in the findings below, and a list of sources is available in Appendix F.

7.6 Findings

In Ruins was designed to investigate the digital sublime through the generation of a procedural romantic landscape combined with a fractured dreamlike narrative. These elements operate together as a form of allegorithm, communicating points of enquiry to the player.

In Ruins deliberately creates familiar romantic imagery and only requires simple gameplay skills (moving, jumping, collecting). These basic elements allowed the majority of players to immerse themselves in the game quickly and explore the themes and ideas communicated through its

58 My presentation was scheduled alongside industry veterans such as Peter Molyneux and David Braben. In an interesting coincidence, Braben produced one of the first procedurally generated games for home computer, *Elite (Braben, 1984).*

59 http://www.nullpointer.co.uk/content/research-hub/

60 This figure is correct as of 10/07/14

procedural world. General feedback to the game suggested that *In Ruins* had more success in communicating ideas of the digital sublime than *AvSeq* did. For example, the writer and artist Porpentine selected *In Ruins* for her monthly showcase of artistic and experimental games, saying that it represented

> Alien architecture... mutated merging structures of disparate styles–I want to see architecture as processed by a machine, our history of design and space filtered through a random generator. This island alone gave me many fragile moments crafted from the myriad intersections of water, foliage, horizon, light, shadow, and stone. I found In Ruins to be almost unbearably beautiful at times. (“In Ruins | Rock, Paper, Shotgun - so many of clowns,” 2012)

This response indicates that the familiar romantic aesthetic of the game and its emotive quotes did much to aid the transmission of theme. But was the experience too meditative? I wanted to immerse players, but also provide them with elements of chaos or confusion that might cause a disturbance in the state of immersion and point towards a sense of the digital sublime. To encourage this I programmed *In Ruins* to generate mysterious and illogical features as well as romantic vistas. This was inspired by Kants assertion that “the Sublime is what pleases immediately through its opposition to the interest of sense” (Kant & Bernard, 1951, p. 108)

I found the most obvious reactions to this strategy in the large number of YouTube “Let's Play” recordings that were produced concerning the game. This format of presentation actively encourages introspection, and many of the videos revealed that players became entranced but also disorientated by the game-world. Those commentators who reached the games end-sequence expressed audible confusion at the collapse of the island and shock at the reward of being able to regenerate more chaotic versions of the game-world.

"I saw things off in the distance.. but...I am so lost I don't know what to do” - lycoplays 22.46

"Not just like cycles of life, but like progressing through a life and like ending it and starting over.. I don't know, I mean there’s a lot of different stuff you can get out of this...I'm not really sure what to say, like should I even try to analyse and review it?" - *fingerfood 19.29*

Reactions like this were not uncommon and mirrored my own experiences, because even though I had written the software myself, I still couldn't predict the labyrinthine forms each play-through

would create. Because of the procedural nature of the game I also found myself wandering and lost, trapped in an oubliette, exposed on a narrow causeway, or surprised by the changing connections of quotes and places. In a metaphorical analogue, the act of exploring the procedurally generated castle is similar to the act of programming the code that produces the game itself. It is a process of trial and error, expansion and redirection, following multiple avenues and forming temporary maps to identify new directions. These are generative processes operating through multiplicities (of form in the game and of code in the programming) like a rhizome, "The rhizome is an antigenealogy. It is a short-term memory, or anti-memory. The rhizome operates by variation, expansion, conquest, capture, offshoots" (Deleuze & Guattarri, 2004, p. 21). In these terms, the act of exploring the game-space mirrors the notion of the rhizome and reflects the experience of generative code.

The exploration of this generative structure is wrapped in romantic imagery and the usage of Lucretius quotes lends a narrative rhythm to the game, underlining the experience with reminders of the sublime. Porpentine specifically remarked on the usage of these quotes, saying "...the excerpts are perfect, suggesting ruins, primordial creation, immensity."("In Ruins | Rock, Paper, Shotgun - so many of clowns," 2012). Even the randomised delivery of these quotes communicates the sense of multiplicity and iteration and it is this combination of narrative, place and algorithmic processes that gives the game is allegorithmic power.

The success of *In Ruins* both pleased and saddened me. It was rewarding to know I had created a generative landscape that people could engage with. And this space did contain many of the elements of the digital sublime including disorientation, multiplicity, alien topology and abstract permutation. However it seemed to me that the most important aspect in eliciting these sensations was the romantic narrative and painterly visuals that frame the game-world. By reacting to the results of *AvSeq*, where geometric abstraction and musical symbolism had been a barrier to many players, I had produced something that almost overcompensated. I wasn't upset that the narrative and visual context for *In Ruins* was stereotypical, but I was disappointed how effective it could be (even to myself). Perhaps because my practice so often focuses on formalism I consider the use of poetry and romantic imagery to be somehow less pure than the abstraction of *AvSeq*. In the analysis and comparison of the first two game projects I could see clearly how much effect context and framing have on the experience[61].

61 It is important to note that I include myself in the audience affected by the different forms of contextual and aesthetic framing. I found *In Ruins* just as intriguing and involving as *AvSeq*, both of them communicating a sense of the digital sublime to me. However I could feel that the stylistic tropes of *In Ruins* made the entry to the proposition much easier, even for myself.

Maybe this is just a case of classic authorial intent clashing with post-structuralist individual readings[62]. Inevitably the success of any medium to transmit a specific concept or experience to its audience depends on how the creator(s) manages to communicate their intent to the reader. *In Ruins* communicates this intent far better than *AvSeq,* and does so to a wider audience. Both games investigate the same underlying questions of autonomy, complexity, permutation and abstract topology. But the context of *In Ruins* provides more familiar hooks and expositional leads for the disinterested user to be drawn in with. The allegorithms within it are successful because they are easily read, and embellished with the textual allegory of classical poetry.

The conclusions I drew from *In Ruins* does not imply that games with a bold abstract or digital style have no audience. But games with those aesthetics rely on a player-base that is already predisposed to that style of design and thinking. This is true for all art forms; genres such as structural film-making or serialist music appeal more to audiences that have existing knowledge of the field. *In Ruins* is a game with more populist appeal simply because its aesthetics and setting are more established via art history and common understanding.

The success of *In Ruins* led me to rethink the approach to my final project. I still wanted to explore a third trajectory to the digital sublime, one of vertigo and high-speed algorithmic topology. And although this aesthetic contrasted greatly with *In Ruin's* dreamlike ambience I was keen to re-create the game's sense of spatial immersion and ease of access. To do this I focused on designing an easily understandable set of game mechanics that would allow players to move rapidly through a generative space. If *In Ruins* was an immersive reverie in the digital sublime then the final game would be a dangerous joyride.

62 Indeed for users attuned to abstract audiovisual aesthetics *AvSeq* did connect; see the extended feedback and section 6.

8. Game 3: Permutation Racer

Permutation racer is the final game in the research trilogy; it is designed to investigate the ideas of vertigo, velocity and algorithmic topology in the digital sublime. It is an infinite racing game where players hurtle across a mathematically-constructed terrain.

Racing games are a long-established genre in both computer and console titles. They present a clear gameplay format that takes real-world racing scenarios and translates them into a virtual environment. In most cases the player avatar is a vehicle of some sort, tasked with the goal of beating opponents or stopwatch timers in a track-bound race through hazard-strewn environments. Racing games embrace the experience of hypnotic speed and vertiginous danger, there is no turning back and no way to get off the ride until the game is over. This enforced movement is an escapist submission that rewards the player with an intoxicating sense of power, velocity and fragility. Some racers even deliberately reduce the risk of crashing and operate “on rails” like a traditional roller-coaster, allowing the game design to concentrate on spectacle and simulated danger[63]. This interest in maximising the exhilarating sense of panic and speed makes the genre a perfect setting for the final game.

Racing games usually require the player learn the structure of the environment in order to progress (generally through their mistakes and crashes) and the persistent player becomes skilled at reading the game geometry and responding to upcoming cues. This recursive scenario presents an ideal opportunity to expose players to the permutations of procedural form and encourage them to engage with the thematic nature of a code-driven topology. Learning the potential forms that a race track can present is closely aligned to learning the expressions of the game's code[64]. Players become familiar with different mathematical aspects of the game-world and begin to understand how the algorithms function simply by learning to read the generated terrain.

Racing games also train players to adopt an increasingly narrow field of vision. As they become more attuned to the environment they can focus on the events occurring in the far distance, on the horizon, where forms first emerge. This trained tunnel vision enhances the immersive quality of the

63 Caillois refers to this form of *rollercoaster ride* as "excitement, illusion and disorder that has been agreed to, falling and being caught, blunted shocks and harmless collisions" (Caillois, 1913, p. 137).

64 This is particularly true in the case of *Permutation Racer*, as will be described later in this section.

experience and creates a trance-like state of tumbling speed. The idea of an endless high-speed race towards the infinite skyline is a familiar metaphor for transcendental journeys seen in such films as *Lost Highway* (Lynch, 1997), *Vanishing Point* (Sarafian, 1971) and *2001* (Kubrick, 1968). The associated notion of a hypnotic voyage that ends in chaotic destruction or transcendence is an ideal framework in which to explore the digital sublime.

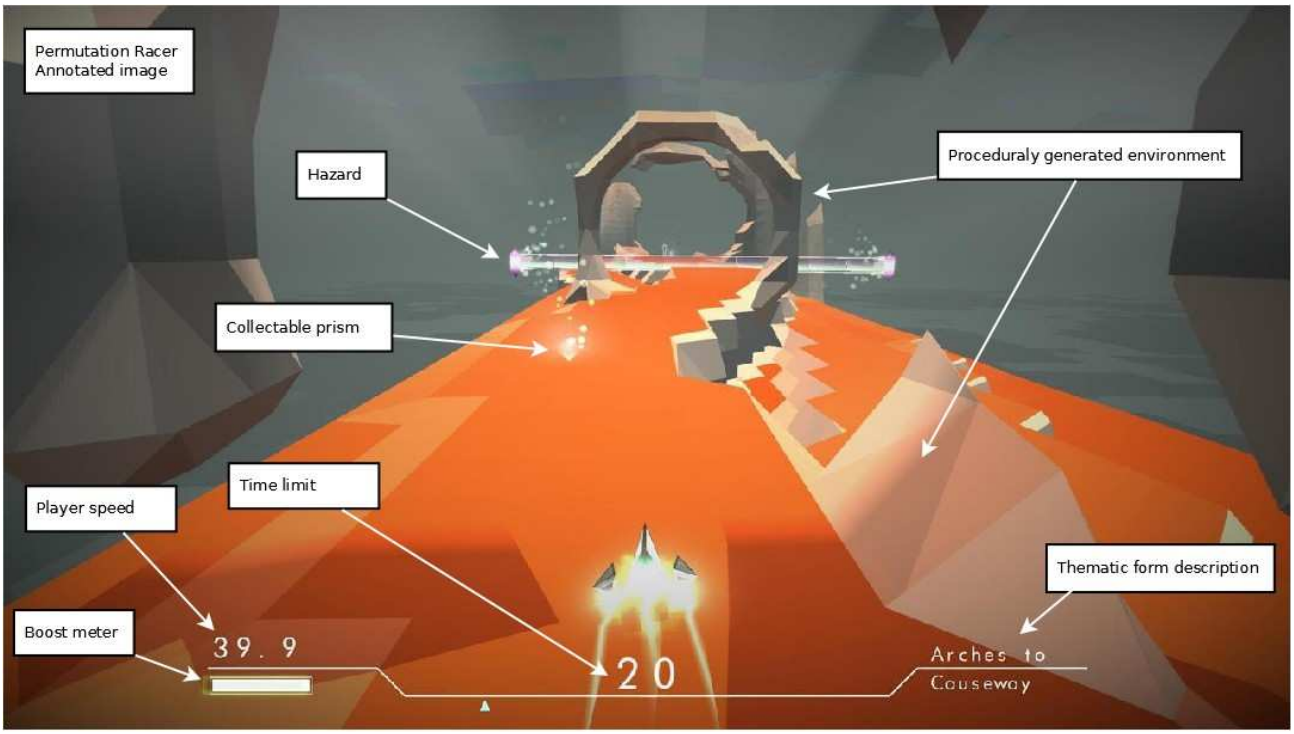


Figure 8.1: Gameplay elements in Permutation Racer

8.1 Game Description

Permutation Racer sends the player hurtling through a code-driven environment that increases in complexity and abstraction. It is a single axis racing game (the road heads only in one direction) that takes place on an infinite, procedurally generated track. The player controls a hovering craft made of simple polygonal shards. This craft can accelerate forwards, brake to avoid obstacles and strafe left and right. There are no forks or intersections in the racetrack and the path ahead forms increasingly complex tunnels and causeways that the player must negotiate. Unlike most racing games, the track never repeats, there are no laps or loops, instead the generated terrain proceeds endlessly towards the unreachable horizon.

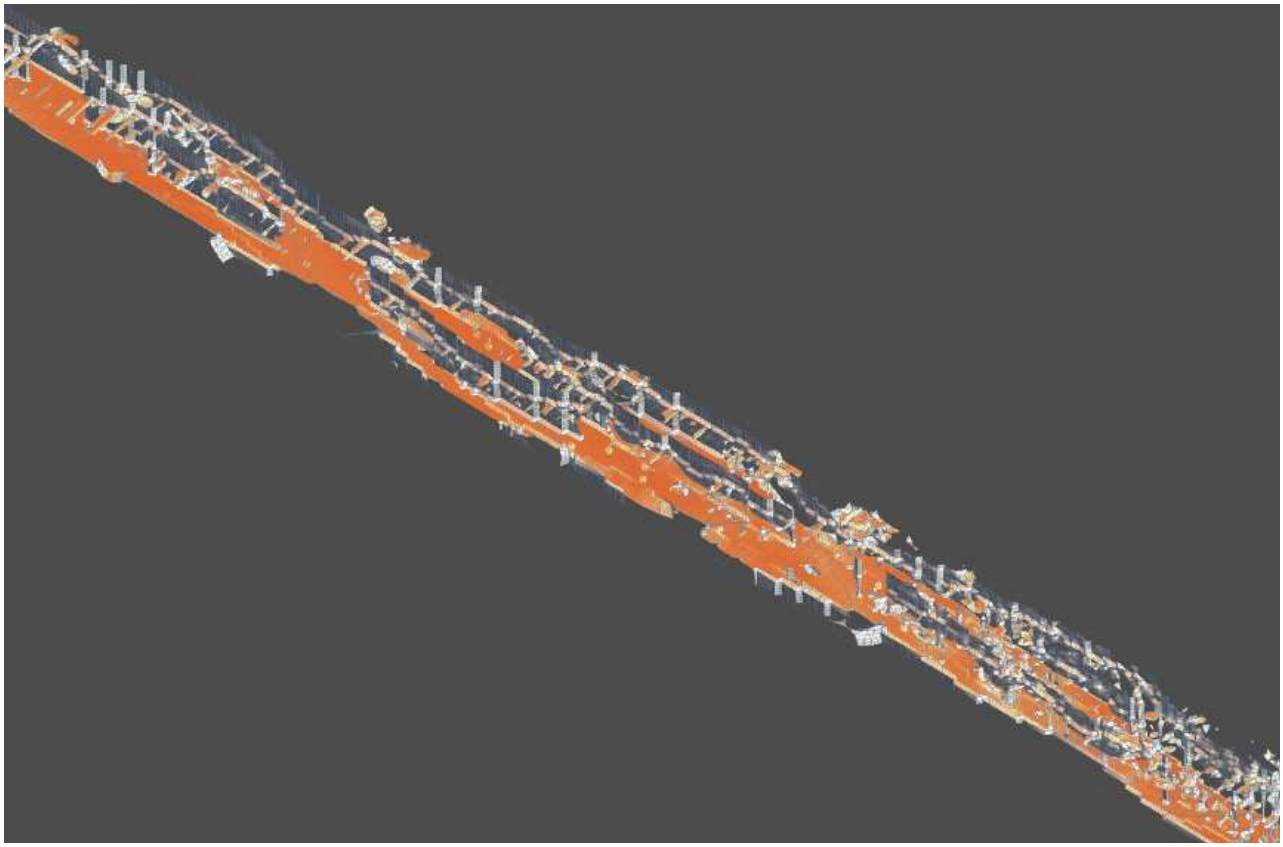


Figure 8.2: Isometric view of a generated track section

The geometry of the track is uniquely constructed each time the game is played. As the player moves forward new sections of track are generated and added to the end of the current path (see figure 8.2 above). Each section is constructed from a different set of terrain generation algorithms of which there are ten environmental themes, ranging from cave-like structures to causeways, cliffs and arches. Each algorithmic archetype is individually recognisable but increasingly corrupted based on the distance the player has travelled. As the player races through these sections, the game dynamically cross-breeds the environments, blending trees into caves and arches into chasms, creating an increasingly abstract terrain. The game visuals employ an oldfashioned computer aesthetic (see section 8.3), mixed with modern visual techniques for enhancing the sensation of speed and complexity.

The sole objective of the game is to travel as far as possible, racing against a decreasing timer. Neon-edged prisms are placed along intersections in the track, and when collected will help the player by enabling a speed boost or hinder their progress by slowing them and distorting the visual field. Each section also contains visual checkpoints that add a few seconds to the game timer when

they are broken through by the player. When the player runs out of time the maximum distance they have travelled is recorded as a "high score". The success of any specific play-through depends on the skill of the player, the current generation of geometry and the placement of collectible items.

8.2 Investigative Points

I wanted to use my third research game to investigate the digital sublime along the trajectories of speed and vertigo. My previous games dealt with aspects of complexity and multiplicity in time (*AvSeq*) and in space (*In Ruins*). Effectively *Permutation Racer* combines these two axes, using velocity (distance over time) as a vector to generate increasingly complex and chaotic forms. It combines the exploration of generative landscape from *In Ruins* with the entropic time-line of *AvSeq*. This creates a trajectory that operates both as a gameplay mechanic and as an allegorithmic structure, because as the player races towards the infinite horizon the detail and abstraction of the forms around them increases towards the point of impassable complexity. This one-way trajectory forms the code-generated world around the player in an irreversible, vertiginous experience.

The sensation of vertigo is common in high velocity games, especially when speed increases and the environment becomes more hazardous or exposed (Bartle & Bateman, 2009, pp. 83–92). The feeling is often accompanied by mixed emotions of self-preservation and abandon (Quinodoz, 1997). And though it is generally linked to physical or sensory stimuli it can also be triggered by internal processes (where thinking can make you feel "dizzy"). Psychoanalyst Danielle Quinodoz remarks on this, "The expression I have vertigo can be used to express a physical sensation (for example, 'I feel the room is starting to spin'), but it can also reflect a feeling of disquiet or anxiety about a psychologically daunting situation (for example, 'The immensity of the task before me makes me feel giddy')" (Quinodoz, 1997, p. 2). I propose that vertigo caused by video games can be an indicator of the digital sublime, it is a signal of when the virtual experience has become too much for the player to handle.

Of course digital games provide the thrill of vertigo without the physical danger. This phenomenon was identified by Caillois as one of his four game rubrics (see section 2.3). He calls it Ilinx, which he describes as "...surrendering to a kind of spasm, seizure, or shock which destroys reality with a sovereign brusqueness" (Caillois 2001, p.23). Caillois sees the sensation of Ilinx provided for in games by fairground rides and haunted house attractions, "excitement, illusion and disorder that has been agreed to, falling and being caught, blunted shocks and harmless collisions" (Caillois 2001, p.135). This sort of experience is at the core of many games with racing titles such as *Wipeout*

(Psygnosis, 1995), high-velocity FPS[65] games such as *Quake3* (ID Software, 1999) and twitch arcade games such as *Rez* (United Game Artists, 2001) all creating sensations of chaotic motion and vertigo.

With *Permutation Racer* I wanted to extend these mechanics to breaking point, by presenting an endless journey through increasingly chaotic code-generated forms. In *Permutation Racer* there is no finishing line, its not the endpoint but the journey that matters, and this journey is one of autonomic generation, boundlessness and algorithmic complexity.

8.3 Aesthetic Design

The graphical style of *Permutation Racer* is designed to draw attention to the mathematical nature of its game-space. It is deliberately minimalistic and geometric, defined by hard vector lines, neon effects and simple colour gradients. The palette and low polygon style reference the graphics of early 3D games like *Driller* (Incentive Software, 1987) or *Zarch* (Braben, 1987). This serves to indicate that the game is not intended to be photo-realistic (as opposed to most modern racing games) but is instead concerned with the presentation of an algorithmic space. The flat, shaded geometry and bold colour palette highlights the structure of the tracks and make the increasing complexity of the game more visible as the player progresses. Just as the first two research games drew inspiration from traditional art movements, *Permutation Racer* is designed to reference the Italian Futurist tradition, a movement which embraced notions of speed, vertigo and technology. The aesthetics of this movement were based on attempts to represent motion and machines in paint, demonstrated by images such as Umberto Boccioni's *Forces of the Street* (Boccioni, 1911) and Luigi Russolo's *House/Light/Sky Movement* (Russolo, 1913). These artworks are presented below alongside screenshots from the game, in order to demonstrate the stylistic similarities.

65 FPS or “First Person Shooters” are games which a player experiences from a first-person perspective, with the world represented from the point of view of the player character's eyes.

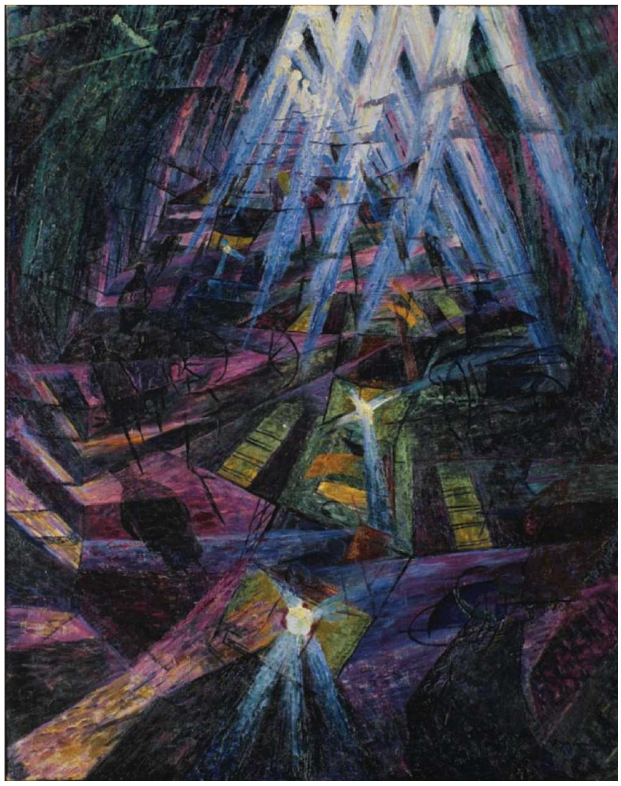


Figure 8.3: Forces of the Street (Boccioni, 1911)

Figure 8.4: House/Light/Sky Movement (Russolo, 1913)

Figure 8.5: Screenshot from Permutation Racer

Figure 8.6: Screenshot from Permutation Racer

To enhance the sensation of speed and to provide intermittent periods of higher risk and vertigo the game allows the player to "boost" at specific intervals. This accelerates the game to almost double the speed and applies a visual blur to disorientate the player and indicate the velocity change. This effect not only adds to the sense of vertigo but also echoes some of the Futurist techniques used to represent movement and acceleration in two-dimensional space.

The game features a rapidly cycling day and night system, where the lighting blends from desert oranges to deep midnight blues once every minute, referencing the colour schemes of early videogames and films like *Tron* (Lisberger, 1982). The sunset falls repeatedly in front of the player on a horizon that they are always approaching but can never reach and through the accelerated day and night the terrain casts geometric shadows across the track, leaving fleeting impressions of abstract code built forms[66].

Above the terrain, pixellated clouds shift in layers echoing the imagery of fictional computer worlds like *Tron* or *The Matrix* (Wachowski & Wachowski, 1999). The stylisation of the game is intended to reflect the nostalgic aesthetics of early computer games. By referencing primitive 3D graphics and the existing tropes of "computer worlds", the game admits its code-driven nature and communicates this to the player. In addition to the visual style highlighting the code-built geometry of the game, the constant motion of the sun and sky mirrors the recursive permutations of its algorithms.

After a short period of gameplay the system introduces disruptive prisms scattered across the track. If the player collides with these obstacles (called glitch bombs) the game screen becomes distorted and fragmented for a few seconds. The occurrence of these hazards increases as the game is played and the increasing visual distortion mirrors the ongoing corruption of the track itself. The intention behind this mechanic is to create moments where a disruption in the surface of the game hints at the fragility of the code beneath, emulating some of the interesting errors identified in the games reviewed in section 3. Seeing the gaps in a game-world, like the glitches in *Love* and *Minecraft* interrupts the sense of flow and reminds the player of the digital nature of the game-space.

As with all the research games *Permutation Racer* features a generative soundtrack[67], where looping audio is gradually layered and re-ordered based on the player's performance. As the game proceeds the music becomes more detailed and variable, adding a hypnotic sonic layer to the channels of feedback. The compositional style of this soundtrack references "Trance" music from hi-tech racing games such as *Wipeout* (Psygnosis, 1995) or *F-Zero* (Nintendo, 1990). This style of music is characterised by the use of repeating melodic phrases and fast rhythmic tempos, and it is often used to enhance the sense of speed or tension in games. However in *Permutation Racer* there is no final refrain or finishing line, instead the soundtrack cycles and re-orders itself for ever, triggered by the

66 The speed of the day/night cycle also reinforces the sense of artificiality, iteration and urgency in the gameworld.

67 Audio is an important channel of communication that I have used in all three games to express the complexities and multiplicty of code. The accompanying soundtracks of each game are composed in real-time just as the environments of each game are constructed procedurally.

players actions. Each gate the player passes will prompt the soundtrack to mutate, and every glitch bomb the player hits adds a distorted sound to the mix. Even the power-ups that the player collects are tuned to play notes from a specific chord set and release clouds of crystal-like particles. This synchronisation and interplay of audio and visual effects mirrors the synaesthetic design of *AvSeq*, and shares the same intention of drawing players into the game-space through multiple channels of communication.

8.4 Development

The technical development of *Permutation Racer* extends a line of enquiry I had started in the early stages of my research. I was experimenting with a technique to render mathematical noise into 3D forms, called "marching cubes" (Bourke, 1994); an example of this technique is shown in the voxel[68] prototypes of section 4.2. When I had developed a range of filtering algorithms to sculpt the noise I realised that the range of forms possible through this technique was effectively infinite and therefore an ideal space to examine for the digital sublime. By changing small parameters in the code I could generate vastly different structures with organic, mathematical and alien-like forms (see figure 8.6 below). Since I wanted players to explore a wide range of these possibilities I needed a way to force the player to keep moving through the world. I had already decided that the trajectory of speed was an important vector to explore in the final project and so being able to combine these two elements (speed and procedural form) in a racing game seemed like the ideal solution.

I wanted the geometry of the world to be initially simplistic and increase in complexity and variation as the game progressed. To this end I produced a range of prototypes, experimenting with different scales of perspective and intervals of terrain type. I wrote the terrain generation algorithms to allow for a degree of distortion and corruption to be directed parametrically; for example, certain values, when increased, cause the terrain to become more broken and restrictive or convoluted and cratered. Eventually I discovered that I could cross-breed these terrain formulas in real-time, combining cave forms with columns or ravines with canopies. This would not only increase the number of permutations, but also visually indicate the transitions from one possibility space to another. Initially the rate of generation possible with the code was too slow to keep pace with player movement, but through optimising the code and running the processes outside of the main program thread I managed to create a system that could produce endless complex geometric terrain at a

68 Voxels are simple cubes in a game environment which can be used as building blocks to define objects or terrain.

speed suitable for high velocity movement. The details of this innovative generation system were made available online alongside the game itself (Betts, 2014)[69].

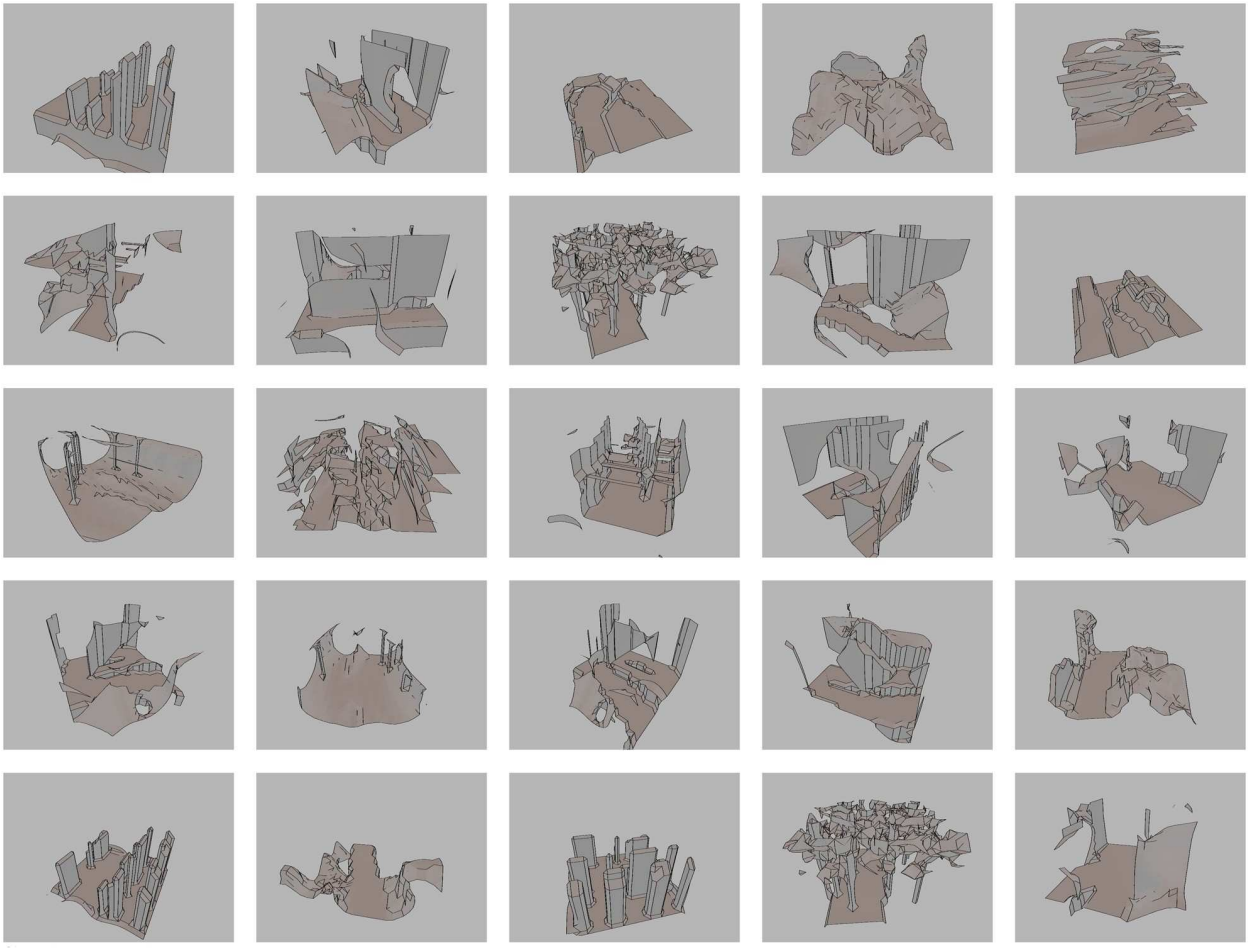


Figure 8.7: 25 different landforms produced by the procedural code of Permutation Racer

The audio effects and soundtrack for the game were developed in collaboration with Noel Murphy ("www.visualdisplayunit.org" 2014) an established musician and installation artist. Noel produced various iterations of the games trance-like soundtrack, and after several stages of fine tuning the resulting layers were assigned to a generative sequencing system that I had written for the game. This system mirrored the recombinant geometry of the game with the individual audio channels being remixed and re-ordered throughout the gameplay.

Although I wanted the player to be able to experience a wide range of environments I also needed

69 The technical innovations and solutions developed through the research are documented at http://www.nullpointer.co.uk/content/research-hub/

some form of challenge and jeopardy. An unrestricted on-rails journey wouldn't provide the appropriate levels of agency or danger. Both of these elements are needed to generate a feeling of engagement and investment that immerses players and makes the psychological effects of the game more effective. I needed to balance the difficulty level of the game to present an enjoyable challenge, while also allowing the player to experience a reasonable range of complexity and transformation (the results of my final decision are discussed in the following sections). To find this balance I play-tested *Permutation Racer* with gamers and non-gamers and spent time adjusting the time limits, hazard points and power-ups to identify settings that would make the game enjoyable but also capable of presenting the ideas it was intended for.

8.5 Publication and Presentation

Permutation Racer was released for free download on the 8th of January 2014. As with *In Ruins* I felt that the game was best experienced by players at home, rather than in an exhibition context. This was particularly true for *Permutation Racer* because it is the most game-like of the three projects and the pressure on the player to perform occurs very soon after the game starts. Learning a game under the view of an audience (even an audience of friends) can make players feel uncomfortable, whereas in a private setting they feel less self-conscious about any failures they may make. *Permutation Racer* was also the project with the most traditional gameplay mechanics, consisting of familiar objectives and quick play times that encourage players to retry the game to improve their score. Replay-based games also suit private play environments because most people would feel obliged to pass the controls to another audience member if the game was exhibited in a public space.

Permutation Racer was included in various presentations at game conferences such as Indievelopment ("Indievelopment - Indie Game Development Conference," 2013) and the Bartlett Plexus ("PLEXUS 04," 2013). In these talks I used the game as a demonstration of procedural generation and as an example of code-driven aesthetics. These events gave me the opportunity to discuss my work and present my approach to programming as a way to facilitate independent artistic production[70]. Some of the programming techniques developed for *Permutation Racer* were also included in my chapter for the *Handbook of Digital Games* (Angelides, 2013).

Being the final game in the series, *Permutation Racer* has had the least time for public exposure,

70 Games development is traditionally a resource and content heavy endeavour, requiring extensive manpower and time. Using the kinds of algorithmic techniques I have developed for this research can enable a wider range of practitioners to produce games by bypassing some of the historical restrictions.

but it did received a significant amount of press from mainstream gaming journalism (Matulef & Eurogamer, 2014) (Schulenberg & Joystiq, 2014) (PC Gamer & Savage, 2014). The numerous articles that announced the games release led to over 2,000 downloads of the software (as of 15/07/14).

8.6 Findings

Permutation Racer was the culmination of several important threads in my work. Throughout this research I had been developing techniques for rendering abstract mathematical forms in 3D geometry (see 4.2, *AvSeq*, *In Ruins*). The topology generated for *Permutation Racer* demonstrates the most advanced and nuanced version of these methods. I had developed an innovative set of algorithms that produced a wide aesthetic range of environments (from regular structures to chaotic forms) and I wanted the player to be able to explore this range of forms in a fluid way. My design for *Permutation Racer* achieved these objectives, sending the player through a rapid sequence of evolving landscapes, increasing in complexity and abstraction. But did this experience communicate a sense of the digital sublime?

As with the previous game, the release of *Permutation Racer* prompted a number of interesting YouTube reviews and "Lets Plays". It was a testament to the game's playability that people began to post "high-score" videos, simply to demonstrate how far they had progressed in the game (*Permutation Racer 4238*, 2014) ("Worth Playing," 2014). One player even managed a single run that lasted close to an hour and eventually caused the system to crash (*Permutation Racer Score 83060*, 2014)[71]. These responses indicate that the game was successful in engaging players via well-balanced mechanics. When reviewers did provide a running commentary, they often had to pause in their discussion to negotiate a specific section of track or would cry out in the middle of a sentence due to a collision or tricky manoeuvre (*Permutation Racer Spotlight*, 2014). Again this demonstrates that *Permutation Racer* provided an immersive gameplay experience, but I wanted to find out if players had felt anything of the digital sublime in their contact with the game-world.

Some reviewers did discuss the game's imagery and aesthetics. In a web-based review from *Indie Statik* the author talks about the game's algorithmic alienation; "What I really love about it is the strange scenery the game produces. It feels like a hostile alien world that you're driving through, full of weird procedural geometries and algorithmic architectures." ("Drive Against The Clock

71 This performance was particularly interesting as I didn't think the game could be played beyond ten minutes or so. The game crash that ended the player's run was also interesting as it was probably a result of the game code reaching the limits of a standard PC's computational range.

Through Permutation Racer's Abstract Procedural Landscapes | *Indie Statik*," 2014) and several YouTube reviews voiced similar opinions[72]: "How incredible it all looks, not so much in terms of texture resolution or lighting bloom, but the kinds of environments that the generation equations build in front of you." - n3rdable 2.29, "Surprisingly addictive, and I think a lot of the addiction comes from, the controls feeling pretty nice, the gameplay being fairly simple, the soundtrack being rather immersive, and of course just sort of wanting to see where the gameplay takes us in terms of these procedural landscapes" -RockLeeSmile 3.07, "Its always different in some way and some of the creations made by this program are simply astounding to behold, the whole games as art argument is one that normally passes me by, but seeing an engine with a not so simple mathematical equation jammed into it produce incredible vistas such as this is art at its finest" - n3rdable 2.40

Despite the comments suggesting that some players had detected elements of the digital sublime in the game, the majority of reviews were concerned with issues of pacing, mechanics or difficulty. In retrospect it seemed that development of *Permutation Racer* had focused too heavily on its gameplay aspects. Whereas *In Ruins* was seen by most players as a meditative and ambient experience, *Permutation Racer* was generally perceived as a quirky racing game with experimental visuals. Few players seemed to think that the game was exploring anything beyond the surface mechanics. This result was partly my own fault, and to some degree echoed the experience players had with *AvSeq*. In both these games I had provided very little narrative or contextual framing. Instead I had focused on creating engaging interactions, hoping that the sense of the digital sublime would be communicated solely through the audio-visual rush of gameplay.

One issue was that in order to encourage player interaction I had to make the game elements very clear, even at great velocities[73]. This restricted the range of forms, aesthetics and mechanics I could use. Unlike *In Ruins* which contained some narrative hints at the digital sublime, *Permutation Racer* presented information in the form of counters, power bars and speedometers, declaring itself as a game far more obviously than it declared itself as an artistic investigation. Its focus on speed also left little room for introspection or meditation, as was present in *In Ruins*. Instead the game demands that the player constantly performs rapid evasive manoeuvres and this interaction overrides any opportunity for a deeper consideration of the algorithmic generation around them.

However, for myself, as an artist-programmer, the experience of racing through the generated

72 A list of sources for the videos and web articles is available in Appendix G

73 *Permutation Racer* had to strike a difficult balance between playability and abstraction. If the game's geometry became too complex or abstract early in a playthough, people would be unable to navigate the track and the sessions would end quickly. This could 'bounce' players out of the game too rapidly and leave them unlikely to replay it.

geometry in *Permutation Racer* mirrored the hypnotic process of coding its algorithms, and during development I would switch seamlessly between programming the game and playing it. This process is common in my working methodology as an artist-programmer (as described in section 4) and it is often difficult for me to separate the two activities. Both modes of interaction deal with the same underlying matter, the source code of the digital sublime. But although the perspectives of player and programmer are integrated in my own practice, they represent very separate roles for most people. The idea that, for me, playing and coding can satisfy the same desire (to explore the complexities of the digital sublime), made me realise that the games I produce are trying to communicate my own experience, representing what it is like to see code and its outputs as part of the same system, a multiplicity capable of producing the digital sublime.

9. Findings and Conclusions

This research is an artistic investigation of the digital sublime in video games. It uses concepts drawn from a literature review (section 2) and a peer practice review (section 3) to create a definition of the digital sublime. It then explores this definition through the artistic production of three video game projects; *AvSeq*, *In Ruins* and *Permutation Racer*. The conceptual designs that underpin these games explore the notions of allegorithm, topological space and multiplicity through the qualities of complexity, abstraction, autonomy. By reflecting on the design, production and analysis of these games a range of conclusions and contributions have been formed.

9.1 Concluding Reflections

Before introducing the main contributions of the research this section presents a brief reflection on the creative process of developing the games and the issues raised during their design and analysis.

The first game in the series, *AvSeq*, had both the longest period of development and the most variations of prototypes. It represents a bridge between my pre-existing artistic practice and the research process as a whole. As discussed in section 6, concerns about the accessibility of *AvSeq's* abstract audiovisual design affected the aesthetic development of *In Ruins,* directing it at a more familiar visual space. The conclusions drawn from *AvSeq* also encouraged the design of both *In Ruins* and *Permutation Racer* to feature more embodied perspectives (first person and third person respectively). The transition from a two-dimensional space to the three-dimensional world of *In Ruins* reinforced this notion of embodiment and although more technically challenging, this shift led to the development of innovative code for procedural geometry construction. The implementation of romantic aesthetics of *In Ruins* resulted in some concerns over the degree to which visual framing might drive the experience of the digital sublime and as a result the design of *Permutation Racer* attempted to return to a more technological aesthetic. The development of procedural construction techniques began during *In Ruins* was refined and extended during the production of *Permutation Racer.* This resulted in a level of procedural architecture that enabled the final game to present the re-interpretation of its chosen aesthetic (Futurism) with the confidence of its own generated forms. This chronology demonstrates the overall development arc of both

concepts and techniques during the practice component of the research, but the final conclusions and contributions result from the combined outputs and analysis of all three projects.

A recurring issue encountered in all three games was how different levels of techno-cultural familiarity in players affected their engagement with the software. This issue was particularly obvious in the cases of *AvSeq* and *Permutation Racer*, although it is arguably an issue for video games in general. If the participant is unfamiliar with the qualities and concepts that a game is trying to communicate, it is unreasonable to expect their thoughts to follow the trajectory the game design proposes. Different levels of familiarity with video games, digital culture and code mean that participants have individual trajectories to the experience of the digital sublime. It is assumed that different generations, and people from different socio-cultural fields may experience the digital sublime differently (Hall, 1997).

Kant refers to the subjective nature of the sublime in his own writing, stating, "True sublimity must be sought only in the mind of the [subject] judging, not in the natural object the judgement upon which occasions this state." (Kant & Bernard, 1951, p. 95). Art work that presents the digital sublime through video games inevitably meets with this issue of subjective judgement. As observed by Shinkle in 2.1.2, an audience with no knowledge of a systems construction is "...confronted with a technological artefact – a featureless surface with no relationship to the unimaginably complex workings that it conceals" (Shinkle, 2010). Of course a deeper knowledge of the medium does not always guarantee reflective engagement either. This is particularly true in the case of video games, where there are few historical precedents of games presenting artistic enquiry or cultural critique. It is only recently that games are being used as a medium for philosophical discussions (Bogost, 2007) and therefore the notion of an "art" game is still relatively unfamiliar.

Providing guidance for players with contextual framing or simple narrative elements can aid in the communication of concepts that would otherwise be too arcane to understand. This is particularly true in a project where the subject material is the structure and expression of code itself, where "Computation is abstract and un-grounded, inevitably needing to be made concrete through some interpretation." (McCormack & Dorin, 2001). Each of the research games provided some form of contextual framing through their procedural re-interpretation of existing aesthetic forms (synaesthesia, Futurism, Romanticism). These different audiovisual frames not only help to guide participants thoughts to the subject being examined (the digital sublime) but also inevitably colour their responses. For example the reactions to *In Ruins* demonstrated a lyrical nature that reflected its

literary aesthetic, “This island alone gave me many fragile moments crafted from the myriad intersections of water, foliage, horizon, light, shadow, and stone. I found *In Ruins* to be almost unbearably beautiful at times.” (“In Ruins | Rock, Paper, Shotgun - so many of clowns,” 2012), whereas responses to *Avseq* focused more on the formal qualities of the game, “Starting out on a blank playfield, it's pretty easy to lose yourself in the zen-like, metronomic rhythm of alternating gem chain connections and explosions” (Orland, 2012). Further research could be carried out to better understand the relationship between pre-existing aesthetic tropes of the sublime and its digital incarnation.

9.2 Contributions

The following sections describe the contributions made by this research in the areas of design, programming and philosophy. The contributions are divided into these sections for the sake of clarity and focus, although as stated throughout this thesis, all three areas are combined in the cross-disciplinary methods of an artist-programmer's practice.

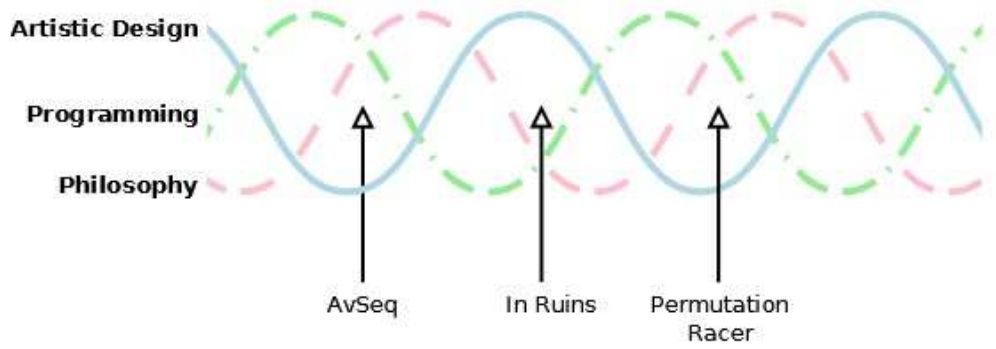


Figure 9.1: The three strands of practice and the games produced

It is important to stress that the three games produced for this research are the principle vehicles for the dissemination of the contributions outlined in this section. The games demonstrates the investigation of the digital sublime in a unique interactive form. The research contributions are articulated through the act of playing the games, and this process reflects the symbiotic relationship between theory and practice throughout the research. It is important that the contributions exist within this interrelated space where the articulation of the digital sublime is fundamentally immersed in programming and playing. The multiple expressions of the game experience also demonstrate the practice approach of using expressive code as a medium for artistic investigation (see sections 4.1, 4.2), and the ongoing availability of the games allows this opportunity for

investigation to extend far beyond the initial scope of the research.

9.2.1 Contribution to Methods of Game Design for Artist-Programmers

This research contributes a new production methodology to the development of artist-designed video games. It presents a novel design framework that incorporates allegorithm and procedurality as key factors in its construction. This framework reflects the cross-disciplinary practice of artist-programmers and facilitates the development of video games as tools for code based artistic enquiry.

The design approach demonstrated in this research employs procedural and generative programming to generate multiple, interactive variations of audiovisual aesthetics. In the three games produced for the research these aesthetics reference synaesthesia, Romanticism and Futurism (see sections 6.3, 7.3, 8.3). The use of procedural and generative code automates, extends and disrupts the re-interpretation of these aesthetics. For example, *AvSeq* represents a fragmentation of the aesthetics of the synaesthetic sublime which are then "remixed" into a vast range of possible variations in a real-time interactive experience.

Figure 9.2: Screenshots showing variations in the generative scores of AvSeq

This design approach opens up the possibility for the semi-autonomous exploration of aesthetics and the production of emergent audiovisual forms that are novel to both player and designer. Examples of this phenomenon can be found in the vast range of musical scores in *AvSeq*, the variations of architecture in *In Ruins* and the infinite mutating terrain of *Permutation Racer.*

Alongside this focus on emergence and procedurality the research presents a second key component in its game design methodology, the incorporation of *allegorithm*. This concept was introduced in the literature review as a scenario where "The gamer discovers a relationship between appearances and algorithm in the game... — that's allegorithm." (Wark, 2007a, p. 31). In the methodology proposed by this research, allegorithmic design uses code to generate interactive scenarios that reflect specific narratives or philosophical concerns. The use of procedural and generative techniques directly supports this form of allegorithm by providing multiple expressions of code that repeatedly demonstrate the relationships between appearances and algorithm. If the game design is expressing its message through the behaviour of its algorithms then the iterative execution of those rules strengthens the communication of the idea. The diagram below illustrates the interaction of these design elements.

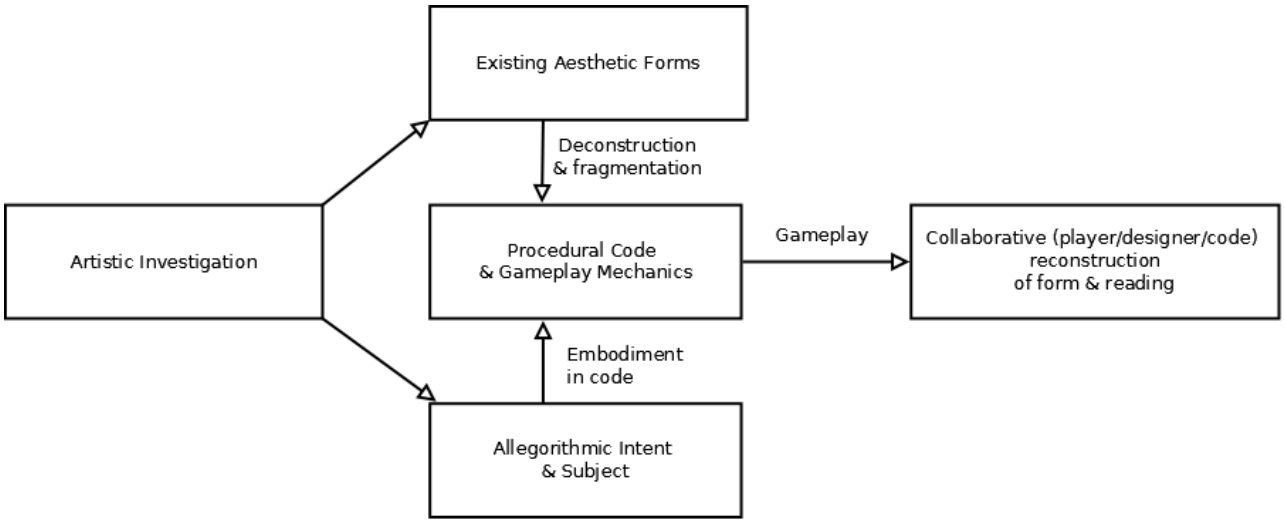


Figure 9.3: The relationship of production elements in the design methodology

Each game in this research demonstrates an allegorithmic design, created to explore specific qualities of the digital sublime.

AvSeq represents a synaesthetic allegorithm of complex structural emergence that leads to chaos. It challenges the player to maintain order against the increasingly chaotic and destructive power of

generative systems.

In Ruins represents an allegorithm about endless cycles of mysterious autonomous creation based on the ideals of Romanticism. It uses algorithms to generate a virtual maze where the player wanders amongst crumbling code-built architecture. It challenges the player to explore a dreamlike space of abstract causeways and dead ends, gathering narrative fragments.

Permutation Racer represents an allegorithm of endless flight into unknown space based on the aesthetics of Futurism, such as the idea of speed represented in *Rhythm & Noise & Speed of Car* (Balla, 1913). It uses algorithms to present the experience of a vertiginous dive into the topology of complex mathematical structures. It is the race towards the infinite, reaching towards the horizon that can never be crossed.

In each game the autonomy and multiple expressions of procedural and generative code reinforce the allegorithm that is being presented.

In summary the approach to game design presented in the research demonstrates a new framework of production that is built on the notions of allegorithm and procedurality. This framework reflects the practice of artist-programmers and facilitates the development of video games as tools for code-based artistic enquiry.

9.2.2 Contribution of Programming Techniques and Algorithms

The development of the three games produced for this research has involved a wide range of technical skills covering the areas of programming, sound design, graphic design and 3D modelling. Drawing these elements together as a solo developer is a substantial task and the methods developed during this process have been the subject of several presentations at conferences such as Indievelopment (NL), the Game Developers Conference (USA), and GaME12 (UK). In addition to general coding approaches discussed in these presentations each game has demonstrated specific technical solutions to procedural programming issues.

The development of *AvSeq* presented specific problems with the synchronisation of audiovisual elements, an element of gameplay vital for exploring the aesthetic of synaesthesia. Video refresh rates in games only offer around 60 frames per second, a speed far too low for accurate audio timing. The project solved this issue by devising a system that measured the elapsed time of a silent metronome audio file and using the intervals to offset synchronisation for sequenced events. This

technique was described, with demonstration code, on the research blog[74] and in the *Unity* forums[75].

A bespoke architectural generation system was devised for *In Ruins* which is capable of producing a wide range of architectonic forms. This system is a new interpretation of rogue-like space-packing algorithmns (Togelius et al., 2011) designed to create open-air ruins. Although initial versions presented significant load on graphics cards, a series of mesh combinations and virtual texturing systems were devised in the game's development to increase draw distance and frame-rate. The resulting system was included in a chapter for the *Handbook of Digital Games* (Angelides, 2013), documented on the research blog and presented at conferences and events in London, San Francisco, Amsterdam and Brighton (see appendix D).

Permutation Racer required the real-time production of continuous polygonal terrain. This terrain also needed to be capable of formal mutation over time. To meet these criteria the research produced a real-time isosurface generation algorithm based on the marching cubes algorithm (Bourke, 1994). This code then constructed polygons derived from a series of filtered fractal noise arrays. The technique was extended to allow the cross-breeding of isosurfaces at generation time. A significant amount of optimisation was necessary to get these computationally intensive functions to operate at the speed *Permutation Racer* required. These techniques were referenced in the *Handbook of Digital Games* (Angelides, 2013), and presented at the conferences and events mentioned above.

In addition to these three techniques a method for connecting 3D shader parameters to real-time DSP[76] audio was developed during prototyping of the games. These prototypes were presented at Culture Lab (Newcastle UK) and code demonstrations were made available on the research blog.

The results of the techniques listed above are clearly visible in the three research games themselves and *In Ruins* even presents a method for players to alter the algorithmic parameter for world generation. All three games are cross-platform applications (Mac and PC) available via digital distribution and in combination have been downloaded over 35,000 times. Details on the technical development of each game can be found in the individual game sections (6, 7 and 8) and further code examples and prototypes are available online (Betts, 2014) [77].

74 http://www.nullpointer.co.uk/content/research-hub/
75 http://forum.unity3d.com/threads/audio-stepsequencer-and-they-said-it-couldnt-be-done.78003/
76 Digital Signal Processing is a method of generating and manipulating audio in real-time via programming.
77 http://www.nullpointer.co.uk/content/research-hub/

9.2.3 Contribution to Philosophical Readings of the Digital Sublime in Game Design

This thesis presents a reading of the digital sublime that is specific to the concerns of artist-programmers working with the medium of video games. This contribution is based on findings from the literature review and the results of developing the three research games.

In the literature review I examined Ngai's and Shinkle's view of the digital sublime. In their opinion the passage from the Kantian sublime to the digital equivalent can be typified in a shift from a state of transcendental awe to state of transfixion or "disinterested pleasure" (Ngai, 2005, p. 271). It is easy to see this interpretation as a result of the relocation of the sublime from the "real world" to the "virtual world". For some theorists this transition divests the experience of the authenticity associated with the natural world, replacing it with a sense of technological alienation (see 2.1.2). However, the line between transcendence and transfixion is blurred. The word *transcendent* refers to a state beyond normal immanent experience, but it is often employed with religious overtones (Chidester, 1990) that imply a sense of external authenticity. It also represents the marker for an experience which is by its nature subjective and never fully definable (being beyond understanding). This makes the term a complex and subjective description for the experience of the sublime. This research indicates that many traditionally sublime scenarios could also be experienced in a mode of transfixion. For example, the experience of a raging thunderstorm could be described as transcendent, but it is equally possible to experience the same scenario from a perspective of stupefaction. Similarly, the digital sublime may be experienced as both transfixing and transcendental. With such subjectivities in mind this research proposes that the digital sublime should not be examined in terms of comparative transcendence. Instead the different forms of the sublime should be studied in terms of the alternative perspectives or insights they might offer to the experience. Each form of the sublime presents a different mental trajectory, and contains unique insights drawn from its own perspective. There are precedents for this approach in Kant's writing, which already distinguishes between two distinct forms of the sublime (See section 2.1.1). Through the production of three games *AvSeq*, *In Ruins* and *Permutation Racer* this research proposes the digital sublime is evident when we encounter boundlessness in a interactive computational space.

Video games typify the virtual world, they are digital simulation spaces built from the audiovisual output of algorithms. They exist in a *magic circle* (J. Huizinga & C., 2000) set apart from the rules of everyday life. The virtual reality of video games can be manipulated in many ways to encourage the digital sublime; time and space can be warped and fragmented, vast worlds can be created and destroyed, impossible structures can be built and explored, and all these elements can be made

interactive or exist autonomously. Video games present an alluring invitation to become lost in the generative space of code and imagination. They also pose no real physical risk, allowing us to wander into the heart of a digital hurricane or dive into a code-built sea. Although video games cannot replicate the dynamically sublime experience of the natural world, they offer mathematical simulations that are mutable and extensible in ways that the real world cannot be. I propose that video games represent a meeting of the dynamical and the mathematical, combining the drama and aesthetics of the former with the infinities of the latter. The result of this merger is more than just a simulation of previous forms, it offers a new version of the sublime that is moulded by the virtual world and reflects the unique traits and concerns of that space. It offers a new trajectory to the sublime, but rather than projecting the mind beyond the sensory boundaries of nature or the logical limits of pure mathematical form, it projects the mind through the boundless virtual world of code. The games produced for this research deliberately encourage this trajectory by drawing attention to the algorithmic nature of the game-space. This is well demonstrated by comparing *Permutation Racer* to equivalent games in the mainstream such as *Pure* (Black Rock Studios, 2008) or *Burnout Paradise* (Criterion Games, 2008). Most racing games hide the generation of their tracks off-screen to maintain a sense of realism and strive to present a photo-realistic racing environment. By contrast, in *Permutation Racer* the track is visibly constructed ahead of the player and deliberately incorporates unrealistic mutations of the terrain and glitches in the environment.

Video games provide a setting in which to communicate and explore this trajectory, from the perspective of both the designer and the player. The games developed for this research produce multiple variations of their game-worlds in a collaboration between player actions, programmer intent and procedural code. This approach helps to loosen the traditional roles of author and audience and encourages the participants to view the game from each other's perspective and consider code as another autonomous component, not unlike Barthes' *Death of the Author* (Barthes, 1989). Allowing code to form multiple expressions in relationship to player and programmer strengthens the ability of allegorithms to further communicate notions of the sublime. From the perspective of an artist-programmer this system of exchange presents one of the best mechanisms for communicating and encouraging the experience and understanding of the digital sublime.

The digital sublime shares many qualities with its Kantian precedents, such as the ideas of *autonomy*, *abstraction*, *permutation* and *complexity* (as defined in section 2). But there are several aspects of the digital experience, such as multiplicity, topology and allegorithm (see section 4), that are specific to the environment of code and virtual systems. Exposing and experiencing these

phenomena within video games leads players and designers into considering how such generative processes function, and through this lens of engagement participants begin to imagine both the theoretical and actualised output of the system. They become aware of the potential spaces and scenarios a program might produce, even if those permutations are never generated during actual gameplay. Trying to grasp the possibilities of code in this way points towards the consideration of the game-space as a virtual engine of production[78]. As the complexity of this engine grows it outstrips the comprehension of the participant and leads to an overwhelming sense of boundlessness. Deleuze applies the word *noumenal* to describe this understanding, which he calls the "virtual co-existence" of possibilities (Deleuze, 1994, p. 83). It becomes impossible to process these possibilities in the "sensible" mind and instead the perception becomes more gestalt[79], a subconscious engagement with the unfathomable patterns of code that underpin the virtual world[80]. This represents the transition into the digital sublime, and the entry into "...a different, nonsensual standard, which has that infinity itself under it as a unity," (Kant & Bernard, 1951, p. 101). The mind is shocked by its own limitations but also shocked by its awareness of those limitations, "...it does violence to the internal sense" (Kant, 1951, p. 98). So the digital sublime in video games exposes the noumenal sense of boundlessness along new lines and prompts us to examine how we value and explore this new digital territory. The resulting experience offers ways to be immersed in the structure of things, to be transfixed with the possibilities of systems and to be thrown into the sublime when those systems outpace our comprehension. Digital games and the code that defines them offer new artistic tools to investigate the virtual structures that are beginning to frame our lives.

9.2.4 Applications and Further Research

The contributions presented above are applicable in various overlapping areas of artistic and technical practice.

The design methods contributed through this research can be used to support the development of video games as artistic enquiry. Using generative code to "remix" aesthetics is a valuable tool for

78 Virtual both in terms of its environment (the digital realm of data and code) and in terms of its ability to contain definitions and expressions that are never actualised.

79 A configuration or pattern of elements so unified as a whole that its properties cannot be derived from a simple summation of its parts.

80 In a paper delivered for DIGRA I describe this connection as pattern immersion, "Pattern immersion operates on a holistic and sub-linguistic level of interaction which can only really be understood through direct experience." (Betts, 2011). It is a mode of interaction that operates on the level of "reacting" rather than "thinking", closely related to Csikszentmihalyi's notion of Flow.

the creation of novel audiovisual experiences. The research suggests that this approach could be applied to a wide range of aesthetic models allowing games to autonomously generate worlds based on specific source material. An extension to this research could involve the dynamic combination of several aesthetic sources, the contrasting areas of Brutalist and Rococo architecture for example. In addition to the reconstruction of aesthetic forms, the research presents allegorithmic design as a tool for developing non-linear avenues of communication in video games. It is suggested that further research in this area should investigate the effectiveness of allegorithmic communication in video games versus existing linear didactic methods.

The synchronizing techniques developed for *AvSeq* offer an effective solution for the production of audiovisual projects in the *Unity* game engine[81]. These techniques can be used for the creation of music games, composition tools or performance software. The thesis suggests that further research in this area could investigate the intersection of autonomous and collaborative composition in audiovisual performance. The procedural generation tools designed for *In Ruins* and *Permutation Racer* can be used to produce a wide range of structural content for games and other virtual environments. The respective algorithmns could be extended to produce more experimental visual forms allowing further research into the aesthetic possibilities of game-based generative systems.

The objective of this research was to develop three games and associated techniques and methods for the artistic investigation of the digital sublime. The form of this investigation was not based on a user driven research model. However, the three games produced could be used for further psychological research. By analysing player reactions in controlled environments, with appropriate qualitative and quantitative analysis, further research could identify psychological triggers that would be of use in general game design (sensations of speed, confusion, vertigo). These tests could also examine how different socio-cultural backgrounds effect player interactions with games that explore the digital sublime.

In the process of developing this research it has become apparent that there are few recent publications concerning the area of the digital sublime. This research embodies much of its contributions within the games themselves, but there is substantial scope for the production of additional written material. New publications could examine the subject of this research further and address the scarcity of existing material. The following topics are suggested as extensions to the contributions of this research: a detailed survey of the aesthetics of the digital sublime, the study of

81 The *Unity* Game engine is an integrated development environment that supports the development of games using the c# language. http://unity3d.com/

computer code and the mathematical sublime and an examination of the translation of non-digital sublime aesthetics into virtual environments.

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Appendices

Appendix A: Glossary

Autonomy

This term refers to the ability of computer systems to operate without user input, and to display some sense of purpose, even if the objective is unknown to the viewer.

Permutation

Computer programming uses permutation to generate a range of possible elements from a set of combined functions or structures. It can result in the total possible number of items built from a specific set of rules (such as every combination of cards in a deck, or every image possible in a simple grid).

Multiplicity

In the context of my research the idea of multiplicity has two distinct meanings. Firstly it is a concept derived from Deleuze's philosophy which describes the set of possibilities in any generative system. Secondly, in the context of generative programming it refers to systems of code that produce a range of formal outputs that can change over time yet demonstrate a recognisable theme.

Topology

Topology is a way of representing the connections between objects in a system. This might be nodes in a computer network, concepts in a theory or environments in a computer game.

Allegorithm

Allegorithm is a portmanteau of allegory and algorithm. It represents the notion that abstract ideas or principles can be communicated via programming and computer-generated interactions.

Generative Programming/Art

Generative programming (or art) is an approach to coding where the computer systems are designed to produce a range of formal results that can vary and evolve over time, based on mathematical equations and elements of randomness.

Procedural programming

This form of programming involves producing complex content from mathematical functions. It is broadly similar to generative approaches but often involves less focus on evolution or random emergence.

FPS or First-Person Shooters

These are games which a player experiences from a first-person perspective, with the world represented from the point of view of the player character's eyes.

Voxels

Voxels are simple cubes in a game environment which can be used as building blocks to define objects or terrain.

Gestalt

A configuration or pattern of elements so unified as a whole that its properties cannot be derived from a simple summation of its parts.

Synaesthesia

A condition in which one type of stimulation evokes the sensation of another, as when the hearing of a sound produces the visualisation of a colour.

Appendix B: Glass Pebble

The following text is an edited version of a talk presented at the 2014 Game Developers Conference in San Francisco. It was intended as a way to explain my experience of the digital sublime through a short personal story and associated metaphorical discussion. It is a sketch of personal thoughts, written partly in response to Ste Curran's talk “In the time it takes your heart to beat” at GameCamp13 in London (18/05/13) – Ste’s talk was a allegorical tale about how significant events punctuate our lives, often without us even knowing their significance at the time, and how these moments might also exist in games. It looked at how we recognise and value these moments, how we remember them and how we might try to create them. His delivery was inspiring and the talk was genuinely moving, but after the end of the story I began to think about how this might relate to my own work. I have been doing several years of research in an area that is often seen as obscure or arcane, I wanted to write my own monologue to explain my work in a similarly allegorical way. The rough script of this talk is as follows.

Several years ago I was huddling behind a windbreak on a Dorset beach, eating apple cake and sheltering scalding hot coffee (which already tasted foul since I'd burnt my tongue). The beach was a yellow-grey mix of sand and pebble dotted with tidemark lines of seaweed and plastic. My two children were tumbling around at the wave breaks looking for stones to skim. My son ran back to me with a glass pebble.

“What's this Dad?”

“Its a glass pebble.”

“Like a normal pebble?”

“Well, kind of, but probably much younger.”

I tried to explain to him how pebbles are made, that pebbles might be thousands of years old. For a six-year-old this time frame was pretty hard to process. But a glass pebble, well, it was different, its history was easier to understand. Maybe a coke bottle, tossed aside a few summers ago, sticky and shattered, its pieces smoothed over years of rolling in the foam. I could see he understood this, but

imagining this transformation happening to all the pebbles on the beach was beyond him.

“How many pebbles do you think are on the beach son?”

“A million.”

(I smiled)

“A lot more than that.”

“How many, Dad?”

(I stopped smiling)

I didn’t know, of course I didn’t know. It would be one of those numbers with a funny raised index, I was pretty sure of that at least. At that point I realised that imagining the scale of transformation was beyond me too.

A pebble is the sum of its impacts, millions of collisions. Individually each clash is almost insignificant , but each impact guides a tiny fraction of the identity of the whole object. The clink of stone on stone is a note in the song of the pebble. Rather than one cataclysmic event, its a gentle layering of permutations. These permutations show in the pebbles themselves, there is no perfect pebble, just a vast family of shapes, colours and textures, all related but all unique. Some people like the smooth granite eggs, or the angled skimming slate, or the marbled quartz, or striped limestones. All pebbles are the same, and all pebbles are different. And almost all pebbles are beautiful in some way. Why?

I hold the glass pebble in my hand and select another one from the furrows in the shoreline. Trying to compare the two, trying to explain to my son that the two things are the same, just variants of the same timeless, persistent process. I say:

“It's happening right now.”

“Where?”

“Everywhere, the sea is shuffling the pebbles, with each wave and each tide.”

“I can't see anything.”

“Maybe if you look close enough, but wait, listen… you can hear it.”

Tiny pebbles rolling out of sight, half-buried stones shuffling in their sandy tombs. Sure, some of it is the pop and play of air in the gaps, but some of it is the pebbles fighting, rattling against each

other amongst the foam. And the sea, the sea is the engine. The sea itself is a machine of permutations, same, same but different. And within both, the sea and the pebble, we can feel the whole, the process behind the product. There is no end either, a pebble implies more pebbles, a family of forms, a system of pebbles.

Many people collect pebbles, I often find the washing machine rattling with them when I come back from a break by the sea. Dom Hans van der Laan collected pebbles. Van der Laan was a Benedictine monk, one of the most original thinkers in twentieth-century architecture. He was obsessed with the idea that architectural form could not be purely subjective, but that there were underlying ratios and structure in the world that we subconsciously mimic. Van der Laan had a special cloth bag which he would use to would store pebbles he selected while walking around the monastery and its surrounds. Later he would group his finds, searching for ratios and relationships that might emerge from the stone shapes. Crucially Van der Laan believed that the relationship between things mattered more than the things themselves. He devised number sequences and formulae derived from his observations, creating elegant structures and designs. But van der Laan was not a purist, pushing platonic ideal form, his work was more didactic, balancing the beauty of formulae with the aesthetics of form and the practicalities of function.

It is easy to be enticed by grand narratives, to be moved by the sway of romance in dramatic gestures. These things are important, they punctuate experience with remarkable moments, peaks and troughs of memorable events. In Ste Curran's piece a fictional alien caller, Epher, contacts him in the middle of the night. She explains her race all have the same limited number of heartbeats, and they measure their experiences out in relation to this fixed lifespan. Epher lives like a metronome, her arrow of time is relentless and cruel. Her culture drives her to annotate and rate individual events, her own life becoming a competition against itself. What will be the most important moments in your life? Have you already experienced them? What will you remember at the end? This is powerful stuff, but there are alternatives to moments. I will remember the wind in the trees, the sound of rain, the waves in the sea, pebbles. These things transcend moments, they become fabric that you can wrap yourself in, perhaps without even realising it. The TV dramatist Dennis Potter gave a famous interview close to his death in 1994 during which he talks about the blossom tree in the garden of his house.

"It's a plum tree, it looks like apple blossom but it's white, and looking at it, instead of saying 'Oh that's nice blossom' … last week looking at it through the window when I'm writing, I see it is the

whitest, frothiest, blossomest blossom that there ever could be, and I can see it. Things are both more trivial than they ever were, and more important than they ever were, and the differences between the trivial and the important doesn't seem to matter."

Potters observation is about something that was always there, and will likely flower again, many, many times. But perhaps, for a brief moment its own unique shape represents all blossoms, a window into the global set of innumerable, beautiful expressions of that form.

So how does this relate to my work, to what I do? Like most people who make stuff, I end up just making stuff for myself and hoping that other people like it (and not even that sometimes). I've never been good at story-telling, even though I love being the listener. Perhaps I don't like endings, maybe the inevitable arcs of narrative upset me, or am I just shirking the responsibility of being an author? When I made music for a living I spent considerable time writing generative material, automated software-driven tracks that were thematically different every time they were performed. I didn't like recording them, it felt traitorous to their intent, to their form. I co-ran a generative radio station, where every program broadcast was an actual program running its code anew on the server each time. When I think of my favourite games, they are often the games that felt like they had their own life, and their worlds would exist without me. They didn't care for my presence and wouldn't remember me after I had left the game. *Shadow of the Colossus*, *Dark Souls*, *Minecraft*, *Stalker,* all of these games made me feel like I wasn't a hero but a wanderer. I was experiencing a place that had its own autonomy, its own eternal cycles and themes, like wandering on a beach listening to the slow erosion of the rock and the wetland scrubs fighting back, rustling in the breeze.

So I make games, or things, about permutation, about procedural form. Stuff that can happen over and over and over, without any real end or beginning. Stuff that has something of its own life. With procedural form there is no perfect version, no final state, there is just the search-space of possibilities. It might not be as dramatic as the grand narratives, but it can be immersive and engaging, and I believe its important too, even if I'm not sure exactly why sometimes. There is a peculiar aesthetic in it too, a sense of the whole process of construction, mixed with the delight at an individual incarnation. For me there is something sublime about it. So I make machines that make beaches and mountains and pebbles, and I train those machines to make pebbles people might like, pebbles that might have their own stories, digital pebbles that make us want to be curious and explore.

"This is a cool one Dad, look!"

“Yeah, it is.”

“Shall we walk down there and look for some more?”

“Yeah, let's do that.”

Appendix C: Quotes from On the Nature of Things by Lucretius

The quotes listed below are revealed in a random order to players of *In Ruins* every time they walk into a bonfire. Because there are more quotes than there are bonfires in a single game, and the system of the quotes is randomly organised, players would need to replay the game many times to see the entirety of the quotes below.

And the primordial germs of things unfold.

Procreant atoms, matter, seeds of things, primal bodies, as primal to the world.

For lapsed years and infinite age must else have eat all shapes of mortal stock away.

By matter eternal, shackled through its parts, now more, now less. A touch might be enough to cause destruction.

The sea, the lands, the clouds along the sky, vexing and whirling and seizing all.

We view the rock-paved highways worn by many feet.

When salt seas eat under beetling crags.

There's place intangible, a void and room.

They yet are formed of matter mixed with void. In rocks and caves the watery moisture seeps, and beady drops stand out like plenteous tears.

Even from the deepest roots, through trunks and boughs, voices pass the solid walls.

Fly Reverberant through shut doorways of a house and stiffening frost seeps inward to our bones.

The void, the invisible inane, right here.

These alone can hunt from thought to thought and keenly wind along even onward to the secret places and drag out truth.

For without void, naught can be crushed, it seems, nor broken, nor severed by a cut in twain.

Through aeons and infinity of time. For the replenishment of wasted worlds.

The first foundations of a solid frame but powerful in old simplicity.

Bide the solid, the primeval germs and by their combinations more condensed.

All objects can be tightly knit and bound and made to show unconquerable strength.

The smallest bodies would have infinites, since then a half-of-half could still be halved, with limitless division less and less.

Possess those properties required of generative stuff–divers connections, whereby things forevermore have being and go on.

Their congress will destroy them quite. Or drive asunder as we see in storms, rains, winds, and lightnings all asunder fly.

Twill come to pass they'll laugh aloud, like men, shaken asunder by a spasm of mirth, or moisten with salty tear-drops cheeks and chins.

From that slight swervement of the elements in no fixed line of space, in no fixed time.

Repeat the movement, as the foot keeps time.

The Nature of Things

Appendix D: Research Outputs

The present thesis has been developed and disseminated through the following activities and publications.

Practice

The three games produced for this research are available from various websites but are always directly accessible from my own website. This website also contains detailed technical discussion and prototypes associated with the thesis.

AvSeq (section 6)

http://www.nullpointer.co.uk/content/Avseq-3/

In Ruins (section 7)[82]

http://www.nullpointer.co.uk/content/in-ruins/

Permutation Racer (section 8)

http://www.nullpointer.co.uk/content/permutation-racer/

Selected Talks and Engagements

***AvSeq*, Phoenix Square, Leicester**

http://phoenix.org.uk/index.php?cms_id=286

8/4/2010 - 24/5/2010

ICMC (International Computer Music Conference), Huddersfield

Installation of *AvSeq*

http://www.icmc2011.org.uk/

31-5/08/2011

82 *In Ruins* was selected by Paolo Pedercini as part of the syllabus for the Experimental Game Design course at Carnegie Mellon University – School of Art http://mycours.es/gamedesign2012/

DIGRA 2011 : Think Design Play (Paper and presentation), Hilversum

http://www.digra.org/digital-library/publications/pattern-recognition-gameplay-as-negotiating-procedural-form/

15/09/11

GaME12, Imperial College, London

http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/engineering/computing/eventssummary/event_23-3-2012-13-3-25

http://www.doc.ic.ac.uk/game/index.php

http://www.nullpointer.co.uk/dropbox/GaME-Talk.pdf

29/05/2012

London Unity User Group : Procedural methods and Unity at London Southbank University, London

http://blogs.unity3d.com/2012/04/02/london-unity-usergroup-10/

06-07/07/2012

Brighton Digital Festival Closing Performances, The Lighthouse, Brighton

Live Generative audiovisual performance

http://www.lighthouse.org.uk/programme/brighton-digital-festival-closing-performances

30/09/2012

Brighton Digital Festival - Digital Art Gong Show, Brighton

http://fortunecatproductions.com/bdf12-digital-art-gong-show/

10/09/2012

Plexus04, Bartlett School of Architecture, London

http://www.bartlettnexus.com/home/

21/02/2013

Realtime Visuals - Workshop and performance at Culture Lab, Newcastle

http://www.realtimevisuals.org/

http://www.ncl.ac.uk/culturelab/

26/02/2013

Keynote Presentation, Indievelopment Conference, Amsterdam
http://www.indievelopment.nl/speakers/tom-betts/
25/04/2013

Presentation, A Bit of Alright, Independent games conference, London
http://bit-of-alright.com/
10/05/2013

Presentation, Rezzed, Birmingham NEC
"Procedural Generation and Independent Development"
http://www.rezzed.com/
22/06/2013

Presentation, Unite Nordic (Nordic Game conference), Malmo
"Procedural Generation of Open Worlds"
http://unity3d.com/unite/nordic/
29/07/2013

AI Game Dev, Interview and discussion
http://aigamedev.com/broadcasts/session-sir-being-hunted/
17/10/2013

Brighton Unity Users Group, Brighton
"Procedural content generation"
http://www.meetup.com/Brighton-Unity-Group/
28/11/2013

Game Developers Conference, San Franciso
"Creatrilogy: Three Talks Exploring Indie Game Creativity"
http://www.gdconf.com/
17/03/2014

Game Developers Conference, San Franciso

“Creating FPS Open Worlds Using Procedural Techniques”

http://www.gdconf.com/

19/03/2014

Feral Vector, London

“The lost game art”

http://feral-vector.com/

04/07/2014

Roguelike Radio, London

Episode 53: Game Design in Academia

http://www.roguelikeradio.com/2012/11/episode-53-game-design-in-academia.html

21/11/12

Selected Publications

Handbook of Digital Games Chapter on Procedural Generation

IEEE / Wiley Publication

06/05/2014

DIGRA 2011 : Think Design Play (Paper and presentation), Hilversum

http://www.digra.org/digital-library/publications/pattern-recognition-gameplay-as-negotiating-procedural-form/

15/09/11

Featured in:

Form and Code in Design, Art and Architecture (Princeton Architectural Press)

15/09/2010

Appendix E: *AvSeq* Feedback

This appendix presents links to the sources of articles, YouTube videos and other informal feedback channels explored during the development and publication of *AvSeq*. This feedback provided me with initial user responses to the technical, aesthetic and philosophical elements of the project.

YouTube

Douglas Glover. (2012, Aug 27). *AVSEQ - Level 01 (Cobalt) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=VFFFmMGtgKA

Douglas Glover. (2012, Aug 28). *AVSEQ - Level 02 (Amber) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=XQ-oZq__Sd0

Douglas Glover. (2012, Aug 29). *AVSEQ - Level 03 (Topaz) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=PFznmL5LVx4

Douglas Glover. (2012, Aug 30). *AVSEQ - Level 04 (Ammolite) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=4IBTDXOlR3c

Douglas Glover. (2012, Sep 1). *AVSEQ - Level 05 (Emerald) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=YDV1yPiTYZA

Douglas Glover. (2012, Sep 2). *AVSEQ - Level 06 (Agate) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=Op5P4oWMXXg

Douglas Glover. (2012, Sep 3). *AVSEQ - Level 07 (Spinel) PC Gameplay* [Video file]. Retrieved

from https://www.youtube.com/watch?v=JVamYCmdFbo

Douglas Glover. (2012, Sep 4). *AVSEQ - Level 08 (Zircon) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=3BCSZCNWDxY

Douglas Glover. (2012, Sep 5). *AVSEQ - Level 09 (Ruby) PC Gameplay* [Video file]. Retrieved from https://www.youtube.com/watch?v=dFIcSbAhlPg

TheGamingOctopus. (2012, Nov 1). *Indie Testing Avseq!* [Video file]. Retrieved from https://www.youtube.com/watch?v=jNiGHFCoCcY

FireBlob0. (2013, Aug 9). *AVSEQ - Random Game Adventures* [Video file]. Retrieved from https://www.youtube.com/watch?v=rhLllbFpqGg

Throneful. (2012, Aug 27). *AVSEQ Gameplay (PC/HD)* [Video file]. Retrieved from https://www.youtube.com/watch?v=Q7mrtu1ZUN0

Levi Maggard. (2013, Jan 30). *Gaming the ABC's Episode A(1) – Avseq* [Video file]. Retrieved from https://www.youtube.com/watch?v=aGi4vKCkVBo

UnfairReviews (Video Game Reviews). (2012, Dec 17). *Should I Buy? AVSEQ (Audio-Visual Sequencer)* [Video file]. Retrieved from https://www.youtube.com/watch?v=Bk1uDd5fFZY

Storpey. (2013, Jan 26). *Steve plays AVSEQ* [Video file]. Retrieved from https://www.youtube.com/watch?v=lP_745Vt63o

John Coster. (2010, Apr 24). *AvSeq @ Phoenix Square* [Video file]. Retrieved from

https://www.youtube.com/watch?v=CjsGMSIoU8s

Web Reviews and Articles

Dan Zuccarelli, (2012, Feb 2). *AVSEQ Review*. Retrieved from http://www.gamezebo.com/2012/02/02/avseq-review/

Kyle Orland, (2012, Jan 31). *AVSEQ: Engaging gem-matching fails to mesh with trippy musical visualizations*. Retrieved from http://arstechnica.com/gaming/2012/01/avseq-engaging-gem-matching-fails-to-mesh-with-trippy-musical-visualizations/

Kevin VanOrd. (2012, Aug 31). *AVSEQ Review*. Retrieved from http://www.gamespot.com/reviews/avseq-review/1900-6394392/

betterbyyouasking. (2012, Nov 12). *AVSEQ*. Retrieved from http://betterbyyouasking.com/2012/11/12/avseq/

Tom Senior. (2012, Jan 24). *Musical puzzler AVSEQ gets a demo, out now*. Retrieved from http://www.pcgamer.com/musical-puzzler-avseq-gets-a-demo-out-now/

IncGamers. (2012, Aug 24). *Big Robot's music-generating puzzle epic AVSEQ arrives on Steam for Windows and OSX*. Retrieved from http://www.incgamers.com/2012/08/big-robots-music-generating-puzzle-epic-avseq-arrives-on-steam-for-windows-and-osx

ICMC Survey

A copy of *AvSeq* was installed in a lecture room of the music department of Huddersfield University, during the period of the ICMC (International Computer Music Conference) July 31 to August 5 2011.The room was a small sized lecture space (approx 30 seats), which had been organised to allow a single user to play the game at a central desk placed in front of the projector

screen. Users were provided with a single mouse and a sheet of simple game instructions. They were invited to play as long as they wished and there were seats for other people to watch and accompany the player. A stack of paper survey forms were placed by the entrance for users to complete as they left the space.

The participants were not a traditional gaming audience, having mostly come to attend the conference. This did mean however that they were familiar with interactive digital technology, audio composition and aesthetics. The survey results did reflect the range of the participants backgrounds and prior experiences with digital games. The survey results represent the collation of 25 completed forms (of 24 questions), automated computer recorded logs of play times, scores and gameplay performance were also factored in. A copy of the complete survey responses is included on the DVD associated with this thesis.

Results

Participants played for an average of 15 mins each

Participants attempted an average of 2 separate stages in the same single session

Participants claimed an above average (3/5) understanding of how the game was operating

Participants felt partly in control of the games progress (2.5/5)

Participants felt that they were not personally making the music (2/5)

Participants felt that the audio and visuals worked well together (4/5)

Participants felt engaged in the game (4.5/5)

Participants played games sometimes (2/5)

Participants were aged between 30-40

Participants chose these words to describe the visuals (in order of popularity)

rewarding>hypnotic>confusing>chaotic

Participants expressed the following sensations while playing (in order of popularity)

immersion>panic>relaxation>confusion>exhilaration>boredom

Participants explained that they stopped playing due to time pressures (other events to attend, other players waiting) , or from ‘seeing enough’ (completed the few levels they tried etc)

Participants descriptions of their experience (selected)

“Awesome, beautiful music, felt inside it.”

“At first a little confused, became more enjoyable as I understood the rules.”

“Fun. Frustrating at times, in terms of difficulty but I could get better with more time!”

“Excellent addictive game, frustrating in a good way, with great well matched soundtrack.”

Participants were asked for their critical feedback

“More of a game with a clever soundtrack than a music/art/computer piece.”

“I've ticked a couple of 'confusion' boxes, but this was only really the first time as I was too lazy to read the instructions.”

“Really good game, but I was too absorbed in the game mechanic to feel like I was involved in the audio, or to pay enough attention to the audio. Also it didn't put my name in the high score.”

Participants chose the following words to describe the visuals (in order of popularity)

rewarding>hypnotic>confusing>chaotic

Participants expressed the following sensations while playing (in order of popularity)

immersion>panic>relaxation>confusion>exhilaration>boredom

Appendix F: In Ruins Feedback

This appendix presents links to the sources of articles, YouTube videos and other informal feedback channels explored during the development and publication of *In Ruins*. This feedback provided me with initial user responses to the technical, aesthetic and philosophical elements of the project.

YouTube

Lycoplays. (2012, Aug 14). *Lycoplays Indie Games | In Ruins* [Video file]. Retrieved from https://www.youtube.com/watch?v=I4i3qRnLwQc

Totes Vidya. (2012, Aug 26). *Totes Indie - Totes playing In Ruins - Ruins Brain* [Video file]. Retrieved from https://www.youtube.com/watch?v=sA6FS84aH-0

Fingerfood55. (2012, Sept 4). *In Ruins - Review and Playthrough* [Video file]. Retrieved from https://www.youtube.com/watch?v=kTFWUNcFBso

Psx2codes1. (2012, Nov 19). *In Ruins [Download in Description]* [Video file]. Retrieved from https://www.youtube.com/watch?v=_nWe7Gt_kvg

Outflow Gaming Network. (2013, Feb 16). *Collect all the lights! - In Ruins (Free Game Friday!)* [Video file]. Retrieved from https://www.youtube.com/watch?v=3H-rJDJvrgU

Fusi0nFrags. (2013, Jan 29). *Freegames Thursday In-Ruins* [Video file]. Retrieved from https://www.youtube.com/watch?v=zb8tg3PYlNQ

Hazzabazza10078. (2013, Jan 22). *Hazza Plays: In Ruins!* [Video file]. Retrieved from

https://www.youtube.com/watch?v=WRRrAPoyTFM

Web Reviews and Articles

Porpentine. (2012, Aug 12). *Live Free, Play Hard: The Week In Free Indie Games*. Retrieved from http://www.rockpapershotgun.com/2012/08/12/live-free-play-hard-the-week-in-free-indie-games/

Matteo Bittanti. (2012, Aug 8). *Art Game: Nullpointer's "In Ruins"* (2012) . Retrieved from http://www.gamescenes.org/2012/08/art-game-nullpointers-in-ruins-2012.html

Wade. (2013, May 27). *In Ruins*. Retrieved from http://www.cheapskategamer.com/pc_adventure_games/in-ruins/

Terry (2010, Aug 7). *In Ruins (Tom Betts).* Retrieved from http://www.freeindiegam.es/2012/08/in-ruins-tom-betts/

The Innocent. (2012, Aug 8). *The Duration of Death: In Ruins.* Retrieved from http://thurot.com/2012/08/08/in-ruins/#more-1925

Aaron A. Reed. (2013, May 12). *Césure, Lumiere, and other hits of pure exploration*. Retrieved from http://lacunagame.blogspot.co.uk/2013/05/cesure-lumiere-and-other-hits-of-pure.html

Ryan. (2012, Sept 19). *State of Procedural Generation: In Ruins*. Retrieved from http://procedurallygenerated.com/?p=246

Appendix G: Permutation Racer Feedback

This appendix presents links to the sources of articles, YouTube videos and other informal feedback channels explored during the development and publication of *Permutation Racer*. This feedback provided me with initial user responses to the technical, aesthetic and philosophical elements of the project.

YouTube

RockLeeSmile. (2014, Jan 13). *Indie Impressions - Permutation Racer* by RockLeeSmile [Video file]. Retrieved from https://www.youtube.com/watch?v=65YU3WJPxCY

Gismone. (2014, Jan 9). *Permutation racer!* [Video file]. Retrieved from https://www.youtube.com/watch?v=b2CoT6dFBKM

WOWTFshow. (2014, Jan 9). *First Impressions : "Permutation Racer" Prototype Game* [Video file]. Retrieved from https://www.youtube.com/watch?v=V5cSNqM90ns

BarryDennen12. (2014, Jan 12). *LONG LIVE Permutation Racer!* [Video file]. Retrieved from https://www.youtube.com/watch?v=ncdv-RFB_5Q

n3rdabl3. (2014, Jan 14). *Permutation Racer Spotlight* [Video file]. Retrieved from https://www.youtube.com/watch?v=rAugu0zqbGE

GameMaster19967. (2014, Jan 13). *Permutation Racer Gameplay - Very Bad Driver* [Video file]. Retrieved from https://www.youtube.com/watch?v=ejq-XCGUxoc

daavpuke. (2014, Jan 11). *PERMUTATION RACER - SIr, You Are Being Gameplay'd [HD]* [Video file]. Retrieved from https://www.youtube.com/watch?v=NdXkuOzpnl4

the gUm. (2014, Jan 11). *Permutation Racer 4238* [Video file]. Retrieved from https://www.youtube.com/watch?v=23a1763Subo

Le Majestique, (2014, Aug 30). *Permutation Racer Score: 83060?(Estimate) Game Crashed* [Video file]. Retrieved from https://www.youtube.com/watch?v=T0gX4SGoHqg

Web Reviews and Articles

Julian Benson. (2013, Sep 25).*PermutationRacer has you racing to stay alive in an endlessly generated canyon*. Retrieved from http://www.pcgamesn.com/indie/permutationracer-has-you-racing-stay-alive-endlessly-generated-canyon

Phil Savage. (2014, Jan 9). *Sir, You Are Being Hunted developer releases free procedural racing game Permutation Racer.* Retrieved from http://www.pcgamer.com/sir-you-are-being-hunted-developer-releases-free-procedural-racing-game-permutation-racer/

James Knack. (2014, Jan 14). *Permutation Racer Prototype Released, Free!* Retrieved from http://www.n3rdabl3.co.uk/2014/01/permutation-racer-prototype-released-free/

Emily Gera. (2014, Jan 10). *Sir, You Are Being Hunted studio releases free procedurally generated racer.* Retrieved from http://www.polygon.com/2014/1/10/5294686/sir-you-are-being-hunted-studio-releases-free-procedurally-generated

Brandon McTaggart. (2014, Jan 13). *Permutation Racer Brings Back The Early 90s*. Retrieved from http://www.batteredjoystick.com/2014/01/13/permutation-racer-brings-back-early-90s/

Tim Stuffs. (2014, May 02). *Transitioning to Unity with Tim Stutts*, Presented at FITC Toronto 2014 on April 27-29 at the Hilton Toronto. Retrieved from http://www.slideshare.net/fitc_slideshare/transitioning-to-unity-with-tim-stutts

Appendix H: Image Portfolio

This appendix consists of a separate book of images presented as an accompaniment to the thesis text. It is divided into three sections, which illustrate the prototyping and visual design of each game. This portfolio deliberately includes a large number of images for each game to demonstrate the permutational and algorithmic quality of their content generation.

Appendix I: Digital Material on DVD

This appendix takes the form of a DVD for Windows PCs or Apple OSX machines. It contains software and other digital materials to support the thesis. This material includes cross-platform versions of the three research games, digital portfolio imagery, recordings of feedback and play-throughs from YouTube and additional survey data.