In Silico: A practice-based exploration of computer simulations in art.

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PhD

2018

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A thesis submitted in partial fulfilment of the requirements of the University of Northumbria at Newcastle for the degree of Doctor of Philosophy.

Research undertaken in the Faculty of Arts, Design & Social Sciences.

October 2018

Abstract

Key Words: Computer simulation, new media art, contemporary art, simulation theory, new materialist philosophy, media ecologies, assemblage, recalcitrant temporalities.

Computer simulations (CS) profoundly alter many aspects of our lives yet exhibit an ontological recalcitrance that impede our understanding of what they are and how they function. The dominant theoretical framework for understanding computer simulation (CS) related artworks is rooted in postmodern ideas that proliferate ‘immaterial readings, consequently hiding the making processes of the artwork, and making it difficult to discuss the material points of contact between the physical and virtual world.

There is limited literature that focuses specifically on CS-related contemporary art. This thesis draws together the most pertinent history, theory and practice for artists and curators working with CS-related artworks.

This study employs a reflective practice methodology to explore the changing modes of materiality ascribed to computer simulation-related artworks. The research consists of three phases of practice, theoretical analysis and reflection.

Five artworks were created for three exhibitions, that elucidated how space, time and behaviour are constructed within game engines, and how this can inform the understanding of existing and future CS artworks. A parametric time system was developed: a new visual scripting logic for real-time artworks that allows them to be exhibited for different durations without altering the content or recompiling code.

Characteristics of CS were established in relation to existing art practices. Postmodern and new materialist theories were analysed and discussed with a view to better understanding CS within art contexts. In relation to my own practice, assemblage theory, media ecology and media geology were found to be the most appropriate theoretical frameworks in which to understand CS artworks. The final chapter expands on these ideas in relation to the recalcitrant temporal aspects of the CS assemblage.

For artists working especially with computer simulated artworks, this thesis provides a set of practical and theoretical examples of the contexts that real-time computer simulations, specifically with ecological and environmental concerns, can be discussed within. The comparison and analysis of postmodernist and new materialist theories provides a way of considering computer simulations within a contemporary philosophical context.

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Preface

I grew up in the Derwent Valley, Gateshead during the late 1980s/1990s. My childhood was a combination of wandering through forests and playing computer games. I took my toys apart as a child, with the small screwdrivers sometimes found in Christmas crackers. This lifelong dichotomy of the real and natural, fuelled by the (sometimes destructive) urge to understand how things work, led me here.

Acknowledgements

This thesis would not be possible without the love and support of my wife Rachel, and her endless patience throughout the challenges of being married to a part time PhD candidate.

I'd like to express a profound sense of love and appreciation for my parents, who were here for the start of the PhD but not the end.

Many thanks to Steve Gibson for his expert feedback, sound advice and moral support. His supervision made the process much easier. Thanks to Dominic Smith for his enthusiasm, encouragement and inspiration. The world needs more Dominic Smiths. Thanks to Rupert Ashmore for his kind and thoughtful feedback on drafts. Thanks to Kelly Richardson for words of support and inspiration.

Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Ethics Committee on 29.4.14.

I declare that the Word Count of this Thesis is 47586 words.

Name: Paul Dolan

Signature:

Date: 6.10.2018

Chapter 1

Introduction

Winsberg calls the late twentieth century and the twenty first century “the age of computer simulation” (Winsberg, E., 2010, p.2). Computer simulations (CS) are significantly interwoven into our lives - through scientific knowledge generation, cultural image production and the quotidian behaviour of society – yet possess an ontological instability and aura of immateriality that obstruct a clear understanding of their form and function. This thesis explores how CS can be considered in material terms, through an ecologically-driven art practice.

The trajectory of this research begins in postmodern concepts of simulation, in which pervasive historical ideas of simulations and simulacra are tested through practice. The research then utilises theory in a more formative manner to explore the possibilities of new materialist philosophies in relation to CS. Figure 1 shows the overlap between the use of formative and summative theory. The ecological focus of the practice dictated a shift away from corporeality, immersion and embodiment, although notions of a situated, embodied practice are introduced in the final chapter as a way of resolving the temporal behaviours of the CS.

The research questions are rooted in the concerns of my art practice, which involves the use of 3D animation and game engine software to create virtual landscapes. It seeks to resolve the gap between the rural green spaces of my homeplace and the videogame environments of my childhood in the 1980s and 1990s, the combination of which created a lifelong dichotomy between the real and virtual in my way of thinking about the world.

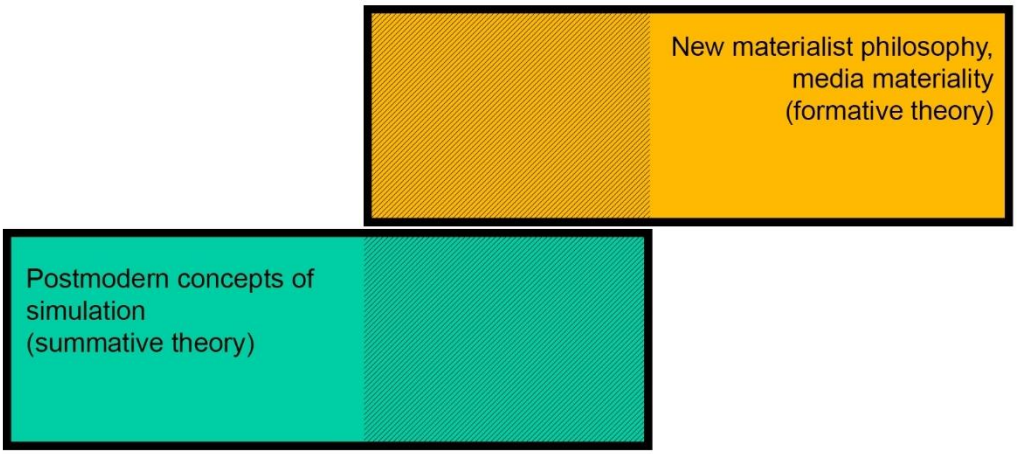


Figure 1. Diagram showing the overlap in uses of summative and formative theory throughout the course of the thesis.

The research aims to establish computer simulations as material entities in order to effect positive ecological change through a research informed art practice. Points of contact between theory, art history and the process of making and exhibiting art with computer simulation tools are explored, in addition to the creation of frameworks for understanding CS characteristics and temporalities. Recurring themes are time, space, algorithms, materiality, modelling and authorship. CS temporality emerges as the most prominent and captivating aspect of the research and is explored in greater depth in the final synthesis chapter.

The research questions were updated after each phase of the research as a result of the iterative methodology. Although the research questions may seem excessive in number, they are all geared towards exploring the characteristics of computer simulated artworks, and were necessary to systematically work through the variety of actors entangled in the CS assemblage. This section documents the research questions for each stage of the process.

Phase One Research Questions

The following questions framed the research during Phase One, which culminated in the exhibition of *Wireframe Valley* (2015):

- What characteristics do computer simulated artworks have?
- What theoretical frameworks are most suitable for making sense of these practices?

Phase Two Research Questions

The following questions framed the research during Phase Two, which culminated in the exhibition of *Floating Point* (2016), *Wood for the Trees* (2016) and *Cohort* (2016):

- What characteristics do computer simulations have?
- How do algorithms function within computer simulated artworks?
- What impact do computer simulation practices have on our understanding of authorship and representation?
- How can the ecological aspect of the work be discussed?
- How do computer simulations function as contemporary art practice?
- What theoretical frameworks are most suitable for making sense of computer simulated artworks?

Phase Three Research Questions

The following questions framed the research during Phase Three, which culminated in the exhibition of Wireframe Valley (remade, 2017):

- What are computer simulations in new materialist terms?
- How can these ideas be explored through practice?

Research Narrative and Contribution to Knowledge

Phase One of the research culminated with a better understanding of the characteristics of computer simulations from a software studies perspective and a better understanding of how using such tools lead to a complex remediation of, and bifurcation from other art practices, due to the complexity and simultaneity of media processes in action. This laid the foundation for conceiving of computer simulations as *assemblages*.

Phase One outcomes also suggest that CS temporalities exist in excess of the commonly used and overly unified term 'real-time' or the broader, overreaching singular concepts of time in Baudrillard and Virilio. The behaviours of CS artworks incorporate a multitude of different time logics interacting with each other in a complex system. Time is found to be manifest as distributed temporalities within a complex adaptive system.

Phase 2 outcomes explored the difficulties caused by finding the human and non-human points of contact within the CS assemblage, which are both in a process of constant change. This sense of flux and variable determinacy is in keeping with new materialist concepts of vitalism and agency as human/non-human and multi-directional. This is explored through the comparison of three artworks that use different temporal logics, durations and algorithmic behaviours. This phase demonstrates the constant reconfiguration of temporal actors distributed across human and non-human actors at work in the CS.

Phase 3 broadened the temporal context of CS beyond software to the material and geologic, in order explore the significance of how CS materials relate to the larger world of differential temporal experience. A parametric time logic was developed that allowed the artwork to be scaled to any exhibition duration whilst retaining a relative speed of movement. This phase developed the political, social and ethical contexts of CS and CS temporalities.

Finally, the findings are synthesised into an ontological framework that focuses on time, and the recalcitrant behaviours enacted by it within simulated artworks.

Although working with summative theory in the first half of the thesis, the application and critique of postmodern ideas to the practice of making computer simulations forms a contribution to knowledge. This is specifically demonstrated in the development of the Characteristics of Computer Simulated art diagram (Figure 52) and the exhibition and documentation of the

artworks themselves. The iterative development of a time logics for use in the creation and exhibition of extended duration artworks also forms part of the contribution to knowledge. The synthesis chapter builds upon new materialist philosophy and the philosophy of time to articulate how assemblage theory can be used to understand the shifting, intractable nature of time in the CS, and the problems and opportunities this poses for future research and art practice.

Chapter 2

Contextual Review: Computer Simulations and Art

As tools for creating computer simulations (CS) become more technically advanced and increasingly available to artists, their potential uses are unfolding within a range of current artistic practices. What themes, behaviours and processes connect them? Is existing theory enough to make sense of them? Key behaviours and themes will be discussed in relation to artist's work, which will be mapped at the end of the chapter for the sake of clarity.

For reasons of clarity and simplicity, the contextual review is roughly chronological (aside from inevitable overlaps), which provides a context and examples of artists work in each area of relevance.

What are the aims of the contextual review?

- To compare the most useful aspects of computer simulation theory from a range of discourses.
- To understand how CS can be considered in material terms.
- To establish the role technological contexts such as military and entertainment have played in the development of CS;
- To draw themes and connections between the behaviours and meanings of the artworks;
- To provide a context for the remainder of this thesis.

Limitations - What is included and what is not?

Computer simulation is used within a variety of contexts with different meanings across the sciences and arts. Simulation has close relationships with 'virtual' and is often used interchangeably with 'imitation' or 'representation' in art contexts (Lister, 2008, p.29). This contextual review will focus on artworks that incorporate CS as part of their production. Due to the interdisciplinary history of simulation, and the variety of liminal modes in which artworks have been produced, the review may seem too broad in its scope. This is an unavoidable consequence of studying CS.

The temporal context of CS is equally expansive. The history of virtual artworks has been traced to wall paintings in Ancient Greece on the basis that they manifest artistic attempts at illusion and immersion (Grau, 2003). This literature review draws upon computer art developments from the 1950s onwards, with an emphasis on contemporary art practice, especially from 2010 onwards when CS technologies such as game engines

became widely available to artists. Although the history of virtual reality is discussed on pages 21- 25, VR does not constitute a genuine part of my artistic practice and as such does not feature heavily within this thesis.

What does this offer that other literature does not?

Notions of simulation in mainstream art discourse have tended to relate to debates about authorship and originality, as characterised by artists like Sherrie Levine and Richard Prince in the 1980s and 1990s. Ideas from this time, collectively termed as postmodernism and Simulation Theory (Cubitt, 2001) provide much of the target of criticism in this literature review. *Computer* simulation is well documented within videogame literature, although not in relation to art practice. Media theory offers an important part of the puzzle by tracking the impact of digital processes on our understanding of screen-based culture, although rarely with reference to artists. New Media Art literature provides a more sympathetic insight into simulations, although this is often fragmented and does not provide extended analysis specific to the role of simulation. The value of this review lies in the connections made between these different contexts and disciplines, to provide a more coherent basis for discussing simulation-related contemporary art in material terms.

Postmodernist Simulation Theory

Simulation Theory is rooted in postmodern theories of reality. Due to the dominance of this rhetoric within art discourse it is necessary to provide a review of the key thinkers and their ideas within the field.

Simulation theory concerns itself with our changing perception of reality in the wake of technological, economic and cultural change. The ideas of Guy Debord, Paul Virilio, Jean Baudrillard and Umberto Eco are key to understanding the currency carried by simulation within the arts. Theories of simulation are complex, interact with several philosophical disciplines, and have often changed as society and the author's thinking has developed over time. Simulation theory is not a unified theory, although the ideas of key thinkers in the field share common concerns.

The fundamental claim of simulation theorists is that reality as we know it has been displaced, distanced or destroyed by the proliferation and distribution of imagery in society. The obfuscation or destruction of reality by the technological production of images is simultaneously connected to modes of politics and economy.

Debord believed "The dominance of a consumer capitalism governed by the circulation of images is now the unifying characteristic of all contemporary societies, East and West, North and South" (Cubitt, 2001, p.33). He called the obfuscation of reality 'the

spectacle', which exists in two forms: a replacement of reality by images of it, and as a dominant system of social regulation (Debord, 1984, p.2). Similarly, Baudrillard believed that reality had been displaced by *hyperreality*, an approximation of reality inhabited solely with *simulacra,* devoid of any reference to the real or original (Baudrillard, 1994, p.6). Eco also adopted the term *hyperreality* to describe the reconfiguration of reality via mass produced imagery, with specific reference to the hyper capitalism of 1970s America.

For Virilio, reality has been displaced by military technology and its gradual encroachment into everyday life via media forms (Cubitt, 2001, p.55), a process he calls "endo-colonisation", with reference to the internal state of a social system. The acceleration and miniaturisation of communication by military technology, via media forms, shifts reality beyond human perception and into *picnoleptic moments*, the moments between human attention. As a result, we are removed from reality in the sense that reality is now happening within a perceptual dimension we cannot access.

The origins of Virilio's ideas are particularly grounded in military architecture and the experience of living through wartime. Virilio claims the verticality of castles and turrets allowed soldiers to artificially expand their natural field of vision, profoundly altering human's 'natural' spatiotemporal perception. For Virilio, the way in which militarised media forms augment natural human perception creates a rift between the humans and the world as we know it (Virilio, 2006). Digital technologies further compound this problem by translating communication to data, the scale and speed of which lies outside of human comprehension. In this sense, freedom becomes inversely proportionate to the speed of technology.

For Debord, Baudrillard and Eco, the subsidence of reality is more a result of mass communication technologies, and the capitalist or communist social structures they inhabit. Baudrillard, (1983, p.27), (1994, p.33) for example, cites "The Wall St. Crash of 1929 and its political and economic aftermath" as a crucial time in the formation of his theory. Eco's ideas are strongly influenced by his first-hand experience of hyper-capitalism in 1970s America, in which he unpicks the façade of happiness constructed by capitalist modes of overconsumption.

Debord's ideas arose from a critique of the Marxist commodity form, also in the post-war era, as he observed the development of mass communications and consumer society.

> "Debord wanted to demonstrate that the sham (of reality) derived from the commodity form at the heart of capitalism, and to show how dangerous and destructive it had become… he wants to show the way in which the spectacle has invaded everyday daily life to such an extent that the very possibility of 'authenticity', of a real experience of reality, has been stolen away… reality itself has been turned into an imitation of itself" (Cubitt, 2001, p.37).

Simulation theories are also firmly grounded in the development of theories of language, especially Sassure's theory of semiotics. Sassure's critique of representation suggested that signs and their meanings are separate, polysemous, arbitrary and socially constructed. This disconnect between sign and signified had a profound effect on simulation theorists' understanding of reality and subjectivity (Cubitt, 2001, p.27). If there is no fixed connection between objects and language, then how can we understand, analyse and assess objects? Sassure suggested that representation was no longer possible. In the act of signification, images and objects were subsumed into a closed circuit of floating signifiers: a state Baudrillard and Eco would refer to as *hyperreality*.

The deep level of mediation in everyday mass communication, especially television, seemed especially characteristic of hyperreality, and suggested it was now impossible to reconnect with reality as it once was. Daniel Boorstin's (1997) notion of the *pseudo-event*, an occurrence that exists for the sole purposes of media publicity, described the way in which reality was generated rather than documented for audience consumption.

Sassure claimed that knowledge is produced only through comparison and difference. For Baudrillard, however, neither are possible. No distinctions can be made between different objects because objects no longer have a connection to their real self, they are merely ultra-relative signifiers, floating within a sea of equivalence. This also makes representation impossible, in the sense that there is no world beyond itself to reference.

Postmodernist simulation theories, generally speaking, are focussed on the immaterial, which provides a clear obstacle to researching the materiality of computer simulations. Simulations break the previous subject-object dichotomy of language and replace it with relationships that reference only the sign's own reproduction. For Baudrillard, they are no less *real* than reality as it used to be, only the "…materialism of simulated reality is rooted in a play of signs and codes - of simulacra - rather than the material realities of labour" (Wright, K., in Bishop, 2009, p.122). Virilio, takes a less language-focused approach to immateriality, instead blaming the miniaturisation and immateriality of contemporary physics, alongside endo-colonisation, as factors that perpetuate immaterial views of reality. Contemporary media theorists such as Lister (2008, p.38), disagree that CS are immaterial, on the basis that not all simulations are imitations, and therefore cannot be entirely relegated to representation or simulation in the Baudrillardian sense. The acknowledgement of simulations as material entities is explored in relation to the artworks produced as part of this study.

The extent of audiences' agency is disputed amongst simulation theorists, which makes it problematic for discussing art. In relation to post-structuralism and reader/audience agency within the semiotic system of interactive media, Baudrillard

acknowledges the process, but describes it (referring in this instance to videogames) as a "…somnambular re-creation of real interactivity, ludic only in the sense that they are governed by rules which demand compulsory involvement which, however, is not genuine communication between people but merely a response to stimuli, a feedback loop through which the code checks out that it is still functioning and we are still connected to it" (Cubitt, 2001, p.50). Eco, however, suggests that some level of audience agency exists, but argues that the communities of agreement within which language are constructed are based upon simulated assumptions.

In addition to the technological and language-based aspects of simulation theory, a recurring theme is that simulated reality possesses an ontological 'liveliness', capable of self-perpetuating itself. Debord's version of this idea, the *spectacle*, exists to encourage consumption, to perpetuate capitalist society. The generative properties of the spectacle have created a dead, empty time at the end of history, filled with smaller cycles of time like fashion seasons and television schedules. Eco and Baudrillard agree that hyperreality is self-perpetuating, and that culture reinforces itself in an autopoietic process. Baudrillard refers to this system of autonomous signification as 'the code', generates increasing numbers of signifiers without real life equivalents, and commodities driven by desire rather than need. The ultimate aim of the code is to "oppose change and eventually divorce itself and everyone caught up in it from history" (Cubitt, 2001, p.44).

How do postmodern theories of simulation relate to art created with computer simulations? It is reasonable to claim several areas of overlap, especially in relation to artists that challenge how reality is mediated. Baudrillard's third era of simulacra has a direct connection to Ian Cheng's work (Figure 1), which is discussed in relation to concerns that "…activities performed in simulated spaces are increasingly shaping our reality. The ubiquity of modelling, algorithms and automated prediction continues to displace the boundary between simulation and the real" (Cheng, 2015, p.9).

CS can facilitate complex adaptive systems from which new behaviours can emerge, which corresponds to Baudrillard's definition of a simulation as an operational, self-perpetuating entity. The capacity for emergence can also be considered through the lens of vitalist philosophies, as discussed in the section on new materialist philosophies. Virilio's ideas about the impact of military technology on human vision and perception are also relevant to the military history and continuing optical development of CS technologies such as videogames and virtual reality.

Figure 2. Three stills from Cheng, Ian *Emissary Forks at Perfection* (2015-6), live simulation.

Despite the areas of overlap, there are several issues with simulation theory that make it a limited framework for understanding CS based artworks. Firstly, the apocalyptic theories of Baudrillard, Virilio, Eco and Debord provide a totalising theory of culture, which overlooks specifics in terms of hegemony. The appeal of a totalising and universally applicable cultural theory is seductive, as it seems to possess all the answers, even if they are answers we would prefer not to hear. Totalising theories miss the quotidian experience of how computer simulations impact life, and the ways in which artists can explore this. The failure of simulation theory is then, perhaps, one of nuance - a refusal to acknowledge the liminal states of being we inhabit in our everyday use of technology: “In networked, technologically intensive societies we increasingly pass between actual and virtual realities; in such societies we deal seamlessly with these differing modes of reality” (Lister, 2008, p.37).

The world has changed since the peak of postmodern simulation theory in the 1990s. Computer simulations are now much more widely embedded in everyday life, providing a more complex technosocial reality than the apocalyptic end point predicted by simulation theorists. Although current social existence may be considered circular or dead time to the postmodernists, and indeed, their end point may still be feasible, it is reasonable to suggest that simulation theory has overreached in its absolutism.

The internet has transformed contemporary life, and although it retains characteristics of hyperreality, cannot be understood entirely in such immaterial terms. Media immateriality is perpetuated in part by marketing techniques that use language such as ‘cloud based’ to conceal and naturalise the extent of manufacturing processes. This relate to the popularity of the Internet of Things, and the appeal of shifting media functionality from physical objects to invisible networks.

The immaterial implications of simulacra also render inert large systems of human and non-human actors within media and social networks. Contemporary media society is presented as profoundly autonomous, whereas software and hardware architecture are at least partially constructed, monitored and developed by humans.

The lack of focus on the material aspects of simulations leads to an over simplification of the technological basis of the theories. Understanding how CS are created, to a degree, can help progress from all-encompassing and apocalyptic relativism. Lister et al (2008, p.38) argue that although simulations are artificial and constructed, they are still real objects, with a physical software and hardware presence: “…a simulation is real before it imitates or represents anything.” Game studies provide a similar techno-empathetic approach, as does the combination of technology and critical theory in Software Studies. Friedrich Kittler, for example, has long espoused the material properties of digital media in his research. The lack of technological insight provided by simulation theorists creates a need for the kind of research undertaken in this study.

Postmodern simulation theory profoundly negates the agency of the artist. Baudrillard believed that reality has been so thoroughly altered by the process of simulation that there is no longer a space outside the simulation with which to compare it. Debord believed that nothing new can be created, only détourned or destroyed. To escape from the tyranny of the spectacle, society must use art as a strategy for making visible the immaterial shackles of oppression.

This relates to how postmodern simulation theory has become synonymous with artists like Sherrie Levine and Richard Prince who used appropriation to challenge notions of originality. The conceptual range of simulation-related artworks has extended beyond the parameters of postmodern simulation theory and appropriation. Notions of ‘simulation’ in the 1980s art world were underpinned by a postmodern and post-structuralist ethos, seeking to examine the veracity and originality of mass-produced images.

Contemporary simulation artworks by John Gerrard and Ian Cheng are no longer responding to the same world and offer new modes of thinking about how computer simulations function within culture and society. CS are “… not a dissembling, illusory distraction from the real world (like Eco’s Disneyland) but rather a model of the world (or some aspect of it).” Computer simulations can model “…complex and dynamic systems

over time in ways impossible in other media" (Lister, 2008, p.41). If we consider simulations as real things, then we can understand them as models in time, with algorithms applied to create states and interactions that may or may not incur emergence and may or may not be immersive.

Specific aspects of postmodern theories do not hold up in relation to art made with CS. For example, Baudrillard's concept of 'the total screen', the point at which the borders of the screen are no longer visible and the difference between real and simulated reality can no longer be discerned is of limited use in art contexts. Wright explores this in a literal sense, suggesting that the materiality of the TV screen or computer monitor is in fact a reminder of reality: "the screen is never total in the way Baudrillard describes it because the interface never disappears completely" (Wright, K., in Bishop, 2009, p.126), although this is argued in relation to the specifics of how interfaces function in the videogame *Deadspace* (2008). In art gallery contexts, projected images and screens are generally exhibited in a way that maximises the contrast between the work and surrounding gallery space, emphasising their separation from the environment as objects to be looked at. For example, overhead lighting is lowered or switched off, projectors with high lumens and brightness are used, and the surfaces on to which art is projected are commonly masked with black or mid grey paint to create contrast with the edge of the projected image.

Finally, the way in which Baudrillard, Debord and Virillio regard technology as a destructive and deterministic force can be criticised as a form of *technological determinism.* This mode of thought suggests that technology is a self-generating force separate from society, but still capable of altering it (Giddings & Lister, 2011, p.95). Technologically deterministic beliefs are particularly unpopular in contemporary art discourse where process and behaviours are prioritised over object and mechanics.

New Materialist Philosophies

Since the apex of postmodernism in critical theory in the 1990s, a variety of 'New Materialist' critiques have emerged, challenging the limitations of immaterial approaches to studying objects, including media and technology. Some are posited at a general philosophical level (Jane Bennett, Graham Harman) and require a degree of ground work to make connections with art practice, and more specifically, computer simulations. Other theories are written with media in mind (Matthew Fuller, Jussi Parikka), and illuminate ways of thinking about the physical properties of media artworks. This section asks -what are those theories and what do they mean for our understanding of computer simulations?

New materialist philosophies are represented by diverse and non-unified perspectives, although they share several characteristics. The first is a shared lack of distinction between human and non-humans, sometimes referred to as a 'flat ontology' (Harman, 2016). This forms the basis for a critique of excessively anthropomorphic

modern philosophies, which have failed to sufficiently explain the role of non-human actors within social, economic and political systems (Coole & Frost, 2010, p.3).

Flat ontology is often cited in relation to Bruno Latour's Actor Network Theory (ANT). Latour posits that philosophy falsely separates nature and society, which leads to a proliferation of hybrid actors that cannot be understood through delineated areas of knowledge. As such, fields of science and enquiry 'purify' hybrids by understanding them in their own terms. Hybrids are ontological combinations of material, social, economic, political, natural things that are irreducible to any particular and isolated line of enquiry. Hybrids can incorporate semiotics, albeit "in a new form, that has a simultaneous impact on the nature of things and on the social context, while it is not reducible to one or the other." (Latour, 1993, p.5). Latour's concept of hybrids lays the foundation for later discussions of CS as assemblages.

A second shared characteristic is a critique of language being over emphasised at the cost of nature and society. Latour argues that it is overly reductive to think of objects purely as something that thoughts are projected on to. "When we are dealing with science and technology it is hard to imagine for long that we are a text that is writing itself, a discourse that is speaking all by itself, a play of signifiers without signifieds. It is hard to reduce the entire cosmos to a grand narrative, the physics of subatomic particles to a text, subway systems to rhetorical devices, all social structures to discourse." (Latour, 1993, p.64).

A third shared characteristic is a radical re-evaluation of the agency of objects. In postmodernism, objects tend to be static until called upon by a human. For Jane Bennet, author of *Vibrant Matter* (2010), objects are deemed to possess a force beyond the physical reality of an object, a phenomenon she calls "thing power". This term roughly maps onto: Casemajor's "a phenomenological capacity of things" (Casemajor, N., 2015, p.11), Latour's *actants* and Manuel DeLanda's *self-organisation* and *emergent assemblages*.

Agency does not work in isolation, although is constituted in assemblages (using Guattari's term), meaning 'networks of human and non-human actors'. Not only does matter exhibit agency, but it is involved in a continual open, emergent complex system of materialization. This brings about a research focus on everyday life, quotidian existence, and the awareness of objects within micro and macro networks. "…all things in the world, including things of the mind and digital stuff, are tied to (and in some cases, determined by) physical processes and matter" (Casemajor, N., 2015, p.5).

The attribution of agency to non-human objects opens up space within new materialist philosophies for discussion of emergence as a material as well as social logic. The emergent potential of CS makes them a suitable environment to explore the onward process of life through indeterminate and complex interrelating networks of matter and

process. Artists' notions of indeterminacy have become increasingly interesting as natural sciences and materialist philosophies envisage a more "…complex choreography of matter than early modern technology and practice allowed…" (Coole & Frost, 2010, p.9).

Table 1 shows a comparison of postmodern and new materialist conceptions of reality, society and politics, which form a useful basis for later discussions. The question of which approach provides a better context for understanding computer simulations as contemporary art continues throughout the thesis.

Table 1. A comparison of postmodern and new materialist conceptions of reality, society and politics.

	Postmodern	New materialist
Nature of reality	Reality is masked by a procession of simulacra, signs are detached from their signifiers.	Reality is socially constructed *and* materially real.
What the theory acts upon	Society and language, signs and texts.	Human and non-human actors.
How the theory functions as a process	Simulation is an ongoing process with a definite apocalyptic end.	Materialization is an ongoing, contingent, complex, open and uneven process.
Relationship to politics	Arguably biased towards western politics (especially Umberto Eco) with a lack of consideration for geo or local politics.	Geopolitics and an awareness of local culture is critical to make sense of unevenness between different populations within emergent capitalist and materialist structures and environments.
How the theory relates to capitalism.	Capitalism is the catalyst for simulation and the receding of reality. It is self-generating and unstoppable.	Capitalism is governed by complex processes and interesting phenomena. It is relational and emergent.
How humans function within the theory	Humans are consumed by capitalism and there is no awareness of bio-politics or agency.	Human bodies are deterministic and the cells, water, and organs within them all play a part in how lives are lived.

Media Materiality

Debates around media materiality help connect the abstract philosophical concepts of new materiality to art practices. There are several schools of thought, which Casemajor separates into: “The Berlin School of media, the field of software studies, the literary critique of electronic texts, the forensic approach, the ‘new materialist’ media ecology, and the field of Marxian critical studies” (2015, p.5).

The Berlin School was formed at the end of the 1980s around Friedrich Kittler’s research and development of computer hardware. Kittler’s approach to materialism, or *informational materialism*, gives priority to the physical substrate and structures of technology, and how data is stored. Kittler is towards the technologically deterministic end of the spectrum and deprioritises the role humans play in technology, although the extent to which has been debated (Winthrop-Young, 2010).

The MIT Software Studies group adopts a similar materially focused research position, but in relation to contemporary digital media. Manovich, for example uses the term *digital materialism* to describe the analysis of “hardware and software and operations involved in creating cultural objects on a computer to uncover a new cultural logic at work” (Manovich, 2002, p.10). This approach is employed particularly in the first phase of research to study the software processes involved in the construction of CS.

Using a ‘forensic methodology’, Matt Kirschenbaum’s research focuses on “the storage and inscription of digital information on hard drives” (Casemajor, 2015, p.9). His model distinguishes between two forms of materiality: forensic and formal. *Forensic materiality* critiques the immaterial basis of digital information as abstract bits, instead claiming that when each bit is inscribed to a hard drive, it has a unique trace. Formal materiality refers to state of the bit - whether it is a 1 or 0. One issue with approaches that look so closely at the material of media is that they often inadequately acknowledge social factors. “What was often left out of such techno-materialist methodologies was the more political side of thinking through these new materialities” (Parikka, 2012, p.96).

Hardt and Negri adopt a neo-Marxist approach that seeks to explore the role of digital media in the context of capitalism. Casemajor critiques their use of the term ‘immaterial labour’, which is taken to refer to knowledge, information and communication industries, but instead “…reproduces the trope of digital immateriality and extends it to the realm of labour…The myth of a ‘dematerialised’ and ‘weightless’ knowledge economy tends to obscure the fact that computers are consuming vast amounts of energy and that many physical commodities need to be transported and sold for this economy to function.” (Casemajor, 2015, p.11).

Such approaches to media materiality prompt discussion around the political economy of digital media and how it is connected to the degradation of the natural

environment. Casemajor (2015) divides these responses into two areas: vibrant matter in media ecologies and neo-Marxism. The term *ecology* in this sense refers to McLuhan's idea of media as embedded within complex systems of interrelation with humans. Media ecology as a term has been adopted by Fuller (2005), Cubitt (2005), Godard and Parikka, (2011) and Parikka (2012) in order to examine the "aesthetic and political dimensions of media" by proposing "to look at media ecologies in terms of 'materialist energies in art and technoculture' (Fuller) 'ecomedia' (Cubitt) and 'media archaeology' (Parikka)" (Casemajor, N., 2015, 11). "Reframed to address the entanglement between humans and non-humans, media ecology has become a site to investigate the links between nature and technologies, questioning the role of digital media in natural environments degradation." (Casemajor, N., 2015, 11).

An important characteristic of these approaches is the articulation of digital media not as pure, immaterial data, but as inscriptions on hard drives visualised by computers produced from a limited amount of raw materials and minerals (Casemajor, N., 2009, 6). Media materiality, especially in relation to the environment and ecology provide a fertile ground on which to base this research. They provide the language and frameworks for thinking about computer simulations as real things.

Technological and military origins of computer simulations

To build a more accurate sense of the CS as a material entity, it is necessary to consider the impact of technology and social political contexts. The history of the CS incorporates a range of parallel and overlapping narratives. This section will adopt a roughly chronological structure for the sake of clarity.

In the 1950s, CS were "severely constrained by prohibitive hardware costs, the general scarcity of computers, and the lack of software tools" (McHaney, 1991). Hardware and simulation-specific programming languages started to appear in the early 1960s as usage became more widespread. At this time, CS were developed in military, industry and academic laboratories, the only places with access to the required level of funding, technology and expertise (Taylor, 2014), (Woolley, 1993). In 1963, *Bell Labs* researcher Edward Zajac made *A Two-Gyro Gravity-Gradient Altitude Control System*, "…the first computer-generated film simulating a satellite orbiting the earth" (Reas & McWilliams, 2010, p.151). In 1972, Dennis Ritchie developed the C programming language, which sped up the process of writing software. Loren Carpenter, a researcher at Boeing, created the first artificial landscapes in 1978 by applying fractal noise patterns to a 3d mesh (Reas & McWilliams, 2010, p.153). Military technology continues to play a significant role in the development of CS. In the 1960s, the US military hired videogame developers and academics to help create computerised war simulations (Mead, 2013, p.12–33).

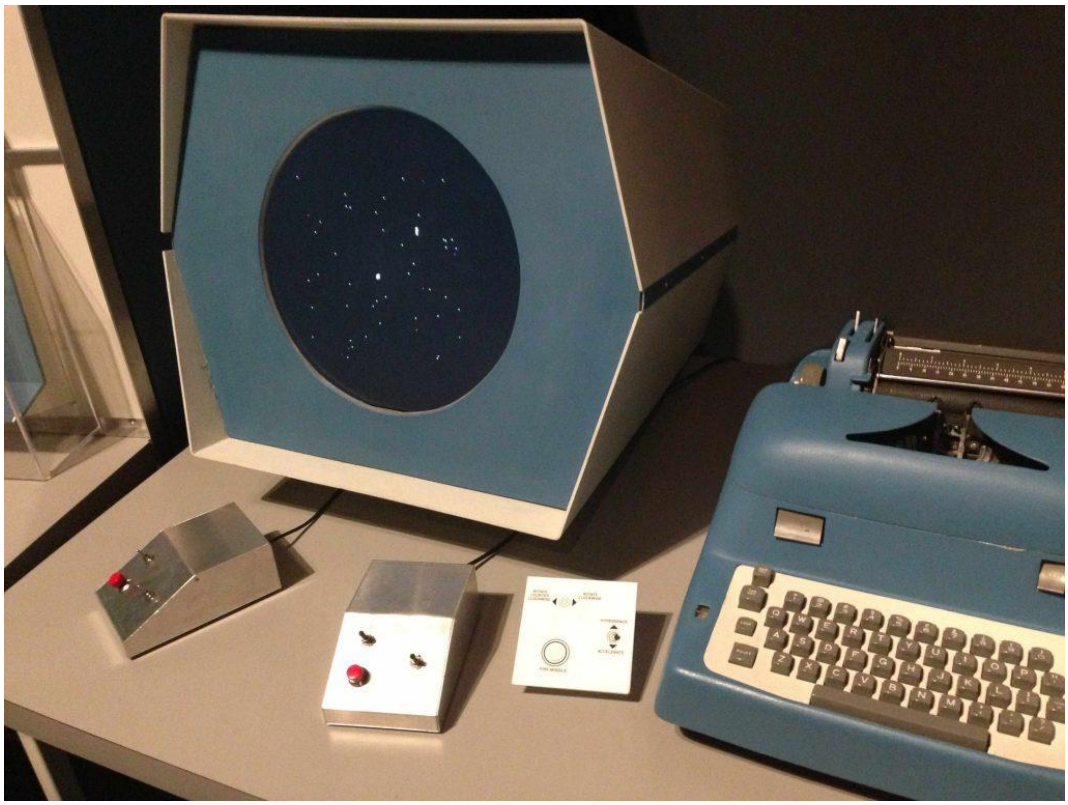


Figure 3. Russel, Steve, *Spacewar* (1962)

The first videogame, *Spacewar!* (Russel, 1962) (Figure 3), was created by Pentagon-funded engineers at MIT. Although the visuals consisted of basic wire-frame models in black space, the military were interested in how it could be used to train soldiers and test possible strategy outcomes. During the tense and suspicious era of the cold war, the ability to minimise risk and enhance the training of soldiers was a driving force behind developing CS technology.

During this period, interdisciplinary research emerged from engineers and artists. Bell labs became a pioneering example of how early computer technologies could be applied to art, with Billy Kluver and Fred Waldhauer forming the Experiments in Art and Technology (EAT) group with John Cage and Robert Rauschenberg in 1967. Michael Noll programmed a Bell Labs computer to 'simulate' paintings by Piet Mondrian and Bridget Riley, in addition to creating a series of computer-generated drawings such as *Gaussian-Quadratic* (1963), which, significantly, he exhibited as art and not as a showcase of technological functionality. Early adopters of computer art such as Manfred Mohr and Vera Molnar relate strongly to the algorithmic characteristics of CS. Mohr created images from algorithmic processes before using a mechanical plotter and other processes to print them to paper, in a simulation of the drawing process.

Cinema technologies also contributed to the development of the CS. Grau (2003) traces the immersive experiences of cinema and virtual reality back to the wall paintings of

Ancient Greece, and more recently via 3D cinema (*Teleview*, 1921, *Ramufilm*, 1930s), tactile effects such as seats shaking (*Earthquake*, 1974, *The Tingler*, 1959), 'scratch and sniff' cards distributed to audience members (*Polyester*, 1981) and extended screens and auditoriums (*Cinerama* 1952, *Sensorama* 1962, *Omnimax*, 1984, *IMAX*, 1990s). Morton Heilig's innovations in multi-sensory theatre in 1955 - and subsequent *Sensorama* machine are especially indicative of pre-modern virtual reality experiences. Heilig's design represented a detour from social to individual immersion: the *Sensorama* was akin to a photo booth, in which one sat alone.

Heilig's designs for a stereoscopic headset were similar to those being developed by Ivan Sutherland for military usage in the Bell Helicopter labs in 1966. Sutherland's (1968) paper and design for 'A head-mounted three-dimensional display' is commonly cited as the first functional VR technology. Sutherland's research was influential in the early days of CS and virtual reality, popularising the definition of 'simulation' to mean a computer-generated reality experienced via technologically-enhanced vision (Woolley, 1993, p.53). Sutherland's concept of the "ultimate computer display" revolutionised the development of computer displays and interaction, but had its sights set further, on the realisation of absolute CS. "In such an image space communicated directly to the senses, handcuffs can restrain and a shot can kill" (Sutherland, 1965, p.506–508).

Quaranta (2013, p.55–56) cites the emergence of an "anti-computer sentiment" in the late 1960s, in which the cold, dispassionate perception of the computer threatened the enduring romantic vision of the artist. The philosophical joining of art and technology faced ideological opposition in the 1970s. Technology was primarily associated with military capabilities and stood in opposition to prevailing romanticist notions of creativity. Postmodernist simulation theory continued this critique of the computer as a perpetrator of the inhuman and immaterial. There are clear connections between Sutherland's military metaphors, Virilio's concept of endo-colonisation, and Baudrillard's concept of the total screen, in which the removal of the frame leads to an irreversible, fascist era of equivalence and loss of the real.

Cinematic Simulations: The merging of computers and cinema

Like the artists and filmmakers before them, intent on bringing the audience *into* the image, computer scientists and engineers like Nobert Wiener and Alan Turing were aiming to recreate the same experience with computer technologies. Nicholas Negroponte intended to combine the visual capabilities of film with computer processing (Grau, 2003, p.165). By the late 1970s computers were used more frequently in cinema production processes. Computer graphics, although incredibly expensive to produce, were capable of simulating environments, visual effects, and eventually, characters.

The merging of computer imagery and cinema also forms the basis of Gene Youngblood's *Expanded Cinema* (1970) in which he demonstrated how film and video practices had moved beyond the two dimensions of the screen and into a new stage of hybrid practice. Dick Higgin's concept of *intermedia* is used to describe the interdisciplinary and liminal work of artists such as Jonas Mekas who systematically explored the materiality of the moving image.

Contemporary CS retain a large degree of visual characteristics and processes from the digitisation of cinema and animation. The creation of virtual environments can be considered an extension of theatrical and cinematic set building, and is a ubiquitous feature of cinematic visual effects, in which three dimensional models are composited with live action footage. Virtual cameras directly inhabit their cinematic forbearers, with most software containing skeuomorphic interfaces for modifying aperture, depth of field, shutter speed, etc.

In the 1980s, cinematic production processes continued to evolve, merging photographic and computer-generated imagery: "…CGI is to all intents and purposes *animation,* cinematic images manipulated at the level of the frame, and as such it results in a fusion of photographed and animated sequences quite different in scale and intent from earlier modes of special effects" (Giddings & Lister, 2011, p.304). The hybrid modes of moving image production are now standard in the cinema industry, with many contemporary software tools providing functionality for the creation of multiple output formats: cinema, videogames, animation.

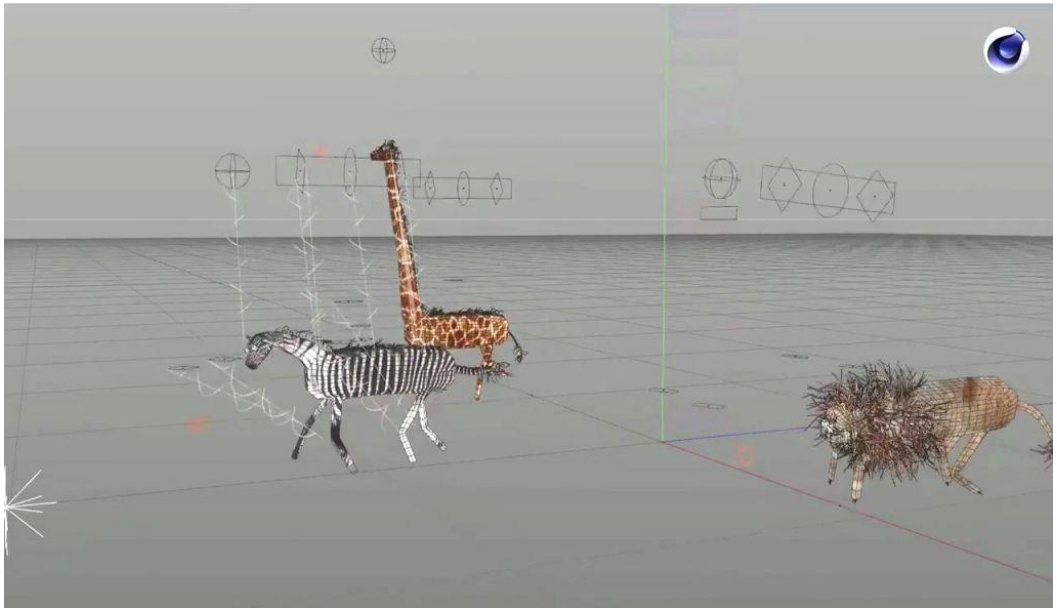


Figure 4. Diakur, Nikita, *Ugly Dynamics* (2016)

Simulation tools incorporate elements of each of these areas: Unreal Engine's cinematic editing system *Sequencer*, the real-time rendering of videogames and several characteristics from animation, such as three-dimensional modelling, texturing and

lighting. In this sense it is difficult to pin down artists working with such software to any specific area. In visual effects terminology, *simulation* or *dynamics* often refer to visual effects that would be too difficult to animate using manual key frame processes such as fire, smoke, clouds, water, atmospheric effects and the animation of large sets of particles acting under physical forces. Alan Warburton explores this aspect of computer simulation in *Cartoon Physics* (2016), in which three dimensional models of coins and dollar bills are moved by software physics simulations. A similar tactic is employed by Nikita Diakur in *Ugly Dynamics* (2016) (Figure 4), in which character animation is driven by CS physics forces, creating unusual and glitchy movement. Such examples tend to demonstrate a breakdown in the simulation, in which the mechanics of the effect, usually too perfectly executed for an audience to observe, become visible.

For other artists, special effects software has become a normative part of the video art toolkit, reacting against the standard mode of hybrid image production in contemporary culture. Kelly Richardson uses special effects software to create environmentally provocational virtual landscapes. In *Marina 9* (2012), a three-channel video installation with sound, a Martian landscape is littered with barely functioning satellites and shuttles, hinting at a time after humans have failed to colonise the planet. The complex software processes involved in the production of Richardson's work are often downplayed in relation to the ecological and *apocalyptic sublime* readings of her work.

Videogames

Videogames are the closest kin to computer simulations due to their real-time and interactive properties. Salen and Zimmerman (2010, p.423) define videogames as "a procedural representation of aspects of "Reality", and Gregory (Gregory, 2014, p.9, his emphasis) as "*soft real-time interactive agent-based computer simulations*" in which "some subset of the real world- or an imaginary world - is *modelled* mathematically so that it can be manipulated by a computer." A "soft" real-time system, in this sense, is a simulation in which missed deadlines or breakdowns do not result in catastrophe or death, as in a "hard" real-time simulation such as a live military helicopter exercise. *Agents* are distinct entities such as vehicles, characters, icons, props and so on, that interact as part of the simulation.

Although all videogames can technically be considered simulations, the term *simulation* or *sim* typically refers to the *simulation videogame genre*. *Flight Simulator* (Microsoft, 1982), for example, allows players to experience a faithful reproduction of flying a plane. A clear difference between videogames and CS is that simulations tend to be non-ludological. A simulation does not require winning or losing conditions, meaning simulations are experienced rather than played. Videogame simulations are process

orientated and allow the user to “play with systems” (Egenfeldt-Nielsen … Tosca, 2008, p.49–50) either as a character exploring and manipulating a dynamic and changing world (*Simpsons Tapped Out* (EA Mobile, 2012)*, Fallout Shelter* (Bethesda, 2015) or a player in charge of more fundamental variables such as taxation levels or elements influencing an ecosystem (*Simcity,* Electronic Arts, 1989, and *The Sims,* Maxis, 2000).

The main tool for creating CS, the game engine, grew out of videogame culture. Most contemporary videogames and ‘cultural’ CS are created with game engine software. The origins of the term *game engine* have been ascribed to the emergence of first-person shooter (FPS) games of the early 1990s, which offered players the ability to modify levels, characters and environments.

Game engines are a complex combination of development tools and ‘runtime component’ in an interactive development environment (IDE) or software development kit (SDK) (Gregory, 2014, p.32). The main component is a viewport interface onto the game world that resembles 3D animation programs like *Autodesk Maya*, which can be used to access tools for modelling, sound, lighting, rendering and coding. The runtime component allows users to run their game design as a finished product, for testing purposes. The toolkits provided by game engines are used to create videogames, simulations genre videogames, machinima, and virtual reality.

Several books concerning the relationship between videogames and art have emerged within the last decade, which are helpful for this study. Bittanti and Quaranta (2006) showcase artists’ videogame-related work, Clarke & Mitchell (2013) offer critical insight and interview artists, Sharp (2015) explores the relationship to art history and Schrank (2014) maps out a new wave of avant-garde subcultures engaged in technocultural play. Bittani and Quaranta (2006) use the term *Game Art* to describe “art in which digital games have played a significant role in the creation, production, and/or display of the artwork”. This definition of Game Art can refer to analogue, digital and hybrid practices, such as painting, photography, drawing, sculpture, performance, and videogames themselves. Many examples of videogame-related art tend to be difficult to categorise from a technological perspective, as the work may be exhibited as a live performance in software (like Joseph Delappe’s in-game protest series), as a physical form in a gallery (Corey Archangel’s *Super Mario Clouds*, 2002), as projected or screened image (JODI’s modified and hacked videogames), as interactive software (Mary Flanagan’s *[domestic], 2003)*, as screenshots (Palle Torson’s *Evil Interiors,* 2003) or a combination of any and more of these elements.

Although videogame-related artworks are often formalist, and concerned with deconstructing their own materiality (JODI, Joan Leandre’s *RC* series), the videogame medium has been used to explore a variety of concerns including the social and political. In Wafaa Bilal’s *Domestic Tension* (2007) (Figure 5), a month-long performance piece, he

allowed online visitors to his webpage to shoot his real body with a remote-controlled paintball gun. The work prompted a frenzy of online activity, including a group who logged on constantly throughout the performance to protect Bilal with a “virtual human shield” (Schrank, 2014, p.91).

Figure 5. Bilal, Wafaa, *Domestic Tension* (2007)

Art that incorporates computer simulations is not required to be interactive in the same way as videogames. This problematises any straightforward use of videogame theory in this thesis, as it is often written with an emphasis on interaction and the increased agency of audiences. Attempts have been made to accommodate non-interaction within definitions of videogame. Carlisle (2009) coined the term *zero-player game* to describe John Conway’s *Game of Life* (1970). Björk and Juul (2012) add four categories to his definition: 1) *Setup-only games*: no player input after manipulating starting conditions; 2) *Games played by artificial intelligence*: AI characters, teams or sides compete against each other without player input; 3) *Solved games*: “Games that are solved through analysis, such that every possible game session is captured in a single atemporal description”; 4) *Hypothetical games*: “Proposed but non-implemented games described to examine a question, or actually existing games that are for practical purposes unplayable.”

Zero player games are useful in terms of framing non-interactive works, because they challenge the notion that a game needs to be played, at least by a human. The way I use simulations in my practice shares similarities with a setup-only game, in that the starting conditions are defined and then left to play out without human intervention. The term ‘zero player game’ pushes the boundaries of what can be considered a videogame, but instead of stretching a definition beyond its essential components, it makes more sense to locate this study within the less ludologically-focussed context of the computer simulation.

Machinima

Machinima, a subset of videogame culture and another example of programmable moving image, also exists in close proximity to computer simulations. It is defined as “animated filmmaking within a real-time virtual three-dimensional environment or virtual reality” (Marino, 2009, p.1). Machinima is related to the practice of videogame modding (which artists such as JODI and Joan Leandre have explored) as it is generally created using pre-existing content in videogames or game engines (Morris … Lloyd, 2005, p.25). Some software, such as *iClone* offers cinematic, rather than game-centric tools.

Machinima practices emerged from the compartmentalised software architecture of *Doom* (1993). The separation of game components allowed players to create their own “recordings” of game sessions without undertaking complex hacking of the engine itself. The file sizes were small enough to distribute as the virtual camera, player controller and game event information were stored alphanumerically rather than as a video file. At this time, machinima files were referred to as “demos” and ran in real-time as the software interpreted and executed it.

Although real-time machinima became obsolescent amongst fan communities due to technical limitations and the growth of video compression, recording and distribution tools, real-time video techniques are still used to create cinematic cutscenes in commercial videogames without the need for large video files. Contemporary machinima most commonly refers to video-captured footage of videogames, often edited and post-produced in external editing and effects software (Lowood & Nitsche, 2011, p.24).

Artists have explored machinima as a strategy for critiquing the social and political connotations of videogame logics, an issue that comes back into focus later in this chapter as part of a larger discussion on how algorithms communicate ideologically. Dave Beck’s *The Highest Score* (2005) is a repeated loop of an in-game performance of the player character stamping on a character’s head. The work was performed in *The Warriors* and exhibited online, until the developers of the original game issued a cease and desist order. Exploring videogame violence from a feminist perspective, Georgie Roxby Smith’s *99*

problems [wasted] (2014) is an online *Grand Theft Auto V* intervention exhibited as an edited video, in which a female player character repeatedly commits suicide in front of non-player characters (NPCs).

Machinima can also be understood as artistic appropriation. Machinima often involves existing videogame engines, environments, characters, props, and sound, such as *99 problems [wasted]* (2014) and Brent Wantanabe's *San Andreas Streaming Deer Cam* (2015-16), which both made use of the *Grand Theft Auto V* game engine. The degree to which the work is classed as appropriation can vary, usually depending on aesthetic similarity to the source videogame. John Gerrard's work, for example, is created from scratch in digital content creation software, from photographic and video reference. The aesthetics of the work index a physical location rather than a virtual one. My practice is more in keeping with Gerrard's rather than machinima or videogame appropriation, as I tend to make the models and environments and arrange them in an engine. I do however, make use of the game engine code which is engineered by a team of developers and plugins (such as ocean materials, and leaf particle systems) often authored by solo developers, so the work is always an assemblage of authorship.

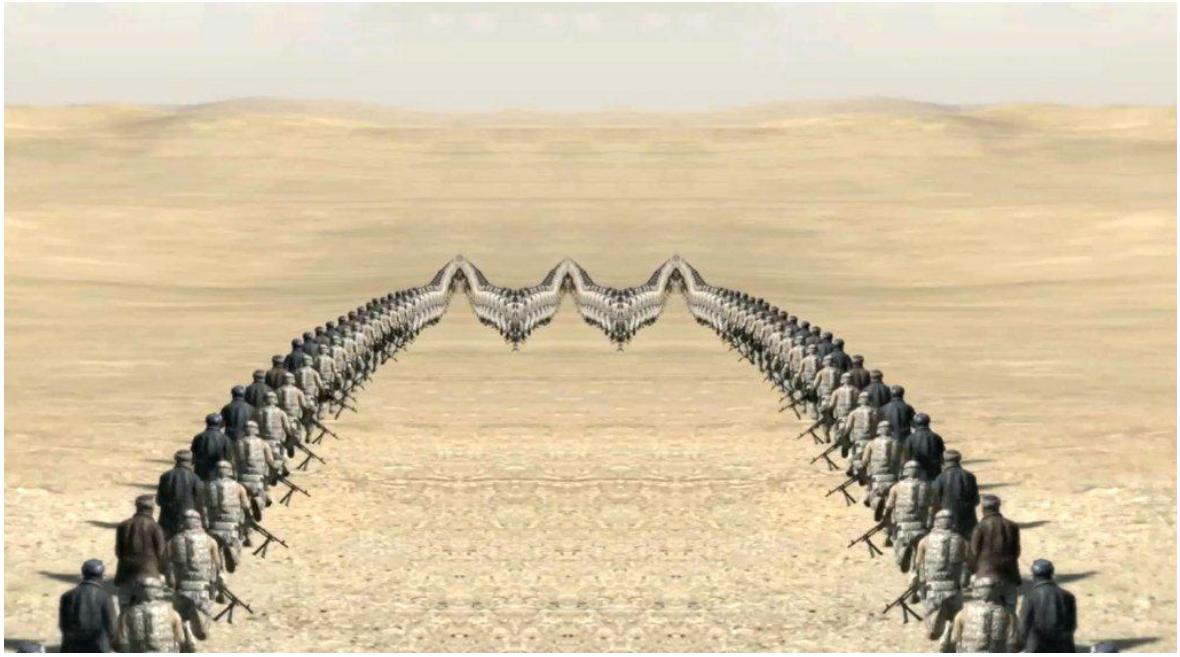


Figure 6. Pailthop, Baden, *Formation* series (2011)

The artist's choice to exhibit machinima as a video recording limits the impact of the work as an open, adaptive system, although does not negate meaning created at an algorithmic or processual level. Baden Pailthop's *Formation* series (2011) (Figure 6), for example, creates meaning from the modified AI behaviours of troops in US military simulation software, yet is presented as machinima, or video recording. Pailthop modified the AI parameters for Afghan and US non-player characters (NPCs) to create an algorithmic truce state. The choreography of the troops, stripped of their procedural

functionality and reduced to a single mass of controllable avatars, plays with the idea of power and control in warfare. John Gerrard's *Live Fire Exercise* (2011), by way of contrast, similarly involves the choreography of virtual soldiers in virtual space, although instead of video, the work is displayed as a live, real-time performance.

Virtual Reality and Art

Virtual reality, alongside videogames, are one of the most immersive examples of CS, and *simulation* is often used interchangeably with *virtual* and *virtual reality* (Biocca & Levy, 1995). Examples of early VR art include Aaron Marcus's *Cybernetic Landscape* (1973), a monochrome virtual environment that "…allowed a viewer to move his point of view around a three-dimensional graphic environment containing abstract symbols" (Krueger, 1991, p.215), and Krueger's *Videoplace* series (1970s-1990s), which aimed to provide a "full-body participation in computer events that were so compelling that they would be accepted as real experience." (Krueger, 1991). Krueger created interactive artworks with the resources and colleagues from University of Wisconsin-Madison as part of his doctoral study, and later coined the phrase *artificial reality* in 1983 which would later be superseded by Jaron Lanier's term *virtual reality* in 1989.

Cyberspace, a term from William Gibson's novel *Neuromancer* (1984), is also used, although more often in relation to networked virtual spaces, like online videogames and virtual worlds such as *Second Life*. Literature on virtual worlds, tends to focus on socio-cultural activity, investigated via ethnographic or virtual-ethnographic methodologies, which are not particularly relevant to the practice-led nature of this study. In addition to being used as a virtual filmmaking space, virtual worlds have hosted exhibitions (Cao Fei at the Venice Biennale in 2007), recreated existing gallery spaces (Palle Torson's *Museum Meltdown* (1996-1999)) and sold art (Dutch team *Art Tower* selling art via *Second Life*).

The Banff Centre has hosted many artist residencies that focus on virtual art. In *Immersed in Technology,* a book published to reflect on these residencies, Morse (in MacLeod, 1997, p.203) provides a framework for understanding virtual artworks, identifying three areas of concern: the relationship between virtuality and materiality in the work, the formation of networks or "linking devices" between different virtual spaces and finally, the content of the virtual world itself. This study more closely aligns with the first and last concerns.

The first wave of virtual reality in the 1990s suffered from a lack of technological sophistication – particularly in relation to graphics quality - and potential for economical scalability. Virtual reality sequences like those in *The Lawnmower Man* existed only as visual effects created by high-end computer graphics workstations. The tools required to

create virtual reality experiences, however, have developed considerably since then. VR resurfaced in the 2010s as *Occulus Rift* developers released prototype kits in 2012 and 2014, and sold their business to Facebook in 2014 for two billion dollars.

Stephen Wilson's *Information Arts* (2001) provides a thorough overview of VR art which he describes as "…immersive visual and audio experience through innovations in perceptual and interface technologies. Perceptually, they augment usual computer displays via technologies such as stereoscopic 3-D eye displays, surround projection on all surfaces, and/or 3-D spatially localized sound" (Wilson, 2001, p.693).

Virtual reality technologies bring their own peculiar set of challenges to art practice and curation: they are required to be viewed individually (although sometimes the experience is networked and shared with other audience members), audience movement and position generally alters what aspect of the work is seen within the headset, the audience's vision is completely cut off from the exhibition space (unless augmented reality or video feed is used) and VR sickness can also have a physiological effect on audience members. As discussed in the limitations section of this literature review, VR does not currently constitute a part of my practice and therefore is not pursued in the remainder of the thesis.

Computer simulations and Art 1960s -1980s

During the 1970s and 1980s discussions about simulation in art tended to refer not to computer simulation, but issues of authorship and originality in non-computational art. This is evident in exhibitions, artist statements and interviews with artists from this era (Evans, D., 2009, 74-103). Influenced by the ideas of post-structuralism, Baudrillard and Barthes, artists such as Sherrie Levine and Richard Prince made work that provocatively challenged notions of originality by appropriating and re-photographing iconic or found images. Baudrillard presented his arguments with a seductive visual sensibility (Halley, 1988, p.63–73) that clearly appealed to artists. The 'desert of the real' became a metaphor for how society had become entirely subsumed by simulacra. Films like *Blade Runner*, and later, *The Matrix*, maintained an interest in his ideas.

Limiting CS to an entirely appropriation-centric art practice, divorces them from their contemporary function and meanings. Contemporary media society has significantly changed since the 1970s and 1980s, with technology playing a fundamental role in how we live. Significantly, the term *simulation* in postmodernist discourse did not refer to a computer simulation but to an act of self-referential representation.

Although there are interesting aspects of appropriation at play in videogame mod practices and artworks, it is more useful to employ the associated terminology of modelling to describe CS related art.

Although computer art had limited impact on the mainstream art between the 1960s and 1980s, the ideas behind computer technology, particularly systems theory and cybernetics, were widely explored in a variety of computational and non-computational art practices. In the 1960s and 1970s systems theory and cybernetic ideas resonated in the Frank Stella's minimalist paintings, Steina and Woody Vasulka's video feedback loops, the computational drawings of Mohr and Molnar, and artists that foregrounded process over outcome, such as Jackson Pollock. A consequence of systems theory percolating into art practices was a general shift from object-orientated to process-orientated modes of art production, which is still regarded as being present in the contemporary art world.

Systems theory incorporates several types of system: ordered, disordered and complex. Ordered systems can relate to modular forms in art such as Constantin Brancusi's *Endless Column* (1938), patterns and tiling. Disordered systems relate to randomised and stochastic systems (systems that are unpredictable due to a random variable). Complex systems possess aspects of order and disorder, in addition to emergence, a phenomenon in which new behaviours, not previously included within the starting conditions of a system, are created. Artworks in the 1960s tended to belong to ordered and disordered systems.

It is helpful to subdivide systems into ordered, disordered and complex generative systems to understand how artists make use of them. Ordered systems can relate to the modular form of Serial Art such as Constantin Brancusi's *Endless Column* (1938), patterns and tiling. Disordered systems relate to randomised and stochastic systems. Complex systems possess aspects of both order and disorder, in addition to emergence. Algorithmic art is a subset of generative art, with a specific focus on the method of autonomous production (the algorithm), although the two terms are often used interchangeably. Despite the broadness of the definition, the term algorithmic art is most commonly used to refer to artists that use semi or completely autonomous drawing processes.

It is also important to understand the different iterations of cybernetics theory. First wave cybernetics concerned the development of self-regulating, homeostatic feedback loops such as temperature regulation in humans and electronic thermostats. The theme of self-regulation or autopoiesis, for example, features often in simulation art. Claude E. Shannon's (2001) Information Theory was proposed in 1948, which offered a new way for thinking about the computational quantification and processing of information.

Second wave cybernetics incorporated the role of the observer into open systems. "Scientists were recognised as active participants in their own scientific experiments and inextricable from them. This observation (of the recursive nature of observation) led to the constructivist position that 'the world as we know it is our invention'" (Shanken, 2015,

p.14). Cultural explorations of these ideas were played out in publications like *Radical Software* and *Whole Earth Catalogue*.

Third wave cybernetics incorporated emergence into existing systems thinking, in which a basic set of objects and behaviours could independently lead to complex, adaptive behaviours. Norman White's electronic sculpture *First Tighten Up on the Drums* (1968) and John Conway's *Game of Life* (1970) are examples of artists exploring emergence from this era. Systems thinking underpins many of the processes involved in CS, hardware, software, code and algorithms can all be considered in relation to second and third wave cybernetics.

Computational uses of algorithms in art were often referred to as *generative art.* Early artists such as Frieder Nake, George Nees, Vera Molnar, Paul Brown and Manfred Mohr used drawing machines called 'plotters' to transfer computer images or algorithms directly to paper. These artists had a group show called *Artificiata* in 1969. Generative art can be defined as artworks that are entirely or partially created with autonomous systems. Although this frequently relates to art made with computers, it can refer to non-computerised methods, such as the cut-up writing techniques of William Burroughs, the systemic permutations of Sol Lewitt and the rules-based work of Dick Higgins.

Underpinning generative art is an interest in the mystery of natural mathematics and algorithms (such as in *The Algorithmic Beauty of Plants* (Prusinkiewicz & Molt, 1996)), and a loose post-structuralist ethos that positions artworks as a kind of offering to ambiguous spirituality. Pearson (2011, p.xviii) references Buddhism and Taoism although the frequent use of fractal imagery is limited in conveying ideas about spirituality in the same way as, for example, Bill Viola's *Ascension* (2000). Generative art is also discussed in relation to post-structuralist discourse in that autonomous systems provide a way for artists to symbolically question notions of authorship and originality.

Much generative art tends to be aesthetically homogenous, eschewing figurative representation for complex lines traced through empty space, their movement and position plotted by the runtime cycle of code and parameters. Pearson (2011, p.xviii) describes generative art as a meeting place between the cold, rationalism of code and the emotional, subjectivism of art. Generative art tends to involve the adherence to sets of principles that determine the outcome of the work.

> "Autonomy must be involved. The artist creates ground rules and formulae, usually including random or semi-random elements, and then kicks off an autonomous process to create the artwork. The system can't be entirely under the control of the artist, or the only generative element is the artist herself. The second hard-and-fast rule therefore is there must be a degree of unpredictability. It must be possible for the artist to be as surprised by the outcome as anyone else" (Pearson, M., 2011, p.6).

When CS comprise *complex adaptive systems* they are capable of emergence, which offers a profound opportunity for artists exploring notions of authorship, modelling, and the flow of life itself. Emergence can be defined as a simple set of rules at a low level that leads to organised complexity at a higher level (Pearson, M., 2011, p.108). Ant colonies are a classic example of emergence, as the behaviour of ants looks different when observed at a micro and macro scale. Ant colonies do not have a hierarchy but operate via a decentralised *stigmeric* system - in which the traces left by actors in a system influence the behaviour of other actors in the system.

Craig Reynold's *Boids* algorithm (1987), which mimics the flocking behaviour of birds, is an example of emergence within a CS. The algorithm only contains three rules, expressed as *separation, alignment, and cohesion*, yet in conjunction these rules can lead to behaviour that is remarkably similar to avian flocking patterns (Pearson, M., p.109). This can be understood as morphogenesis - the way patterns naturally form in time because of emergence. The term *cellular automata* is used to describe individual units of emergent systems, which simulate John Von Neumann and Stanislaw Ulam's state-changing cell-based systems, capable of producing behaviours not present in the initial states.

Scientific developments in this area percolated into the art world, but only in a limited way. Mathematician John Conway's *Game of Life* is a canonical example of an emergent computer simulation, but it is difficult to find many other examples. Systems theory is more generally discussed in relation to chaos theory and complexity theory, two branches of though built on third wave cybernetics. With the further discussion of how these ideas impacted our lives, and the increase in cheaper, easier technology, the exploration of emergence became more feasible for artists to explore in contemporary contexts. This is discussed more in the next section.

The increase in computer art in the 1960s and 1970s occurred around the same time as a growth in conceptual art. Conceptualism brought about an interest in process as the primary value of an artwork - an approach that devalued the materiality of the art object. This process-oriented approach can also be observed amongst new media artists, who are "…interested in how the system becomes both the space and the material of the work" (Graham … Dietz, 2015, p.61). The representation of computer simulations in popular culture has also maintained their status as immaterial. Since the advent of computer simulation technology in the 1950s, CS are often evoked in relation to science-fiction notions of utopian immateriality and transcending corporeality.

Computer simulations in Art (1990s – present day)

Many of the contextual examples so far, especially in relation to the media histories of cinema and videogames, involve modes of moving image production that exist

in close proximity to the CS. In the 2000s, however, artists such as Ian Cheng and John Gerrard started to use computer simulations as the primary medium for their art practice. These artists tend to be trained in computer graphics and/or programming to some extent, (Ian Cheng, Katie Torn, Alan Warburton) or employ technical teams (John Gerrard) in the production of their work. Their work covers a variety of ideas and contexts, although concerns with systems thinking, algorithms ecology, media materiality, politics and the formal characteristics of CS have emerged.

Figure 7. Gerrard, John, *Farm (Pryor Creek, Oklahoma, 2015)*

John Gerrard makes real-time CS of that expose the hidden industrial and agricultural sites of hyper capitalism. In *Farm (Pryor Creek, Oklahoma) 2015* (2015) (Figure 7), Gerrard created a real-time simulation of a Google “data farm”. Source images were captured from a helicopter flown over the location, after being denied ground access by Google. Gerrard uses simulations to reveal the hidden physicality of contemporary culture, as exemplified by data farms that make online culture possible, and livestock processing plants that allow us to buy meat in supermarkets. Gerrard’s work is expressive not just in its visual representation and modelling, but also at a procedural level. The encapsulation of real-world processes as algorithms highlight the pervasiveness of systems thinking on our way of life.

Gerard’s work is also interesting in terms of how computer models of time function within *real-time* art. Real-time can more accurately be thought of as a cycling of the computer’s central processing unit (CPU) at the same rate of time passing in the real world. “Real-time used to mean not having to leave the mainframe computer to process overnight and hence concerned the speed of processing within the computer itself…”

whereas now it is more often used to convey a sense of the "…instantaneity of processing and manipulation of data" (Graham, B., & Cook, S., 2015, p.97).

Katie Torn's *Breathe Deep* (2014) (Figure 8) is a virtual architectural ecosystem created from composited video, GIFs, three-dimensional models, and visual effects like liquid simulations. The work is exhibited as a projected video. The sculptural qualities of *Breathe Deep* (2014) are reminiscent of videogame aesthetics, although the intended focus of the work is more interesting in the context of image-making ecosystems. The artist's use of the word ecosystem suggests an exploration of McLuhan's *media ecology* and the loud, clashing collage of media forms create a dynamic system of relentless cultural barrage.

Figure 8. Torn, Katie, *Breathe Deep* (2014)

The concept of affording agency to computational objects also exists in 'agent oriented programming', a computer programming paradigm which replicates the function of symbiotic agency. Jeremy Thorp's *Colour Economy* (2008) is an example: a system of cubes can trade colour values in the pursuit of profit. Each cube follows the same rule, but has "different leanings and idiosyncrasies influencing it's self-interested behaviour" (Pearson, M., 2011 p.147).

Artist Ian Cheng employs similar techniques using the *Unity* game engine and programming behaviours for individual characters and props that interact within a virtual environment. He refers to them as 'live simulations'. "The simulation in the end is a virtual space with a huge accumulation of mini-behaviours and laws that act and react to each other with no master design, just tendencies, all playing out in parallel with each other" (Cheng, 2015, p.111). Previously an employee at Industrial Light and Magic, Cheng describes the appeal of the immediacy game engines provide, citing his impatience with waiting days for renders to generate and preference for the immediacy of "real-time rough drafts" (Cheng, 2015, p.102).

Sheldon Brown's *Assembly* (2015) uses 3D graphics and coding to simulate the process of evolution in an interactive software application that uses the audience's

gamma waves via a head set and input via a mobile device or game pad. Brown explores similar concepts of emergence to Cheng, although aesthetically the work is closer to scientific visualization of biological matter.

Computer simulation tools offer artists ways of visually exploring emergence. The image "… no longer reactualises the past, but instead actualises a possible present, which is also that of the digital signal and its on-screen appearance" (Hoelzl, I., & Marie, R.,2015, p.5). There is something profound about the image becoming a site of possibility rather than a captured moment of the past that resonates with the computer simulation as a parallel or sideways reality. This is also articulated as a shift from projection to processing and from representation to operativity. "Simulation is the creation of the possibility of form." (Reas & McWilliams, 2010, p.149).

Rachel Rossin, the first Virtual Reality Fellow at The New Museum's NEW INC group, explores the relationship between painting and virtual space. In *I Came and Went as a Ghost Hand* (2015) (Figure 8), Rossin rebuilds paintings in the three-dimensional space of a game engine in a way that exposes the flat, constructed nature of the polygon objects. Audiences experience this via a VR helmet, stored on a white plinth. Painted versions of the spaces, flattened and distorted by the dimensional process from flat to 3D to flat again, make the familiarity of virtual space unfamiliar again. Observing what happens to space when we move it back and forth through real and virtual spaces recalls Lister's critique of simulation theory rendering all objects as unreal. Rossin helps us reflect on the everyday process of switching our perspective from the real to virtual and back again.

Figure 9. Rossin, Rachel, *I Came and Went as a Ghost Hand* (2015)

The use of CS to explore the real/virtual nature divide is present in Timur Si-Qin's video and sculpture practice. Si-Qin's digitally rendered landscape and installations explore the commodification of natural imagery in speculative visions in which the landscape is co-opted by corporate mysticism. In *Campaign for a New Protocol, Part III*

(2018) the simulated landscapes are presented within an installation of real and fake plants. The screen is one component amidst a variety of sculptural objects that confront the viewer with real/simulated natural imagery. Speculative simulated natural spaces are explored in a more minimal fashion in Jennifer Steinkamp's walls of plant imagery, such as *Blind Eye* (2018-19), which exist within the blackness of software space.

Figure 10. Holdsworth, Dan Argentiere Glacier no. 1-18 (2016-2018)

The ability for CS to recreate immersive natural environments has been utilised by artists to document places that are disappearing or have already disappeared because of environmental destruction. This is a key theme in the work of Kelly Richardson, who uses visual effects software to simulate virtual spaces, such as the surface of Mars in *Mariner* 9 (2012) and the speculative future landscape of *The Erudition* (2010). Daniel Steegman's *Phantom (Kingdom of all the animals and all the beasts is my name)* (2015) is a monochrome virtual environment created using data from a three-dimensional scan of the Brazilian Mata Atlantica Rainforest, a rapidly disappearing natural environment. The VR helmet hangs suspended from the ceiling in a semi-enclosed white cube space. In a similar act of preservation, Dan Holdsworth's *Argentiere Glacier no. 1-18* (2016-2018) displays point cloud data that accurately maps the contours of Alpine glaciers.

The use of crowd simulation techniques in Phase 2 of this research has similarly been utilised by Baden Pailthorpe, Alan Warburton and Gregory Bennett. Bennet's work explores the choreography of virtual humans and the archaeology of real and virtual spaces. The colour palette consists of grey untextured polygon surfaces, the pure black of software space and the primary colours often assigned to interface tools to aid in the production of the work. The stark use of software tool aesthetics situates the work in a simulated sandbox of minimalist archaeological elements.

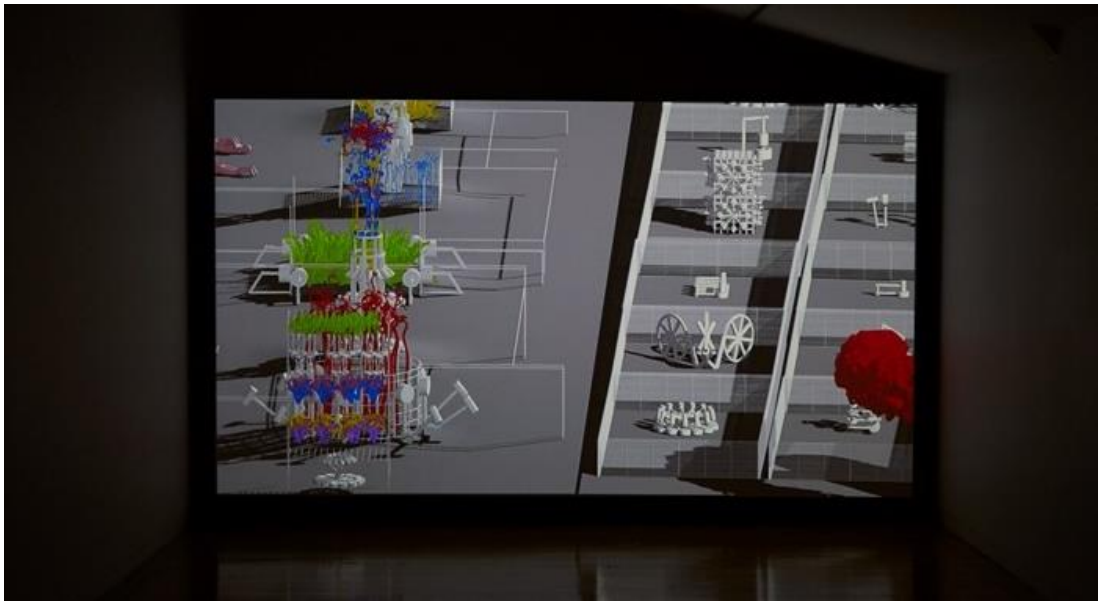


Figure 11. Bennett, Gregory, Nature Morte (2017)

My practice has affinities with photographic landscape practices in the work of Clement Valla, Mark Dorf and more recently, Dan Holdsworth. In *Postcards from Google Earth (2010-ongoing)*, Valla scours Google Maps for spatial errors that occur in the application of satellite data to the application's virtual topology. The breaks in spatial continuity bend bridges and roads around the terrain. The effect renders the concrete architecture of highway systems more pliable and organic, yet also undercuts the realism of the algorithmic mechanisms underneath their surface: "…no person really planned for this or that image to be produced. Rather the image is a result of process. And it's entirely conceivable that, as I fly around this simulated planet and point my virtual camera at specific places and specific angles, I am seeing an image materialise on my screen that no other human has ever seen" (Shore, R., 2014, p. 68).

Figure 12. Valla, Clement Postcards from Google Earth (2016-ongoing)

My practice situates itself within these communities of practice, but with a focus on landscape, duration, materiality and the simulation in a combination which more directly deals with the duration of landscapes and technology. There are overlaps with artists working with duration in interesting ways - such as Tabor Robak's *Colorwheel* (2017) a 9 channel 4K generative animation which is synchronised to the time of day, and Hiroshi Sugimoto's *Theatres* series – in which the duration of the film exposure is synchronised exactly to the duration of the film shown in the theatre. My practice more explicitly enacts duration as a way of connecting natural and technological actors.

The use of CG imagery in contemporary art practices can fetishize a specific kind of unreal – the foregrounding of the rawness of untextured, unlit, default character rigs and objects in software space. An overly aesthetic approach can often lapse into machinic fetishism and doesn't take us much further than the initial explorations of such imagery from the early 1990s. The interesting work comes from places where there is an awareness of the real and virtual being interwoven, a space for the multi-directionality of agency to flow and change the real and the virtual simultaneously. The processes used by artists engaged in simulations are an equally important, if often less tangible arena for meaning creation. The overuse of CG spaces without process can perpetuate an immateriality that my own practice challenges by attempting to make CS more tangibly connected to the physical world.

Figure 13. Two Way Mirror Series – Untitled 1 (2014)

A previous project entitled the *Two Way Mirror* series (Figure 12) can be viewed as a precursor to this thesis. In this series, virtual cameras are placed behind or under terrain elements inside *Skyrim Creators Kit*. The reverse side of polygons appear transparent, resulting in images constituted by a combination of transparent and rendered polygons. The sky or environment texture shows through whenever a polygon is transparent. The

outputs of this series were photographic and also “real-time” software-based pieces, with fixed cameras. The only movement is manifest with the embedded animations of vegetation, trees and clouds, swaying in a virtual breeze.

Later works in this thesis begin to develop the sense of the ‘infinite duration’ simulation into a more defined use of duration to explore the lifespans of the elements within the environments. The synchronisation of the length of these simulations with the length of the exhibition also evokes a sense of the scientific experiment, of a temporal boundary or ‘control’ variable, within which repeated exhibitions can be compared or understood in relation to one another.

Algorithmic Images

Post photographic and post cinematic practices and literature are useful in examining how artists have responded to the impact of the algorithm on image production. The key difference between post-photographic practice and CS is that post-photography tends to constitute still images whereas computer simulations, despite using similar software and processes (in some cases) unfold in time.

Eivind Rossaak describes the shift from photochemical to digital photographic practices as the ‘algorithmic turn’, in which the image is transformed into a programmable object. “We enter the area of codes, algorithms, software, programming. All of these new aspects of the image belong essentially to a new non-visual regime of the image. All too often this non-visual component is taken out of the picture.” (Mackay, R., 2015, p.53).

If we consider the moving images produced by computer simulations as ‘algorithmic images’, then considering the ontological differences with film can help elucidate the ontological idiosyncrasies of CS. Rossaak (2011, p.190) references Rodowick’s ideas about continuity to articulate the difference: “While the photochemical process is based on a principle of continuity between input and output, the information processing of the digital image is, ontologically speaking, based on a separation or discontinuity between input and output.” This discontinuity is either a space for creativity, or a space for exploitation. Ontological recalcitrance forms an important part of the characteristics of CS.

The proximity between CS and other media forms can also be problematic, as it can be difficult to isolate their specific characteristics from incorporated or ‘remediated’ media forms, like cinema, photography, and videogames. Rossaak (2011, p.191) has referred to this phenomenon as “transversal culture” and argues that medium specific qualities, such as the flicker and grain of celluloid, have become part of a lexicon of pre-made digital effects and as such their previous connections to medium specificity have

become redundant. The impact is that algorithmic cultures possess a new type of materiality, which operates in “mutable information codes” rather than via material distinction from other media. The result is that “Film and photography are no longer medium-specific qualities, but are rather two of the ways that algorithms hide themselves” (Rossaak, E., 2011, p.191).

Modelling / Commonalities with Scientific Computer Simulations

Algorithms constitute the way in which space, time and behaviour are created and performed in CS. It is helpful to consider these elements as part of a modelling process.

The way in which computer simulations are authored in the arts has commonalities with the scientific processes, although with a focus on the conceptual and aesthetic rather than mathematical fidelity. Scientific modelling reduces space, time and behaviour to differential equations and parameters that dictate the behaviour of models during the simulation. Although scientific CS possess different aims and audiences, they can still be considered fundamentally expressive. The overwhelming volume of variables that can impact on experiments make it impossible to construct reality within any degree of significance (Winsberg, E., 2010, p.7), which means that scientists improvise and “…supplement the model with features that have nothing to do with the theory at all but are designed to compensate for the errors that the coarseness of the approximation is found to create” (Winsberg, E., 2010, p.9). This softens the binary separation between scientific and artistic CS.

A similarity between definitions of CS within scientific, sociocultural and artistic contexts is that they simultaneously enact, and seek to describe a sense of epistemological and ontological uncertainty (Winsberg, 2010, p.29–48). “Simulations are a bridge between two worlds: speculation and calculation, theory and experimentation” (Roundtree, 2014, p.3). Although the debate over the status of CS in science continues, current thinking indicates that simulations are better understood as ontologically and epistemologically dynamic rather than static entities. This mirrors the position of CS in contemporary art, as examples of hybrid, protean and productive media.

Although I will later argue for CS as material entities, they are still one step removed from their source phenomena, an ontological stance generally accepted in the sciences (Gilbert and Troisch, 1999, p.13). This is not quite the same thing, and it is not helpful to conflate ‘realness’ with fidelity to the source model, if, indeed, there is one.

Computer simulation tools such as game engines have their own limitations on what can be modelled. Although written in relation to videogames, Wardrip-Fruin’s list of criteria are useful here. The source object or system must be: “1) specific enough to be defined in computer code; 2) efficient enough to run on the chosen computer platform; 3)

able to be produced within time and resource constraints, and 4) resemble the author's directorial wishes with a view to producing engaging gameplay" (Wardrip-Fruin, N., 2009, p.82). Hardware also provides limitations: processor, graphics card and time constraints make it impossible to simulate real world processes to a degree of high fidelity and execute them in real-time.

Computer simulations and Representation

Computer simulations are difficult to understand in relation to existing representational concepts because they are complex assemblages constituted of multiple autonomous agents. "[emergent] systems are marked by considerable instability and volatility since their repetition is never perfect; there is a continuous redefining and reassembling of key elements that results in systems' capacities to evolve into new and unexpected forms." (Coole and Frost, 2010, p.14).

For Lister et al (2008, p.43) CS contain representational actors but are also "productive of reality" that "…is mathematically structured and determined". This view of computer simulations is mirrored by Parisi (2013, p.9): "…algorithms are no longer or are not simply instructions to be performed, but have become performing entities: actualities that select, evaluate, transform, and produce data."

Parisi has made provocative claims about the capacity for CS to produce realities, by giving *the system* priority over *reality:* "If we understand reality as that which a system pragmatically needs to perform its operations, the simulation can be seen to be 'realer' than the reality upon which it is putatively modelled. Such a view suggests a conception of the real as a contingent fold in the world realised by a given entity as it strives for its own efficacy within that same world. In this sense, simulation is not the activity of merely representing reality, but rather an intense site of its production" (Mackay, 2015, p.19). It also, perhaps conversely to Parisi's intentions, aligns with Baudrillard's concept of simulacra as being more real than reality.

From a technical standpoint, Parisi's argument has some support. It is natural to think of the computer simulation in the same way as a painting or photograph, especially when exhibited in a similar way, although as Rodowick suggests "…electronic images are not "one" – it is never wholly present to us because screens are constantly refreshed and rewritten" (Rodowick, D., 2007, p.198).

Mackenzie Wark claims that CS are not representational or indexical, and that "…the gap between the simulation and its other is what's interesting" (Mackay, R., 2015, p.72-73). The algorithmic nature of visual computer simulations creates a new form of representation in which processes, behaviours, rules and interactions augment aesthetic

authorship. This complex form of representation has been described as *procedural rhetoric* (Bogost), *simulation rhetoric* (Frasca) and *expressive processing* (Wardrip Fruin).

Procedural rhetoric describes how the authorship of processes and models can be used persuasively. In videogames, for example, the designer's decision to reward or punish specific behaviours is representative of a world view or ideology. In this sense, behavioural algorithms are inseparable from their real-world political implications. Wardrip-Fruin and Frasca developed their terms in relation to videogames, but Bogost indicates that procedural representation can be used as a framework to understand a variety of arts practices.

Frasca's (2001) similar term *simulation rhetoric* compares computational processes with narrative and drama as a form of representational storytelling. Frasca approaches the use of simulations as educational tools, with the aim of encouraging players to question reality and raising critical awareness. This stands in opposition to what Frasca calls "Aristotelian videogame design", meaning videogames that foreground immersion and narrative. Whilst not directly contemporary art focused, Frasca's approach shares a common critical ground.

Wardrip-Fruin's (2009) *expressive processing* describes the way processes are distinctive and convey links to histories, economies, and ideologies (Wardrip-Fruin, N., 2009, p.4). Bogost and Wardrip Fruin offer similar terms to describe units of simulated representation- *unit operations* and *operational logics*. In this sense, the artwork becomes a "configurative system" (Bogost, 2008, p.ix) and unit operations are the interlocking components of meaning within any artwork or medium. This is useful for understanding the highly modular form of CS, which are comprised of multiple interlocking units of code, models, software, hardware and display.

Operational logics are similar in their attempt to define a unit of computational representational capacity, although retain a technological focus that makes the concept less transferrable to other non-digital mediums than unit operations. For example, Wardrip-Fruin does not map this term onto non-computational artworks or culture in the same way as Bogost does. Wardrip Fruin (2009, p.17) describes operational logics as non-specific processes that "…foreground critical and aesthetic modes over that of efficiency".

From Semiotics to Simiotics

Frasca claims that simulations fit Peirce's definition of a sign, as "something which stands to somebody for something in some respects or capacity" (Frasca, G., 2001, p.29), although with important differences. Firstly, computer simulations are multi-state - that is capable of existing in different forms - meaning that different viewers may have different

ideas of what real life object or process is being simulated. For Frasca this is a different issue to that of polysemy, in which people have different interpretations of signs. He therefore extends Peirce's concept of the sign to incorporate the interpretamen, based on Philip Johnson-Laid's (1983) concept of the 'mental model'. This extension of semiotics is referred to as simitotics (Frasca, 2003, p.223).

Figure 14 shows Frasca's extension of Pierce's 'sign' to include the interpretamen, which functions as a sign generating machine (Frasca, G., 2001, p.39). The *Transformers* toy in the diagram exemplifies a multi-state object, i.e. it can be a car or a humanoid robot. The capacity for the object to be multi-state requires this augmentation to the traditional semiotic model to allow for different interpretants to possess different mental models of a multi-state system.

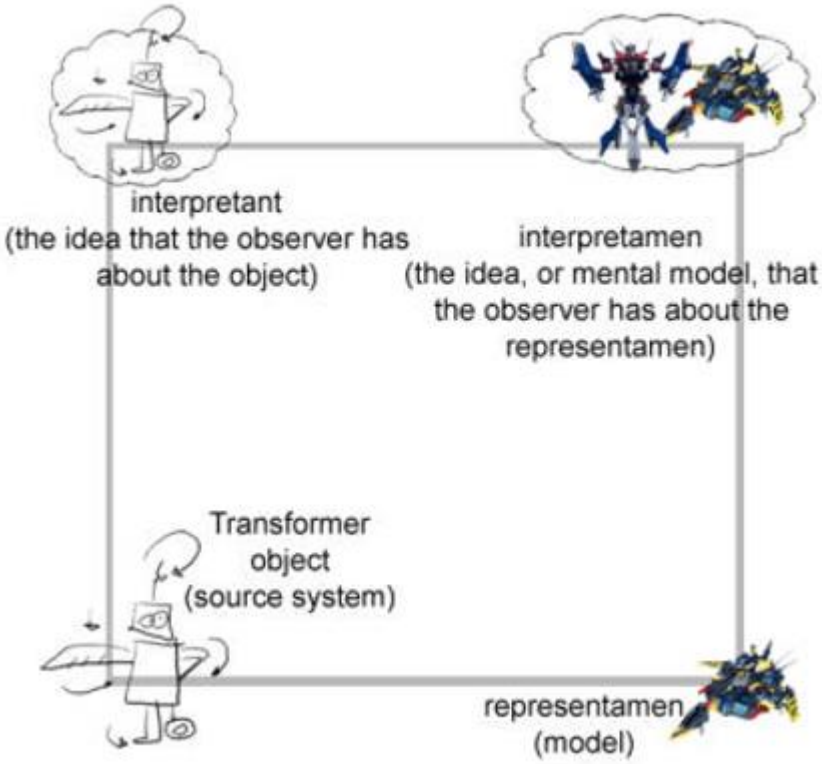


Figure 14. Augmentation of Pierce's sign model (Frasca, G., 2001)

Parisi offers a similar critique of Pierce's concept of the sign: "Simulations cannot be attached to a permanent form of representation defined by a semiotic structure of signs because they are permanently bound to ungrounding substrates of meaning" (Cheng, 2015, p.125).

Artist Ian Cheng disagrees with semiotic or representational definitions of the computer simulation: "Simulation is not a symbolization or a representation. It is a sandbox of reality's dynamic processes, or like reality's gym. Writers simulate a thousand forking words on the draft page. Boeing simulates new aerodynamic designs in a sub-zero

wind hangar. Athletes simulate low oxygen conditions and new diets in training. We simulate with friends what to say to haters, what to say to lovers. It is a private game we devise when the aliveness of a situation is too complex to really know." (Cheng, 2015, p.113).

Cheng's definition feels similar to Huizinga's Magic Circle concept, in the sense that it is game performed in a delineated environment, or *sandbox* in which imagined rules can be shared and followed. The primary focus on behaviour is understandable given the nature of his work, although it is interesting how little is written about the aesthetic properties of the work, which consist of laboured, cell-shaded artwork, desaturated colour schemes and deliberately dismantled character designs.

Frasca compares the limitations of semiotics as a framework for understanding simulations with Espen Aarseth's theory of cybertexts. Aarseth argued that literary theory wasn't capable of understanding hypertext and adventure games, as hypertext wasn't a fixed sequence of signs but a system that generated them.

Media, Post-media or something else?

Manovich (2002) and Krauss (1999) suggest we are in a *postmedia* or *postmedium* existence, in which the differences between discrete media have eroded to such a degree they are no longer useful distinctions. This approach is appealing in the technologically and contextually fragmented world of CS. Computer simulations have been created with a range of technologies and media, and will inevitably continue to do so in a way which would quickly render a purely media-related approach obsolete. However, completely rejecting the role of media technologies in the production of art creates the risk of generalities, inaccuracies and lack of insight into the behaviours of the artwork.

With this duality in mind, this study operates within the media and art worlds with an equivalent sense of belonging. This stance is inspired by Graham and Cook's (2015, p.6) use of the postmedia approach, in which they give priority to the behaviour of the artwork, followed by a media-based discussion if needed. Their own reticence to fully embrace a postmedia stance is due to new media art requiring "…accurate subcategories of description that can identify the particular behaviours of particular media."

This study gives significant focus to the software components of simulations, and the processes used to create artworks with them. In this sense, this study shares the more overtly technological stance of MIT's Software Studies group, by developing "cultural, theoretical, and practice-orientated approaches to make critical, historical and experimental accounts of (and interventions via) the objects and processes of software." (Cox … Berardi, 2012).

Summary

Postmodernist theorists like Baudrillard, Virillio, Debord and Eco used simulation as an overriding metaphor for visual culture but failed to fully account for their technological, computational or ontological components. However, the processes involved in making computer simulations share similarities with previous artist strategies (modelling, appropriation, indeterminacy, interaction, algorithms and rule-sets) that can be considered in relation to postmodernist ideas, such as authorship and the challenge to semiotics presented by polysemy.

Computer simulations, however, retain idiosyncrasies that require further exploration and understanding beyond existing art practices. The ability to create emergent behaviour is one such idiosyncrasy, which requires notions of authorship, ontology and representation to be reconsidered. Not all computer simulations exhibit emergence, and in these cases previous modes of contextualisation are more relevant.

New Materialist philosophies re-contextualise computer simulations within contemporary art discourse as real objects. Alongside ideas from media materiality research, these approaches establish frameworks for researching the connections between computer simulations and everyday life. Jane Bennet (2010) and Manual DeLanda's (2000), (2015), (2016) ideas about vibrant matter and emergent assemblages, for example, provide language and ideas that may help disentangle the semiotic and material components of the computer simulation artwork.

The Software Studies approach is also useful for this research, due to the focus on how characteristics of media technologies, especially programmable media, can exert a cultural logic. In relation to the natural and environmental aspects of my practice, the media ecology work of Parikka and Maxwell/Miller are particularly relevant and specifically indicate new areas of research and practice.

In practical terms, it is helpful to think about computer simulations as hybrids - combinations of material, economic, social, cultural systems. This is a stance that will need to be explored in more detail during the study. New materialist philosophy provides a framework for thinking about how computer simulation artworks can be simultaneously materially real and socially constructed.

This chapter has explored the most prescient contexts for understanding computer simulations as contemporary art. Aspects of these contexts will be drawn into the practice, theory and reflection that occurs throughout the research. The next chapter provides more detail and rationale for the research methodology.

Chapter 3

Methodology

a) Methodology overview
b) Reflective Practice
c) Discussion of details
d) Summary

This study employs a practice-led methodology and reflective practice approach to develop a theory-informed art practice. Drawing upon the *Framework of Visual Arts Research* (Sullivan, 2005), this process will be iterative and 'relational', engaged in a continuous cycle of reflective enquiry that informs modifications to methodologies as appropriate.

Practice-led research has been defined as "research in which the professional and/or creative practices of art, design or architecture play an instrumental part in an inquiry" (Rust et al., 2007). Practice-led methodologies are often differentiated from practice-based methodologies, in which there is an implication that the practice can stand on its own as a claim for new knowledge.

Approaches to practice-led PhDs vary at an international and institutional level; often between staff in the same departments; a state that MacLeod describes as an "epistemological anxiety" (Macleod & Holdridge, 2009, p.9). This problematises the applicability of art as research and can lead to students re-inventing the methodological wheel in the absence of standardised approaches. This study avoids making a claim for an innovative methodology and instead builds upon existing frameworks of action research and reflective practice.

New knowledge will be generated through theory and practice, specifically the thinking, planning, making, documentation and exhibition of artistic practice undertaken over five years of doctoral candidacy. This section seeks to justify this approach and elaborate on the requisite methodological, epistemological and ontological stances.

Within art as research contexts, it can be argued that 'appropriateness' is the key factor in the development of a suitable methodology. The aim of this study is to explore the materiality of the computer simulation in contemporary art, therefore it is appropriate to adhere to a practice-led methodology, in which the tools and processes that are theorised in literature are used as the basis for artistic practice. A key finding from the literature review is that simulation theorists such as Baudrillard, Debord and Eco tend to ignore

media materiality. This adds greater importance to a practice-led approach as it functions to expose areas which aspects of dominant theories cannot account for.

Jones (2002) has criticised the oversimplified, binary dichotomy between theory and practice in Art and Design education. This dichotomy is maintained via *knowledge on reflection,* in which practice only becomes intelligent through reflection and writing. He uses the term *knowledge in action* to refer to the belief that practice is intrinsically intelligent, without mediation. This study employs both forms in an ongoing, iterative process, designed to create genuine points of intersection between theory and practice.

Reflective Practice and Action Research

Although the origins of reflective practice may well have existed before academia, it was John Dewey's ideas on reflective thinking and metacognition that introduced the concepts to eastern and western audiences in the early to mid-20th century. Donald Schön developed Dewey's ideas in the 1980s, with an increased emphasis on practitioner-led reflection. This approach viewed practitioners' subjective experience in the research process as a strength rather than a liability. "Effective practitioners have the capacity to bring implicit and tacit understandings to a problem at hand and these intuitive capacities interact with existing systems of knowledge to yield critical new insights" (Sullivan, 2005).

A certain degree of mapping terminology from these models to art practice is required as reflective practice and action research were developed in educational contexts, often with a focus on professional learning. The underlying intention is to improve workers' skills and thought processes to become more optimal and efficient at their jobs.

Reflection is used here to mean thinking about events and actions, whether past or present, in order to inform future events and actions (Reynolds, M.,2011, p.5). Reflection is used to analyse which aspects of theory require working out through art practice, and which aspects of practice require underpinning with theory.

Dewey defines reflective practice as "… the sense of a problem, the observation of conditions, the formation and rational elaboration of a suggested conclusion, and the active experimental testing." (Dewey, 2015, p.151). Dewey's process matches the process undertaken during this thesis, although here with three iterations.

Action research shares similarities with reflective practice. McMahon (McMahon, 1999) suggests that both approaches involve reflection on experience yielding potentially transformative results. A key difference is the necessity for action research to contain *strategic action*. McMahon (1999) defines strategic action as "a deliberate and planned attempt to solve a particular problem or set of problems using a coherent, systematic and rigorous methodology." In this thesis there is a directionality of purpose after each phase of art practice which synchronises with the term *strategic action.* This may take the form of

an idea for a new piece of work that explores a specific recalcitrant aspect of theory, or a desire to undertake more reading and research around a particular area of theory. In this sense, the artwork occupies the role of strategic action in McMahon's model.

Successful reflective practice can be identified in the following ways. *It elucidates the connections between theory and practice*. Doloughan argues that successful fine art doctorate submissions display "textual elucidation and critical (self-)reflection on the part of the researcher, as well as validation from the examiner who must be satisfied that the candidate has displayed "an understanding of the ways the practice is related to theory, in relation to the specific work being undertaken" (Doloughan, 2002).

It has transformative impact. "The radical educationalist Paulo Friere observed, […] to reflect from a critical perspective means acting on the world 'in order to transform it'. The implication being that if reflection does not lead to action, it cannot be said to have been critical" (Reynolds, 2011, p. 9). The art practice that runs throughout the research can be considered 'action'. Although it might be tempting to conflate this term with the academic concept of research impact to a wider audience, the aim is to consider impact at a local level, within the scope of the research, art practice and theorisation of it.

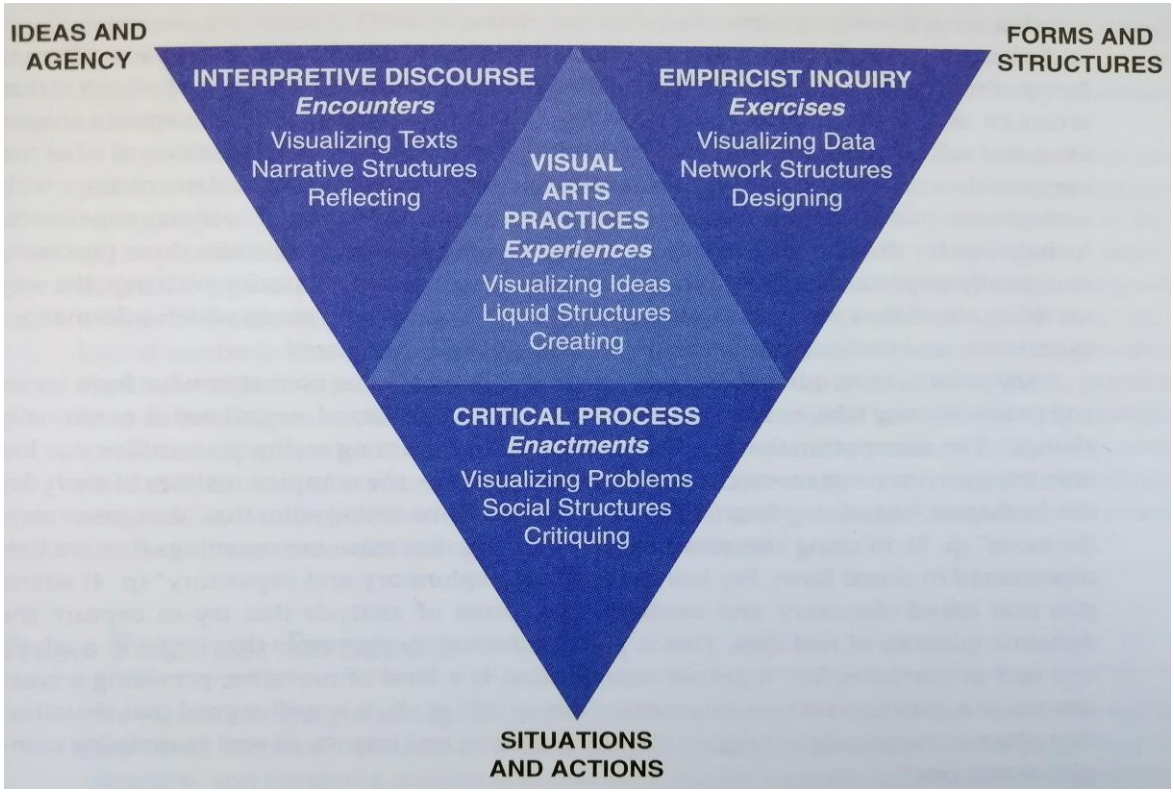


Figure 15. Sullivan, G., (2010, 193) *Framework of Visual Arts Practices*

Sullivan's (2010, 193) *Framework of Visual Arts Practices* (Figure 15) places practice at the centre of interpretivist, empiricist and critical discourses. This is a useful model for understanding the ontological and epistemological characteristics of the research methodology employed in this study.

Edmonds' (2010) *Trajectory Model of Practice and Research* (Figure 16) adds further articulates how theory and practice will relate to each other over the course of the research. Figure 16 illustrates how the production of artwork (W) can theoretically correspond to theoretical criteria (C), frameworks (F) and results produced from evaluation (R). Edmonds uses the term *framework* to mean "a conceptual structure used to influence practice, inform theory and, in particular, shape evaluation" (Edmonds, 2010, p. 472).

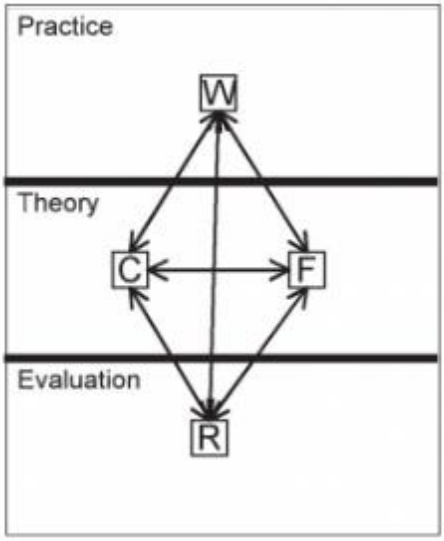


Figure 16. Edmonds (2001) *Trajectory Model of Practice and Research*

Edmond's model identifies the relationship between theory and practice through a robust data collection of ten case studies and semi-structured interviews with artists undertaking PhDs, including artists working with digital technology. The directionality of the arrows in the model allow for the possibility of the artwork, theory, frameworks and results to happen in different orders and sequences.

The key aspects of the model that indicate suitability for this thesis are: 1) it provides a scaffold for connecting theory and practice through iterative stages; 2) There is a focus on questioning the validity of larger thought structures in addition to one's own practice; 3) This process occurs reflexively and neither have natural superiority.

In practical terms, I employed the following strategies as part of a practice-led methodology:

- Development, production and exhibition of art works;
- Sketchbooks and reflective diary as a means of documenting and developing reflective practice;
- Round table discussions with experts and practitioners within the field.

Responses from the exhibition of work, either from gallery or online shows will be documented via videos, photographs, visitor statements, discussions and reviews. The methodological focus, however, is on uncovering new knowledge via making, and not audience reception.

Intensive reading and writing will be undertaken whilst generating ideas for artworks. This will subside whilst the research and development stage for each artwork begins. During this stage software processes and techniques will be researched, learned and tested for suitability, feasibility and relevance to the aims of the artwork. Most of the research and development stages will last for several months. The practice element of each research phase will be designed with the intent of opening up a tangible space for exploration of the research questions. The research and development stage will then be followed by a production stage in which the artwork is made, which again will last several months. The practice elements from each research phase will be exhibited on an annual basis, totalling three separate exhibitions. Although the reflective aspect of the methodology continued throughout the research, it will likely peak after the exhibition, when it is possible to get a sense of how the artwork functioned in a gallery space. Owing to the low-key nature of the first two exhibitions, it may be difficult to obtain extensive reviews and feedback about the artworks.

This study has been approved by the Northumbria University ethics committee board. Aspects of the study such as the exhibitions and roundtable discussions have also been reviewed by the same ethics panel. Further ethics documentation can be found in the Appendix i and Appendix ii.

The next three chapters constitute the main research phases of the study, conducted over a period of 4 years. Each chapter adopts the same structure – context, documentation of the making process, discussion of emerging themes, and a revision of the research aims in light of new information. Sketchbooks were used heavily throughout each phase, in order to document idea development and technical research. Each sketchbook is included on the USB stick, alongside selected documentation and video excerpts from the artworks. The real-time and long duration nature of the work provides certain challenges to experiencing the work outside of an exhibition context. Video excepts have been used to provide a sense of how the work moves.

Chapter 4

Phase One: *Wireframe Valley*

a. Context
b. Edited documentation of the making process
c. Identification and analysis of emerging themes
d. Outcomes and revised research aims

A) Context

Wireframe Valley (2015) was the first practice-based element of this thesis. It is a real-time simulated landscape in which the materials covering the three-dimensional models are programmed to slowly degrade into wireframe forms over a three-month duration. The camera is in a fixed position, and the trees, grass, clouds, birds and pollen move in relation to simulated wind.

Dominic Smith, an artist and curator, asked me to produce a commission for the exhibition *Land Engines* at Queens Hall, Hexham, Northumberland between January and March 2015. Queens Hall is situated in rural Hexham, a market town around 25 miles from Newcastle Upon Tyne. Dominic was keen to increase the length of the exhibitions from 1 to 3 months to give the work more prominence and time to be seen.

The exhibition incorporated work from Mark Tribe, David Blandy and Jen Southern. *Wireframe Valley* (2014) was installed on its own in the upstairs room of the gallery projected in SD onto a screen. During the exhibition I was invited to do a talk, which was an opportunity to disseminate some of the ideas behind the work.

Queens Hall considered taking photographs of the work and uploading them daily to document how the work was changing, although they didn't have the marketing capacity or staff to pursue it. I was curious how this might work, but ultimately preferred that people see the work in the gallery context.

The research questions for this Phase were:

- What characteristics do computer simulated artworks have?
- What theoretical frameworks are most suitable for making sense of these practices?

B) Edited documentation of the making process for Wireframe Valley

The making of *Wireframe Valley* (2015) took 7 months to complete, and included the following activities:

- collection of source photographs from Simonside, Northumberland
- digital creation of the terrain and textures using *World Machine*, *Maya* and *Photoshop*
- research and development into how to create the time logic using the *CryEngine* visual scripting system,
- animation
- lighting
- compiling
- testing of the work.

A previous project entitled the *Two Way Mirror* series (Figure 17) can be seen as a precursor to *Wireframe Valley* (2015), in which virtual cameras are placed behind or under terrain inside game engines. The reverse side of polygons appear transparent, resulting in images constituted by a combination of transparent and rendered polygons. The sky texture shows through whenever a polygon is transparent.

This series examines the role of surface in the construction of game worlds, and the thinness of the threshold that constitutes an object's presence or non-presence. There is an ontological curiosity about the simulated world inspired by videogame mod art, and Harun Farocki's *Serious Games* series, especially *IV: A Sun Without Shadow* (2010). In this work, Farocki explored how videogame simulations are used to treat post-traumatic stress syndrome in US soldiers on return from war.

Figure 17. Still from Dolan, Paul *Two Way Mirror* series (2013)

In *Wireframe Valley* (2015), the material degradation of the work can be considered as a process of self-destruction. This element of the work emerged from a desire to explore how representation functions within computer simulations, by exposing

the mechanics of the game engine image. Whereas the real-time *Two Way Mirror* series occurred after a destructive intervention, *Wireframe Valley* (2015) makes the process of self-destruction the defining behaviour of the work.

Extensive research and development was undertaken to solve the technical problem of programming material changes over an extended period of time. Videogame time systems are intended for short durations - a minute, an hour, as appropriate for commercial videogame play structures. In this case the work was required to last for the duration of the exhibition, which was three months. Online documentation for *Flowgraph*, the visual scripting system inside of the *CryEngine* game engine software was sparse, so each *time node* was tested to understand its functionality. Experiments were screen-grabbed and stored in a *PowerPoint* file called Time Experiments.

This process led to the final time logic in Appendix vi, which shows the ‘game start’ node, which inititates the code, followed by the ‘seconds counter’ nodes which simulates a clock and culmulatively adds the values. The ‘failsafe’ node can be used to enter in a value of seconds since the exhibition began in order to restart the work from a specific point in the event that it crashes. The ‘Debug Purposes’ nodes print text to screen to confirm how much time has elapsed in the work. The ‘CVar Effects’ uses a longer list than displayed, but essentially switches on a different render view once the time counter reaches specific time ranges. This approach constitutes a first attempt at triggering events over long durations and was developed into a more complex format with later artworks.

The terrain mesh was developed in parallel with the time logic. Working from source photographs taken at Simonside, Northumberland, aesthetic considerations such as scale, colour, texture and composition were developed through sketches and software experimentation. The view from the top of Simonside hills provided a landscape that felt at home within rural Hexham where the work would be exhibited.

Turner’s *Raby Castle (1818)* contained similar topography and perspective from the top of the Simonside Hills, Northumbria (Figure 18) which created a useful point of reference although it was difficult to construct terrain from these perspectives. Game engines are only technically capable of rendering nearby terrain elements in detail. Mid and background areas of landscapes need to be modelled and rendered at a much lower quality to maintain the frame rate of the videogame. The reference photographs contained too much mid and background space which would have overall decreased the sense of photorealism in the work. In turn, this would have decreased the impact of the material change from material to wireframe. As a result, the work was framed and composed in the software in a way that emphasised the foreground elements and maintained a sense of detail and resolution.

The construction of the landscape involved the creation of a polygon mesh for the terrain in several software packages. The original mesh was created in *Autodesk Maya*, additional detail was added in *Mudbox*, before moving into *World Machine* to simulate procedural weathering details such as soil erosion and weathering effects with a node-based system. Finally, several texture maps were extracted from *World Machine* for different heights of the terrain, which were assembled in *Photoshop* and then applied to the mesh inside of the game engine. These textures would be visible in the background of the scene, on the distant hills. High-resolution close-up textures such as grass and soil were painted on to the terrain mesh inside of the game engine using pre-existing foliage textures. The separation of near and far assets is necessary due to the game engine only rendering objects near the camera at full resolution to maintain a satisfactory frame rate (above 30 frames per second).

Many project files and compositions were tested before the final work came to fruition. Controlling the scale of the terrain was challenging as it only became clear how large the topological details of the terrain surface were at the end of a complex and time-consuming sequence of software processes. This made it impossible to accurately preview the scale of the terrain until it was inside of the engine, by which stage, it was difficult to fix scale issues.

The workflow has a dimensional hybridity to it, with the shape of the landscape frequently oscillating between two and three-dimensional objects during its production and presentation on screen. For example, the terrain began as a three-dimensional mesh, which after being sculpted in *Mudbox* sculpting software, was converted, or *baked* down to a series of two-dimensional images - a monochrome image file called a *height map* which the engine reinterprets as height data (black – high, white- low), and an image containing the colour and texture details of the landscape, which was further manipulated in *Photoshop* before being re-connected with the height map in the engine.

Different visual strategies for conveying the sense of destruction over time were developed, some of which threatened to divert from the core idea of the work. Some were not possible through *Flowgraph* and required a programmer to create a custom solution in C++. It was not, for example, possible to render wireframe materials on to individual objects in a scene without advanced programming at the time of making the work. Gradually blending from a standard material to a transparent wireframe material also required custom shader programming.

This problem was solved by working backwards from the affordances of the game engine. Experiments were performed with the console system in *CryEngine,* in which different commands can be entered to access different render modes of the game space. Developers use console commands to quickly check the functionality of game mechanics

that are usually hidden from view. For example, ‘E_terrainBBoxes=1’ would render outlines around separate terrain textures.

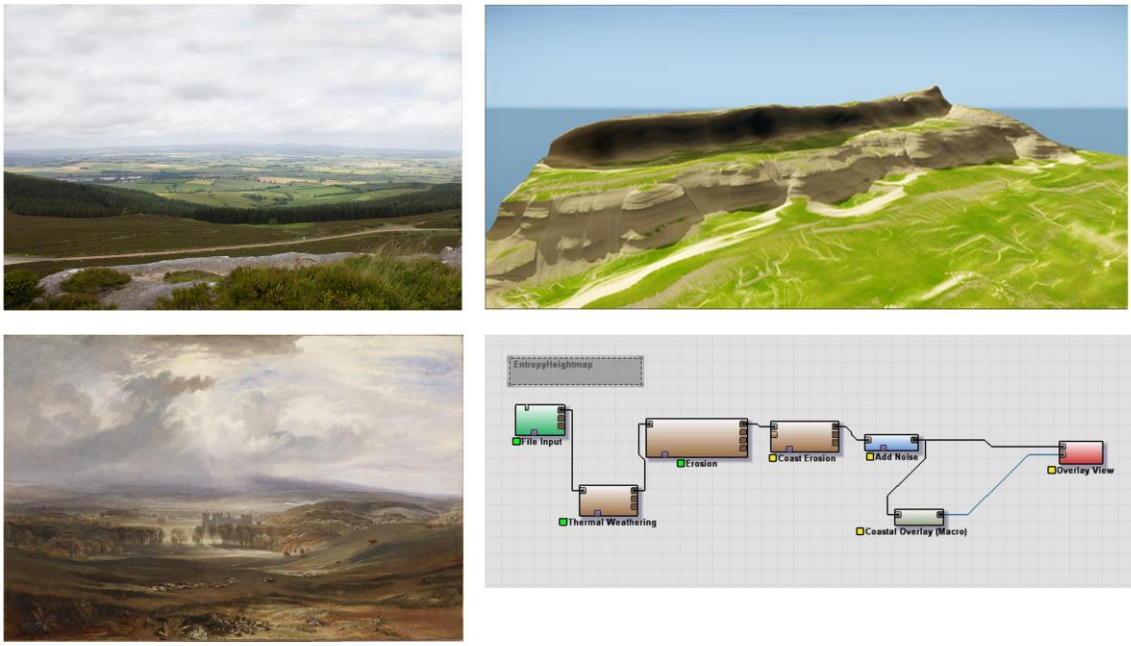


Figure 18. Top and bottom left: Comparison of Turner's *Raby Castle* (1818) and the view from Simonside peak - artist's own photograph. Top right: reverse view of the simulated terrain in Unreal Engine. Bottom Right: node structure used to replicate natural weathering and erosion effects in *World Machine.*

Instead of the work operating as a seamless sequence of gradual destruction, as was originally intended, the work became a programmed sequence of debug visual modes (Figure 19) triggered to switch upon the internal clock reaching pre-defined time ranges. This means there is a noticeable transition between the different states of virtual degradation as the work progresses.

A script was also created to remove the first-person player from the scene (including the players arms and weapon) and prevent any input devices from being able to move around the scene. In other words, the camera was programmed to adopt a fixed position. This functionality already exists within game engines to prevent player input during cut scenes and cinematic sequences.

Final visual tweaks were made to lighting, colour grading and weather system parameters before the work was exported as an executable file. This file was tested over a few weeks at home before the installation to check for bugs and issues encountered by running the PC for months at a time. The PC was installed in a concealed cupboard space in the gallery with the work being projected at 1920 x 720 onto a screen. The room was otherwise empty apart from benches to encourage people to sit and watch the work for an extended period of time.

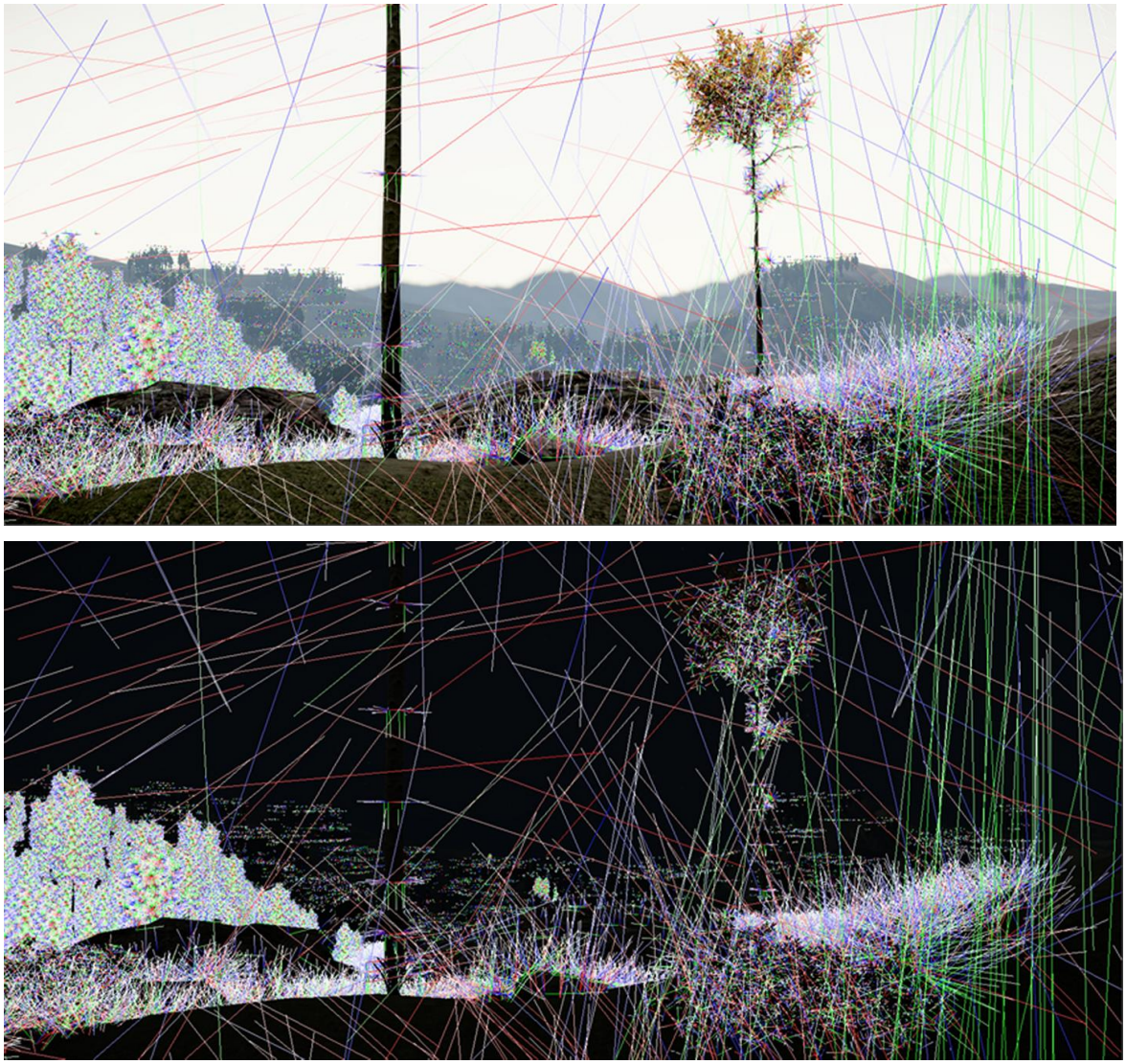


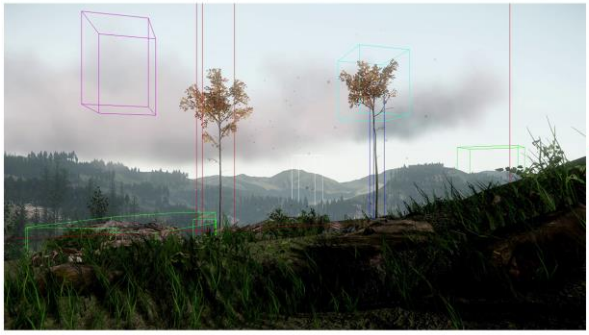
Figure 19. Examples of debug nodes in *Wireframe Valley* tests

During the exhibition the frame rate of the work dropped, causing the animated elements (trees, grass, clouds, birds) to move slowly and jerkily. This was an unintended outcome but contributed to the concept of the work at a material level of the computer hardware itself. Unintended consequences were a likely outcome of working with a parameter driven simulation over a long period of time.

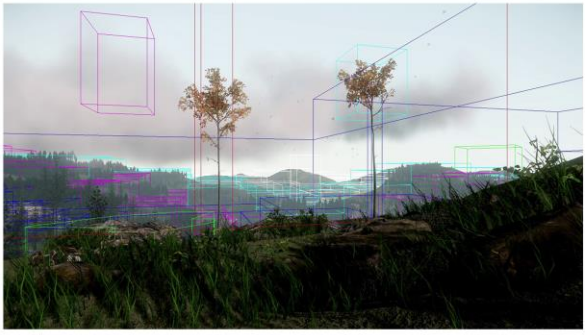
The work would have had to be finished at least three months ahead of the exhibition in order to test it all the way through. Even if this was the case, and there was an error, it would require further weeks to fix it and another three months to re-test it. It was a high-risk way of exhibiting work, especially as the first piece of work to be used for a PhD.

DAY 1-7
Debug mode: none

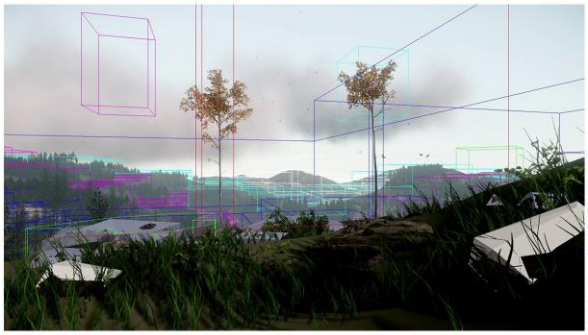
DAY 7-14
Debug mode: display pollen as polygons



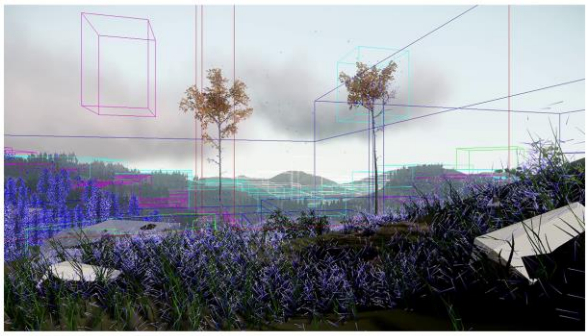
DAY 14-21
Debug mode: draw areas



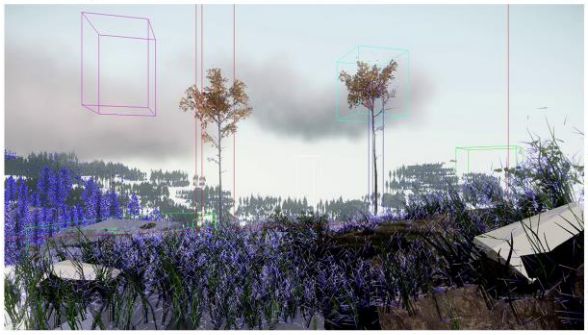
DAY 21-28
Debug mode: terrain Bboxer



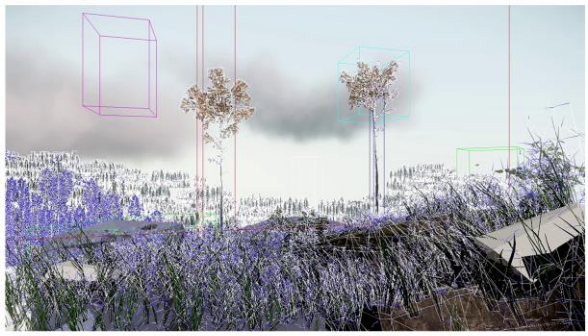
DAY 28-35
Debug mode: p_Draw_helpers



DAY 35-42
Debug mode: show lines



DAY 42-49
Debug mode: show tangents



DAY 49-56
Debug mode: show normals

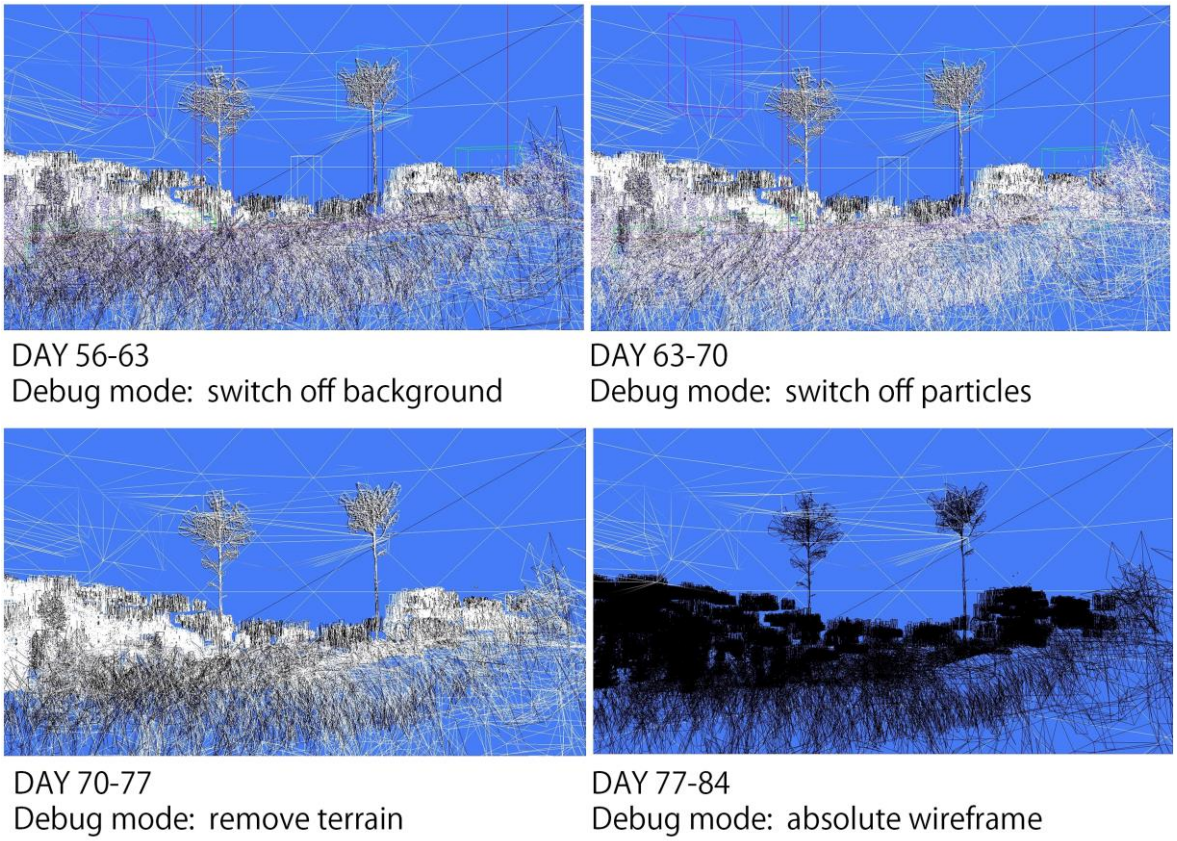


Figure 20. Continued from previous page. Screenshots showing the debug node sequence employed in *Wireframe Valley* (2015)

C) Identification and analysis of emerging themes

This section attempts to reconcile the theory and practice gap by discussing emerging themes from the making process of *Wireframe Valley* (2015) in relation to theory and art history. The main themes that emerged from the making of the artwork were: *self-destruction, space, time, the algorithm, representation vs simulation, authorship and affordances*. This section will discuss each before drawing conclusions and making changes to the initial research questions.

Self-Destructing and Auto-Destructing Artworks

The relationship that *Wireframe Valley* (2015) had to other self-destructive artworks was only uncovered as I finished the work itself. This is documented within the findings section rather than literature review in order to preserve a sense of chronology to how knowledge was uncovered during the research.

Wireframe Valley (2015) bears some resemblance to previous uses of self-destruction in art, although is ultimately responding to a different world in which simulated media play a more significant role. The early 1960s saw a rise in the number of artists,

such as Yoko Ono, Jean Tinguely and Gustav Metzger incorporating self-destructive processes into their work.

Figure 21. Installation shot of Dolan, Paul, *Wireframe Valley (2015)*

For Yoko Ono, George Mancunias and other artists working under the Fluxus title, destruction was an act of aggression against the bourgeois art world and the commercial status of art objects. Destruction, ephemerality and sets of instructions were key in Fluxus artworks and performances. Ono's *Smoke Painting* (1961), a set of instructions to place a canvas near a burning cigarette, was performed with a candle, leading to the gradual singing and burning of the canvas. Mancunias' controversial performance of Philip Corner's *Piano Activities* in Wiesbaden, 1962 led to the destruction of a piano in front of a live audience. The use of instruction sets shares similarities with the use of algorithms in computer simulations: variations occur around a set of established parameters.

In 1960, Jean-Tinguely's *Homage to New York* was exhibited in the sculpture garden of MOMA, New York. It was a 23x27ft assemblage of bike wheels and objects, painted white, that took three months to build and 27 minutes to destroy. Tinguely rigged the work to set fire on its own accord, although the fire service were asked to speed the process up (Landy, M., 2009). Members of the audience took parts of the work home with them as souvenirs. Tinguely described the work as a liberation from the fixedness of materials, a way to celebrate, as the title suggests, the ephemerality of the city itself. A later work, *Study for the End of the World No 2* (1962) became a more overtly politicised critique of the "aesthetics of the nuclear desert", responding to the way in which the cold war and fears of an imminent nuclear attack were aestheticized in media coverage

(Nardelli, 2014). The assemblage contained found objects, dolls and scraps of metal rigged to explode with dynamite in the desert outside of Las Vegas.

Figure 22. Tinguely, Jean, *Study for the End of the World no.2* (1962)

Although Tinguely's work has been canonised, during the 1950s and 1960s Gustav Metzger had already explored auto-destructive art through painting with hydrochloric acid, publications, a manifesto, and symposium. For Metzger, the key principles of auto-destructive art were that the work must contain "an agent which automatically leads to its destruction" within a twenty-year time period, and it must be viewed publicly rather than for a select group (Metzger, 1960). The shared public component of destruction in Fluxus and Tinguley and Metzger's work emphasises the importance of being present for the process of destruction, which synchronises with the general shift from art object to art process during this time. Additionally, Metzger and Tinguely wanted to confront audiences with raw, un-mediated violence, to take part in and comprehend the horrors of war, capitalism and nuclear annihilation (Figure 22) and (Figure 23).

These themes were present in the work of 'land artists' such as the Robert Smithson, although the impact of human initiated destruction was now focused on material consequences rather than the social and spiritual. Smithson's canonical *Spiral Jetty* (1970) is a large outcrop from the Utah coast line built using mud, basalt rocks and

salt crystals, built to gradually succumb to weather and the elements over a long period of time.

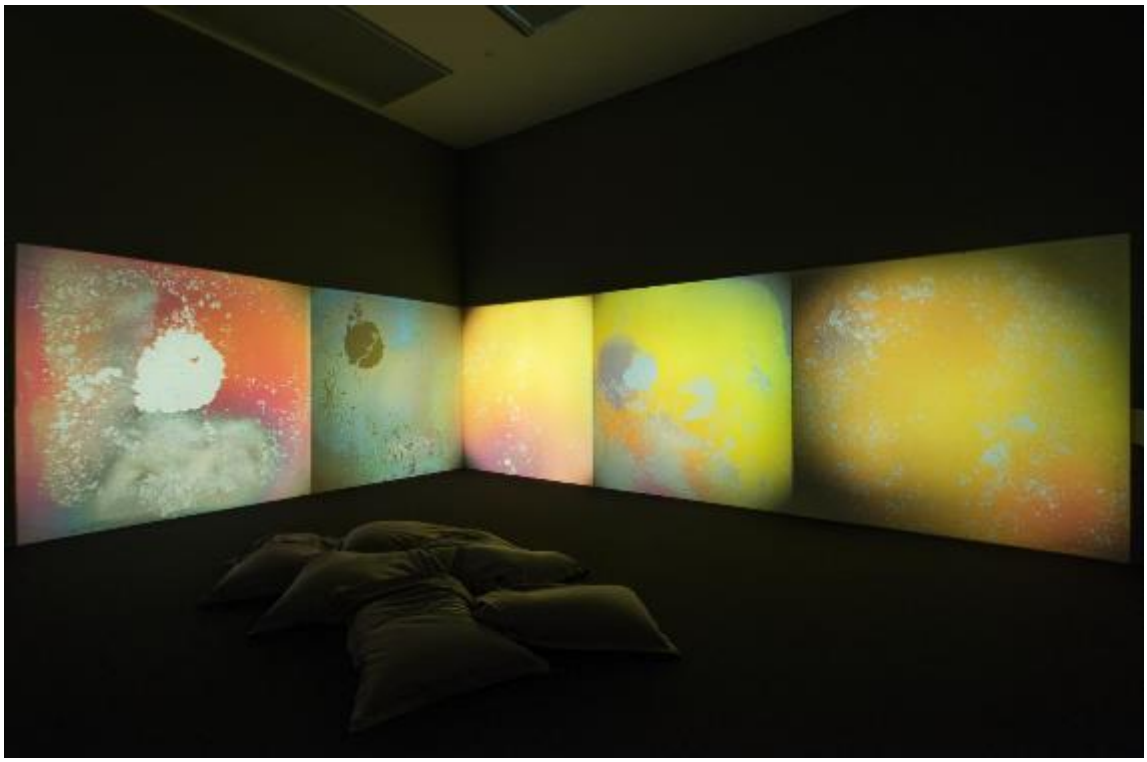


Figure 23. Metzger, Gustav, *Liquid Crystal Environment (1965, remade 2005)*

Like other examples of art made from natural materials, it would not be accurate to describe *Spiral Jetty* as self-destructive. It does not contain a code, agent, or algorithmic impetus to self-destroy, the materials are weathered and slowly eroded by wind, water, sand and rocks. As such they are more accurately described as impermanent or transient artworks. Smithson was interested in entropy and the diminishing energy and order of objects over time. These ideas fed into the idea development process for *Wireframe Valley* (2015), although they were too underdeveloped to foreground in the artwork.

Thijs Rijke's work is more evocative of the new materialist concerns of how human and non-human agents interrelate. *Suicide Machine V 2.0* (2013) is an industrial motor that powers a saw to gradually cut through its own components. Rijke describes the work as an experiment to see if humans are capable of feeling empathy for non-humans. There are also precedents for videogame artworks that use destructive processes. Artists Joan Heemskerk and Dirk Paesmans (known as JODI) modify existing videogames to create artworks. In *Ctrl-Space* (1998-99) and the *Jet Set Willy Variations* (2001-2) JODI modified existing videogames to the point of abstraction and non-functionality.

This work fed into ideas about displaying wireframe components and programming the degradation of videogame media in *Wireframe Valley* (2015). Videogame art is often discussed in relation to Dadaist and Situationist strategies of appropriation (Clarke &

Mitchell, 2013), (Sharp, 2015), (Schrank, 2014) in that some processes can be described as a sabotaging or détournement of the original media.

During this phase of the research there was a hunch that art historical notions of appropriation were complicated by real-time artworks, especially those constructed with game engines, which are designed to be used as tool kits containing pre-made elements. *Wireframe Valley* (2015) made use of pre-made trees, grass, birds and clouds models and textures, although they were modified parametrically during the making of the work. Other elements, such as the terrain, were created from scratch. The work does not consist solely of appropriated imagery, but as a combination of readymade (trees, grass) and custom made (landscape, textures) elements. At this stage, further research and reflection were required to draw out new knowledge in this area.

Unlike the artistic uses of self-destruction explored here, *Wireframe Valley* (2015) aims to challenge the representation of 'the natural' and its construction via technology rather than capitalism or war. Starting with a sublime, peaceful landscape, the visual display of the work became progressively more structural and machinic, revealing layers of graphics intended only for developers to use as guides in the production process. The choice to leave the software running for three months pushed the code beyond its capabilities, destroying the fluidity of conventional game time. The frames per second dropped from 40 to 3, reducing the progression of images from smooth and realistic to stuttering and machinic.

The Aesthetics of Debugging

Wireframes are the most basic visual representation of three-dimensional space as points and lines, which strip away photorealistic techniques such as shading. Mitchell (1994, 132) compares computer wireframes with aboriginal 'x-ray' paintings in which the internal organs and bone structures of animals and humans feature as part of the image. Although common during the early days of computer graphics, they are now resigned to debug drawing modes, which are used in *Wireframe Valley* (2015) to visually reveal the tools and underlying mechanics used to construct the image. It is also possible to find historical precursors in Ned Greene's *Untitled Landscape (1983)* (Jankel & Morton, 1984, 96/97) and other early CGI techniques for representing landscape and terrain. These examples relate more to technical innovation rather than a conceptual or critical stance.

Debug drawing modes are one set of many tools used by developers during the production of videogames and computer simulations that audiences do not see. They can be used to check models for issues that may be easier to see in wireframe mode, like overlaps and incorrectly placed models hidden under surfaces. Due to the mathematical complexity of computer graphics, debug drawing modes provide developers with coloured

lines, simple shapes and 3D text that help make decisions about how objects should operate within the virtual space (Gregory, 2014, p. 416).

Such visual elements fall under Galloway's (2006, p. 7) definition of *non-diegetic game elements*: "gamic elements that are inside the total gamic apparatus yet outside the portion of the apparatus that constitutes a pretend world of character and story." In this sense, *Wireframe Valley* (2015) can be seen to move slowly from diegesis to non-diegesis.

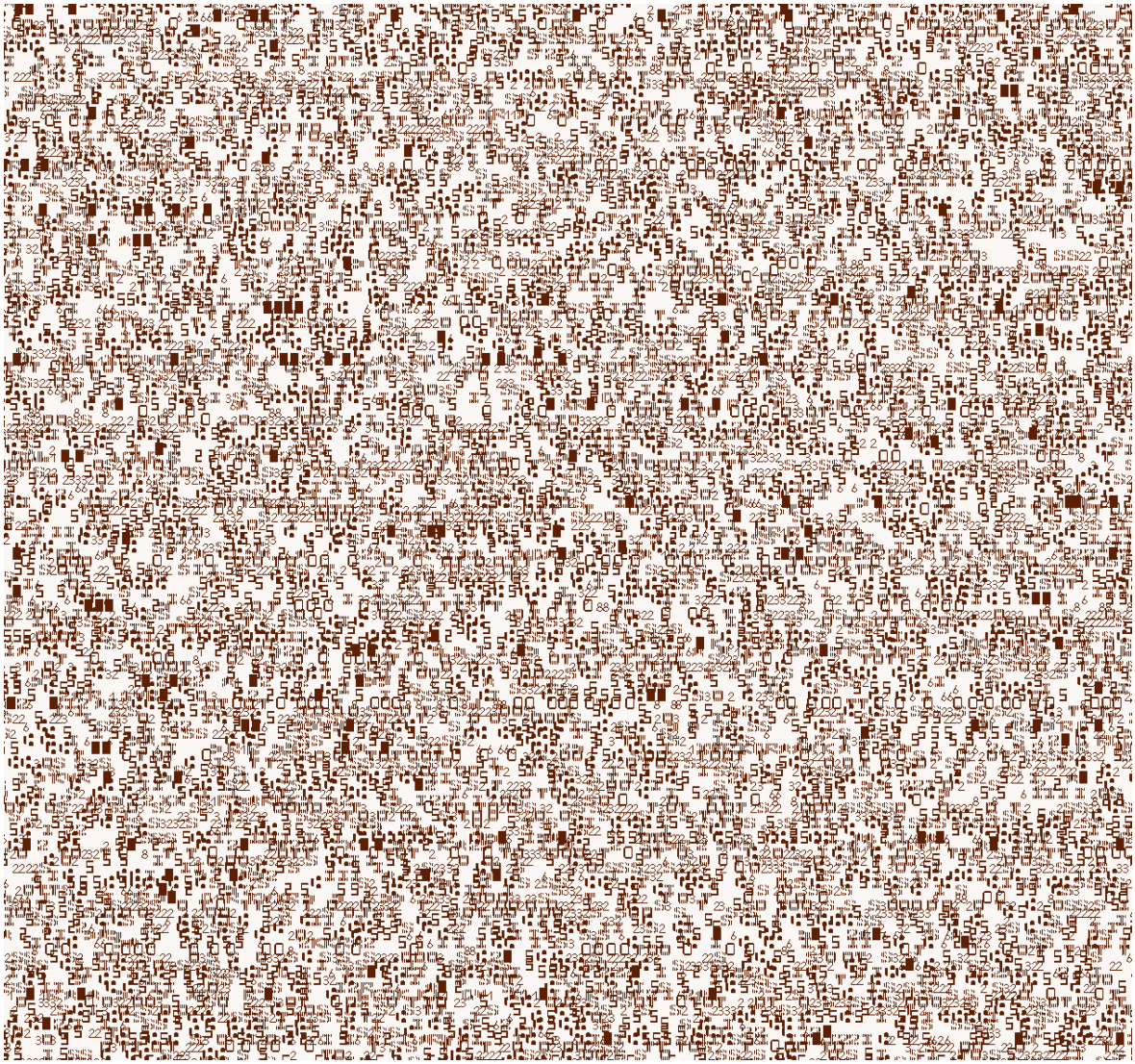


Figure 24. Muller-Pohle, Andreas, *Digital Scores (after Nicephore Niepce) (1995)*

Eivind Rossaak uses the work of Andreas Muller-Pohle to explore these ideas. Figure 24 shows *Digital Scores (after Nicephore Niepce)* (1995), a series of images of alphanumeric signs generated from the digitisation of the oldest existing photograph. In his articulation of algorithms made visible, a connection with the simulated images of *Wireframe Valley* (2015) can be made: "…if this process [making the algorithmic visible] is arrested to reveal the codes conditioning these operations… the impression will denigrate

the image as we know it" (Rossaak, 2014, p.192). Debugging is a useful technique for visually finding fault in digitally constructed images and by making visible the processes (debugging and error checking) used in computer simulation production.

Diegesis and Non-diegesis

The theatrical and cinematic concepts of diegesis and non-diegesis can be comfortably applied to videogame space (Galloway, A., 2006, 7), (Tavinor, 2009, p.74) and (Wolf & Baer, 2002) and therefore the simulated space of *Wireframe Valley* (2015). Egenfeldt Neilsen et al (2008) refer to this distinction as *on and off-screen space*, with off-screen space further dividing into *passive* and *active* categories. Passive off-screen space "logically exists but nothing happens out there" and active off-screen space involves loaded actors waiting beyond viewable play space, ready to act upon player proximity or action. The off-screen space of *Wireframe Valley* (2015) consists of partially textured and empty spaces, hidden unless viewed in editor mode, where the entire space can be navigated. The player's ability to move and rotate the view has been deliberately locked down using visual scripting, to present the work as close as possible to a conventional landscape photograph or painting. The functionality to restrict player movement is often used during cinematic and dialogue scenes where the videogame directors don't want player input to interfere with pre-planned compositional choices.

Editor Space and Run Time Space

There is difference in space within game engine software depending on whether the project level is being viewed in editor mode (within the software interface, with editing tools visible) or having been compiled and exported into an executable program for distribution to an audience (in which only the artwork itself is visible). This is akin to the difference between working on the animation within the software and viewing the rendered images as an edited animation. In editor mode, there is a seemingly infinite empty space that the virtual camera can be tumbled, rotated and moved around. At this stage, the developer is immersed in non-diegetic space and can initiate run time mode to see through the player's camera. This allows the developer to see what the work will look like once it is 'finished'. Once compiled and exported into an executable file, the camera obeys the rules programmed by the developers, the player is locked into diegesis and 'editor space' is generally invisible and unnavigable, unless exposed by a player cheat, mod, config edit or glitch. In this sense, CS space is reconfigurable and is dynamically constituted as different arrangements throughout the production and exhibition process.

The Collision World and the Render World

Collision meshes are simplified shapes surrounding game objects that dictate which parts of an object are 'solid' or physicalised within game space. Collision debug modes can help identify holes or overlaps with objects that might cause gameplay issues such as a character not being able to walk through a doorframe, or falling through a hole in the floor that is invisible during normal gameplay.

In videogame culture, cheat codes (such as 'NOCLIP') can be entered via console command to allow players to walk through walls. In technical terms, the cheat code switches off the collision geometry allowing the player to navigate beyond the diegetic confines of the game into non-diegetic space. Cheat codes save developers time during the production process - "You often don't want to be bothered about having to defend yourself from enemy characters… as you test out a feature or track down a bug" (Gregory, 2014,428) and are occasionally left in the game for audiences to discover and play with.

Game objects like trees, houses, characters and so on, exist in the space as a combination of visual representation, physical representation (if the objects are 'solid' or not) and a code-based representation. How does this contribute to an understanding of representation within art discourse? If the solidity of an object has not been modelled, they are purely visual representations (as far as presence within the software, they still have a physical presence on a hard drive as data), and do not possess the ability to interact with the physical and dynamic systems of the computer simulation, such as gravity.

The Virtual Camera

It is essential to acknowledge the role of the virtual camera in the production of images in *Wireframe Valley* (2015). The phrase "virtual camera" is attributed to Poole (2000, p.88-91) and describes software tools built around the functionality of traditional cameras. The use of a camera as software metaphor remediates concepts from film and photography, focal length, aperture, filters, for example, but also extends them. Virtual cameras can control how much of the space is rendered within a 'clipping range' and dictate the proximity to camera required for objects to render.

Crucially, virtual cameras can also be programmed. In *Wireframe Valley* (2015), the debug modes were executed via automated command lines within a timer set up. This relationship between text, code and image emphasises the programmability of the aesthetic. "An in-game console provides a command-line interface to the game engine's features, much as a DOS *command prompt* provides users with access to various features of the Windows operating system…" (Gregory, 2014,426).

The Algorithmic Landscape

The aesthetics of *Wireframe Valley* directly reference landscape painting and rural, natural environments. This was prompted by Stanley Fish's reader response theories and an interest in the technological constructed-ness of 'the natural' as an idea. This is documented in an audio diary tested as a possible documentation strategy in the early stages of the research: "…the kind of skeletal, wireframe nature of the work is a visual device to strip back the landscape… it incorporates ideas from Stanley Fish's ideas of… the piece of work itself has no meaning, it's sustained by communities of agreement… people who are projecting and maintaining ideas onto the work. Therefore, in a lot of ways, the structure, the wireframe to me is all kind of indicative of… the hooks that we place our ideas about art on." (Audio diary, 20.11.14).

Wireframe Valley (2015) was also an attempt at trying to understand the natural through the lens of postmodernist simulation theory. This was especially prescient in Queens Hall, Hexham, which is an agricultural town surrounded by countryside. I was interested in whether the computer simulation would evoke ideas about Baudrillard and the map overtaking the territory. Guest book and feedback slips were collected from the gallery although there wasn't much useful data. Many of the comments related to whether videogames could be regarded as art, which indicates perhaps the text and explanation of the work could have perhaps more clearly foregrounded the concepts over the technology. It also suggests that a different approach is required to capture useful data on the reception of the artwork. A roundtable discussion may be useful for the next phase, in order to capture peer's thoughts in addition to that of the audience.

The curatorial guise of the exhibition as a selection of artists working with videogame technologies had likely wrong-footed reactions to the work by contextualising it within a form of popular culture being used as an art form. The question of whether or not videogames can be considered art can be so time consuming and elliptical that it reduces the amount of attention given to other, more pertinent discussions about the work.

During the production of *Wireframe Valley* (2015), I had a growing sense of dissatisfaction with the immateriality of the computer simulation as posited by postmodernists. The sheer amount of labour and time taken to make the work undermined the description of simulacra as effortlessly displacing the real in an abstract and immaterial process. It is important to note the labour that produces simulated environments and spaces. Tavinor (2009, p.68) notes that *Grand Theft Auto IV* is "reported to have cost around US$100 million to produce." To cite a more relevant example, John Gerrard employs a small studio to make his simulations.

I was interested in making a landscape that was driven by algorithms and what impact this might have on the work and its meaning. During phase one of the research, the algorithmic components were under-theorised, although they did form a large part of

the work by helping to model a time system that drove the animation and changes to the debug modes.

Modelling time in the game engine

Wireframe Valley (2015) ran for a three-month period without pause. Although there are many examples of extended time being used within film and video art (Douglas Gordon's *24 Hour Psycho*, Andy Warhol's *Empire*) real-time art constructs time differently, as each frame is rendered afresh depending on the current structure of the code, before being replaced by the next. Computer simulations and videogames are often referred to as 'real-time', in that they are not playing back pre-rendered images like video, but unfold live on screen as the work takes place. In videogames, this allows for player input to be accounted for. The specifics of real-time are rarely discussed in relation to art, partially because of the complexity of how it works, and partially because of the preference for focusing on artwork behaviours rather than media.

Videogame literature is more sympathetic to the variety of ways in which time can be modelled and simulated. *Game time* refers to the speed at which time elapses within a videogame world, but can be useful for thinking about time within a computer simulation. "We can define a *game timeline* that is technically independent of real-time…If we wish to pause the game, we can simply stop updating the game timeline temporarily. If we want our game to go into slow motion, we can update the game clock more slowly than the real-time clock. All sorts of effects can be achieved by scaling and warping one timeline relative to another." (Gregory, 2014, p.346). Importantly, a pause does not stop the main game loop - the executable code is still running alongside the main program.

Technically, real-time refers to just one method of time production within game engines - a counting system synchronised with the machine's CPU clock: "We can think of times measured directly via the CPU's high-resolution timer register as lying on what we'll call the *real-timeline.* The origin of this timeline is defined to coincide with the moment the CPU was last powered on or reset. It measures time in units of CPU cycles (or some multiple thereof), although these time values can be easily converted into units of seconds by multiplying them by the frequency of the high-resolution timer on the current CPU" (Gregory, 2014, p.346).

It is important to consider the hardware's role in how game engines construct time. Without a powerful enough graphics card, the game will not be able to render images fast enough and the FPS will drop. The CPU speed, measured in hertz (Hz) is also an essential component in maintaining the playback speed of the simulation. Hz and FPS are considered to be interchangeable (Gregory, 2014, p.348). FPS are based upon the optimal point at which still images appear to be animated, and upon the natural refresh rate of PAL and SECAM colour television signals (Gregory, 2014, p.349).

By experimenting with the nodes used to model time in *CryEngine* I found game time can be constructed in the following ways:

- *Synchronised Time*: simulation time syncs with the internal clock of the computer it is being played on (for example to simulate the local time zone of a particular country).
- *Abstract Time*: simulation time is algorithmically programmed to be faster or slower than real-time, for example, how the day-night cycle in *Skyrim* takes 30 minutes rather than 24 hours.
- *Static time*: a time of day is visually or auditorily referenced but not functional (sky textures are fixed at 6am sunrise, for example). This is easier to programme as a single texture can be used instead of animated texture, lighting, shadow and cloud changes.

Game engines model time and allow artists to manipulate models of time through abstraction and relativity: “A timeline is a continuous, one-dimensional access whose origin (t=0) can lie at any arbitrary location relative to other timelines in the system” (Gregory, J., 2014, p.346). In other words, there can be multiple, overlapping, interconnected timelines flowing at different speeds and applied to different objects.

In videogame development terminology, *local* and *global* timelines refer to the differences in authored time per object. Time can be authored differently in animation programs, with frame rates usually matched to the 25 frames per second (FPS) of PAL or 30 FPS NTSC video standards. In traditional animation techniques, using less FPS is often used to save time and create smoother movements, in which each frame is counted twice, halving the amount of animation necessary to fill 25 or 30 frames. The engine does not have to play back the animation clip at the authored speed, and can speed up, slow down and reverse clips, all functions that are traditionally embedded within film and video editing systems (Gregory, 2014, p.347). In this case, the local timeline refers to authored time within the animation clip, and global time refers to the rate at which it is played back within the game engine.

Through the process of making *Wireframe Valley* (2015) I found game engine time to be relational, complex, and resistant to unified descriptions. Time felt like a sculptural material, arranged like a collage – independent objects juxtaposed but withholding their own temporal properties. In this sense, the language of systems thinking was useful – especially in relation to agents within networks and assemblages. The temporal components of artworks are considered more thoroughly in Phase 2 and 3 of the research.

Exhibition Time

I gained a sense of how time functioned in the work from exhibiting it, observing audiences, and listening to their verbal and written feedback. There is a tension between the kind of cultural time associated with computer simulations and art. Although commercial videogame titles, the most popular form of computer simulations, are capable of engaging audience imaginations for long periods of time "a *Playstation* title can easily take 70 hours of game-time to explore to the end - roughly what it takes to read seven 500-page novels, attend around 20 plays or opera performances, see about 40 feature films, or watch some 120 episodes of a soap" (Penz & Thomas, 2003, p.53), gallery audiences typically spend much less time viewing work.

Although *Wireframe Valley* (2015) contained animated elements (the movement of grass, wind, clouds, etc.) the most significant changes occurred roughly on a weekly basis, which denied audiences the opportunity to witness the process that was most crucial to its meaning. As a result, the meaning became largely conceptual and not satisfactorily embedded in the durational mechanics of the work. This dissatisfaction led to further research into 'time logics' – networks of time nodes that could be used to start events over long durations within an exhibition.

This relates to John Gerrard's *Thousand Year Dawn (Marcel)* (2005), a simulation that confronts audiences with the unknowable scale of computerised, inhuman time. The work moves away from postmodern ideas about reality becoming masked and replaced by the virtual, and towards ideas about the materiality of computers and their relationship to human-centric modes of time. "The medium moves beyond the realm of the consumable in a sense, and involves much more inhuman timespans, which cannot be watched like a film." (Gerrard, J., 2011). The distinction between a computer simulation and a film or video is crucial to understanding the work, but not to a deeply technical level. The ambiguity over how computer simulation artworks have been created often contribute to a sense of ontological confusion that seems appropriate for such shifting sets of tools and objects.

Marina Zurkow's *Mesocosm* (2011) also explored extended time via an online 'software driven animation' that updates in a web browser. Audiences are encouraged to leave the browser window open whilst they surf the web and work. Zurkow suggests that "because change happens slowly, but can be radical over time, the works are intended to be seen in public places where people gather or pass through frequently or lived with like a painting – in living rooms and meeting spaces" (Zurkow, 2011). *Mesocosm* (2011), a term which refers to simulated landscapes created for environmental science research

purposes, explores the passing of time on the Northumbrian moors, in which 1 hour of real-time passes in 1 minute within the artwork.

Software, Hardware, Affordances

During the making of *Wireframe Valley* (2015) it became apparent how much influence software and hardware tools have on the development and production of art. The limitations of the game engine were dialectically related to the development of ideas throughout the making process - a constant tug of war that informed the planning, making and exhibition of the work.

At many levels, there are compromises the artist must make in terms of using game engines. The software architecture, the programming language used, the models and textures (if using readymade assets), even the colours used to replicate a sun set (with the built-in directional light properties found in most 3D game engines) have been created by software developers and artists with a view to modelling reality with their own parameters.

The choices that developers make can have political consequences, such as the furore that erupted when an *Assassin's Creed* developer admitted why there were no female characters in the game. Animations are usually motion captured once and then duplicated onto different size skeletons known as 'rigs'. Female rigs are too different from male versions, meaning that two sets of animations need to be captured, doubling the amount of time and money required.

Knowledge of the differences between game engines is useful for artists in establishing what work can be created with them. Different engines may be more suitable for different types of projects. I chose *CryEngine* based on how well it could render realistic terrain and for the visual scripting system seemed faster and more straightforward to set up than in *Unreal Engine* and *Unity* at the time.

D) Outcomes and revised research aims

The research questions for this phase of practice were:

- What characteristics do computer simulated artworks have?
- What theoretical frameworks are most suitable for making sense of these practices?

The making of *Wireframe Valley* (2015) helped illuminate specific spatial, temporal and behavioural characteristics of CS artworks. Time created with game engines was found to be constructed via different methods simultaneously, problematising straightforward

understandings of the temporality of the artwork. Similarly, spaces created within game engines occupy several different forms throughout the making and exhibition processes. Both the spatial and temporal characteristics of computer simulated artworks require further exploration in the next phase of the research.

A fairly crude time logic was created to enable the long durational component of the artwork. Although it was problematic to exhibit, it constitutes a useful start and helped uncover many of the challenges of working in this way. Perhaps the time logic can be developed further in the next chapter.

Certain behavioural characteristics of the work, such as the self-destructive logic, are less applicable to other computer simulated art practices and are more specific to my own interests as an artist. Although there are historical precursors of auto-destructive art, Wireframe Valley (2015) responds to a different social, political and technological climate. Instead of referencing the horror of WWII and the following threat of nuclear strikes during the cold war, Wireframe Valley (2015) is a reaction to how computers technically and semiotically construct reality, and a comment on environmental destruction.

Research into theoretical frameworks at this point was focussed on postmodernism and software studies approaches to understanding simulation. The level of understanding of simulation theory and materialist philosophy had not yet developed and although present, was under-theorised. The videogame literature and theory that had played a bigger part in the starting phase of the research was beginning to lose its value as Wireframe Valley (2015), although created with videogame tools, was behaving in a way that ludological frameworks are not equipped to discuss.

Research aims were re-written to focus on simulation rather videogame-related artworks. Simulation theory is less hindered by the cultural baggage of videogames. Interaction is less of a foregrounded process or function in simulations. The simulation has value with or without interaction. My practice does not fit comfortably into the definition of videogame art due to the lack of interaction, player input, or ludic rule framework. Although it is possible to look to the fringes of such definitions, like zero player games, or Schrank's (2014) four avant-gardes of videogame art, expanded definitions become so broad as to be meaningless. The result is a discourse that perpetually exists to justify itself in relation to a definition it seeks to move away from.

The interplay between theory and practice was uncertain at first. It was difficult to focus on a highly specific area instead of being free to explore ideas as they occurred. It became progressively more natural to swap between theory and practice, although each would 'take the lead' and a genuine balance was difficult to maintain.

Although the findings from phase one of the research are technology focused, there was an attempt to contextualise the findings within the broader context of art practice and theory. The technological focus may be a result of having to learn several technical processes for the first time. The complex and lengthy technical processes involved in creating work with game engines can take cognitive priority over creative practice and reflection. Bogost describes the videogame production process as "… overwhelmingly esoteric. They require a considerable amount of abstruse knowledge and experience to practice effectively." (Bogost, 2008, p.x). Although more strategies for bridging theory and practice are required in this research, there will always be a degree of flux involved. Processes involved in making computer simulations changes frequently and software is constantly updated.

As discussed in the literature review, new media art and contemporary art are conflicted by the idea of medium specificity, in which it is considered naïve or inappropriately technological to consider the medium in which an artwork has been created. This is, at least partially, a consequence of large-scale changes in focus from objects to process in contemporary art discourse from the 1960s onwards. The focus on the material and technological aspects of the game engine in *Wireframe Valley* could be considered a medium specific practice that cannot be accommodated within the current theoretical landscape of contemporary art. However, the ideas that this work pushes towards – those of the function of CS in culture and nature, are prescient and deserving of exploration. It is entirely valid to make use of the mechanisms of how computer simulations are produced within art practice without being conceived of as naïve or redundant due to the 'volume' or presence of the materials used to create it.

Revised Research Questions

- What characteristics do computer simulations have?
- How do algorithms function within computer simulated artworks?
- What impact do computer simulation practices have on our understanding of authorship and representation?
- What theoretical frameworks are most suitable for making sense of computer simulated artworks?
- How can the ecological aspect of the work be discussed?

The first question was kept from Phase One, as further research was required to adequately answer the question, specifically in relation to how algorithms function in the work. The third question is designed to help provide clear examples of how computer simulation artworks relate to existing forms of art discourse, namely modes of authorship

and representation. Can computer simulations be satisfactorily understood in these terms, or are different frameworks and language required? If postmodernist simulation theories cannot fully account for the material and conceptual characteristics of computer simulated artworks, then what other theories can help? Although this is considered in the literature review, the actual chronology of the research led to new materialist philosophies becoming incorporated during the reflective part of research Phase 2. The ecological aspect of the work – a concern with the destruction of the environment has yet to be explicitly connected to theory. The next phase of research is designed to explore these ideas.

Chapter 5

Phase Two: *Floating Point*

a. Context
b. Edited documentation of the making process
c. Identification and analysis of emerging themes
d. Outcomes and revised research aims

A) Context

I had intended to show three pieces of work at a solo show during the second stage of the research to experiment with different visual languages and gather more data about how the work functioned within a gallery space. I organised a solo show *at B&D Studios*, a gallery and studio space within Commercial Union House on Pilgrim street, Newcastle Upon Tyne. The exhibition was open from 13th October to 2nd November 2016. Showing work in a low-key gallery appealed as I was still unsure of the work and how it could be talked about in terms of a cohesive body of work.

B&D is a collection of artist studios and gallery space on the third floor of a recessed, inconspicuous building with a concierge, so it does not attract much foot fall from occasional passers-by. The opening night was reasonably busy and approximately 60 people attended. The gallery was unable to track visitor numbers throughout the exhibition but a visitor book was left open for comments throughout the exhibition.

On the 26th October 2016 I held a roundtable discussion in the gallery with artists Kelly Richardson and Narbi Price, supervisors and artists Chris Dorsett and Dominic Smith and curator James Daltry. I recorded the discussion with the intention of using aspects of it to support sections of this chapter – especially in relation to how the work was received and what kind of themes were arising. This was an attempt to collect responses from peers in addition to those from audiences to improve the relevance of feedback. The transcript is available in Appendix vi.

B) An Overview of the Making Process

Several pieces of work were made during this phase, although I chose three to exhibit as part of the exhibition: *Floating Point, Wood for the Trees* and *Cohort*. *Floating Point* (2016) is a simulated Arctic ocean in which an iceberg with wireframe insides, imperceptibly melts into the sea over the duration of the exhibition. *Wood for the Trees* (2016) also lasts for the duration of the exhibition, but uses a reduced visual language, in which a single tree slowly becomes immaterial and disappears. *Cohort* (2016) is a video loop of a

simulated crowd walking around a mobius strip. This section provides further detail about the making process for each piece.

Wood for the Trees (2016)

During Phase 2, a theme of concealment and submergence developed that formed a visual starting point for thinking about how algorithmic images are generated by computer simulations. The iceberg is a classic example of an object containing submerged and exposed components. The tree is another, and this was the starting point of this work. This approach was also an attempt to reconcile the virtual, immaterial simulation of the natural environment with grounded, physical examples of terrain.

Scale and composition were experimented with, moving away from the panorama of *Wireframe Valley* (2015) and towards a closer, perhaps more analytical framing of 'natural' objects. 3D models of foliage and a tree trunk (Figure 25) were purchased and arranged in *Unreal Engine* (Figure 26). The aim was to individually animate each object from realistic material to wireframe texture in a more sophisticated manner than the sequence of debug modes employed in *Wireframe Valley* (2015).

Figure 25. Virtual camera view of Dolan, Paul *Wood for the Trees* (2016) work in progress

Figure 26. Editor view of Dolan, Paul, *Wood for the Trees* (2016) development in *Unreal Engine*

Different ways of creating forests in procedural software *Houdini* were researched (Figure 27) with the aim of exploring the natural world as an endless cycle of random programmatic images. The scene would be in a constant state of flux, with objects moving between all possible arrangements, permutations, and combinations. *Houdini* allows for objects to be procedurally modelled, which means that are highly editable at a parametric level. A procedural model of a house, for example, would automatically add extra windows in after the width of a wall was increased within the software.

This idea had to be shelved as the procedural files could be exported from *Houdini* to *Unreal Engine*, but the parameters could not be accessed at run time by *Unreal Engine's* visual scripting system. This meant that I could import a procedural forest as a network of parameters, but I could not animate specific values, only create instances of the forest in each state and export them as separate actors. This led back to an issue that lingered throughout the second phase of the research – whether it was conceptually incoherent to use video to make artworks. My preference as an artist is to work with real-time simulations, as they have the capacity for emergence, indeterminacy and, as discussed in previous chapters, function differently in relation to temporality and ontology. Experimenting with this idea led to the development of *Cohort* (2016), a video loop that utilises crowd simulation techniques. I was keen to explore what impact using video had on the reception and meaning of the work.

As the level of visual scripting became more sophisticated, further thought was given to the role of the code and algorithms within the work. Daniel Schiffman's *The Nature of Code* (2012) was a useful reference at this stage in the research, specifically the

demonstration of ways in which code can simulate natural processes. Schiffman shows explicitly how natural processes can be simulated using mathematical and algorithmic processes. Further research into systems thinking and emergence led to an understanding that a unique characteristic of CS is their capacity for emergence, whereas procedural and algorithmic concepts are more widely applicable to a variety of new media art practice.

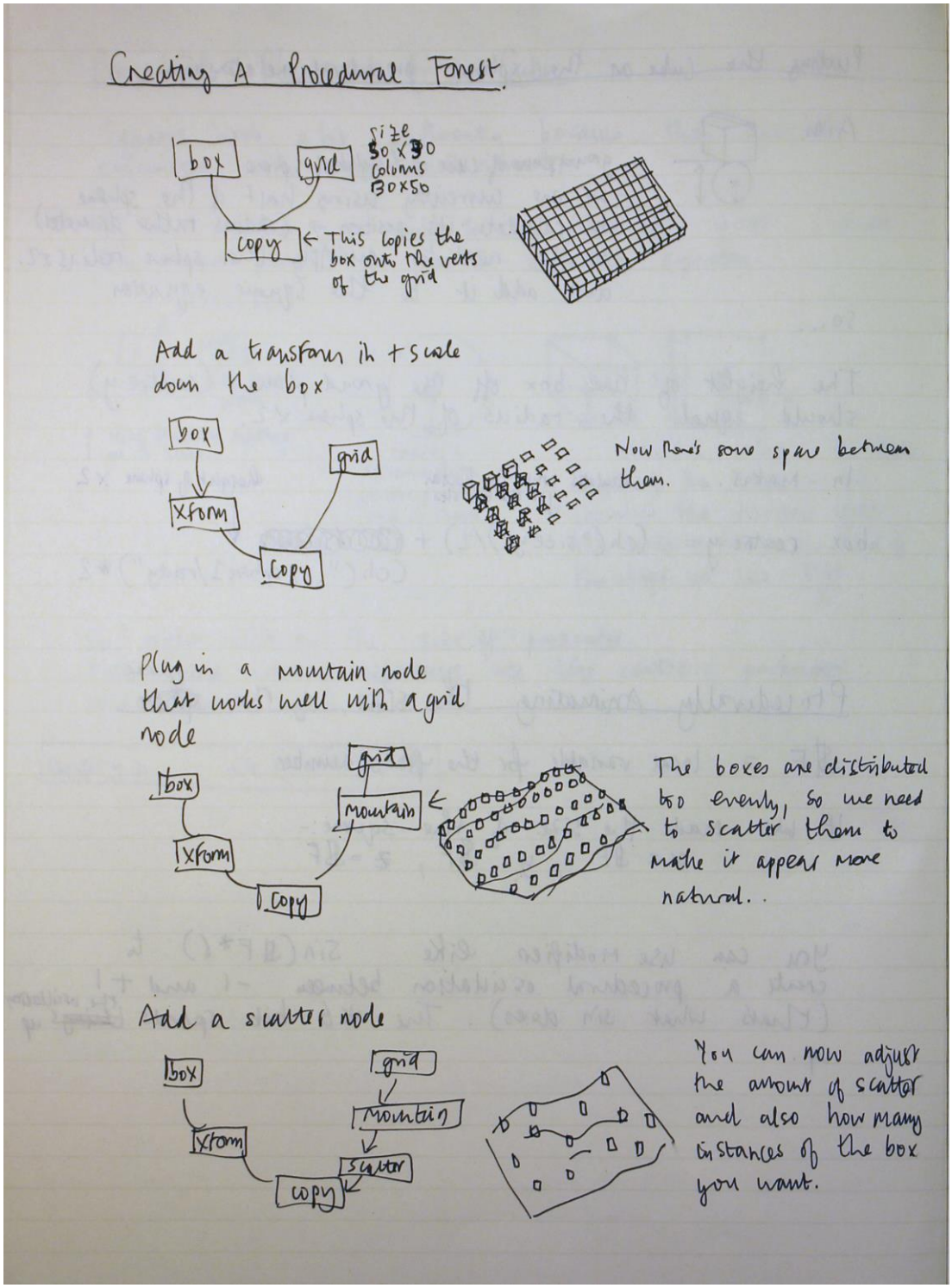


Figure 27. Sketchbook page showing the node arrangements required to scatter objects over a terrain in *Houdini.* These methods were eventually used in a later work *Spruce Pine, North Carolina (2018)*

Figure 28. An alternative scene used during production of Dolan, Paul, *Wood for the Trees (2016)*

At this stage I considered if non-emergent visual scripting behaviours were somehow working against the affordances of the medium. I later realised that the technicalities of how the work is created and presented only have their own particular idea to answer to, and there is no particular set of technical conditions a computer simulated artwork needs to fulfil in order to be interesting.

The fixed role of the camera was reconsidered, with a view to exploring how it could visually reinforce the programmatic, spatial and temporal characteristics of the computer simulation. A scene was built with a circle of trees, lit from above and with wireframe leaves falling in a continuous stream (Figure 28). The camera was programmed to slowly orbit around the scene to make the camera more active in producing a looped temporality. This was informed by Baudrillard, Virilio and Debord's apocalyptic ideas of reality as an endlessly repeating and self-generating system of image masking and disappearance. This clearing in the forest was a way of looking at a site in which that process had occurred.

At this stage the technical research and development overwhelmed my cognitive capacity, and the conceptual development of the work suffered as a result. My practice had become trapped in its own temporal loop. I succumbed to *parameter-fever* and started to endlessly move between different ways of articulating an under-developed idea. Using software only after the idea was at a greater state of development became a more successful approach. However, to do so is not always so simple. The research and development stage often uncovers technical limitations that require the concept to be

changed in order for the artwork to be produced. Using video for example, often involves long render times, which for long duration artworks can exceed several months of 24-7 rendering. This also produces huge files that could not be played in gallery contexts without breaking the sequence apart.

Eventually all the environmental components of the work were removed, apart from the tree and a patch of grass. This was a reaction against the confusion of ideas during the development stage and a way of embracing the research aspect of the work as a process for testing and experimenting rather than producing sellable artworks. These decisions changed the aesthetic of the work to reference videogames more than I had intended.

Custom materials for the tree were created, which allowed for material parameters to be exposed to the engine where they could be referenced within the *Blueprint* visual scripting system. This process was used to make the tree materials become translucent over long periods of time (Figure 29).

A menu system was programmed to appear when the artwork began, which, upon input of a day variable, would start the work from a different point of a single internal timeline. When gallery staff open the file on the computer, the interface prompts them with a list of days to choose, one for each day of the exhibition.

Once a day (from 1-11) is clicked, one of 11 different *Unreal* sequencer files is opened containing animations that progress from specific parameters over a 9-hour period. Like *Floating Point* (2016), I took the overall animation of the tree becoming gradually more wireframe and partitioned it into 11 different files. A plan was created for how much movement should occur over each day before material parameters were animated in 9-hour sections. The values from the end of Day 1 would form the starting point of Day 2's activity. This became a much less stressful way of exhibiting real-time work than *Wireframe Valley* (2016). Switching the computers off at the end of the day also meant that FPS slowdown and lag did not happen. *Wood for the Trees* (2016) and *Floating Point* (2016) also used the same visual script nodes to lock the camera and negate player input.

The benefit of working with visual scripting systems is that they can be copied and pasted within different artworks, reducing the amount of time required to setup complex functionality and time systems.

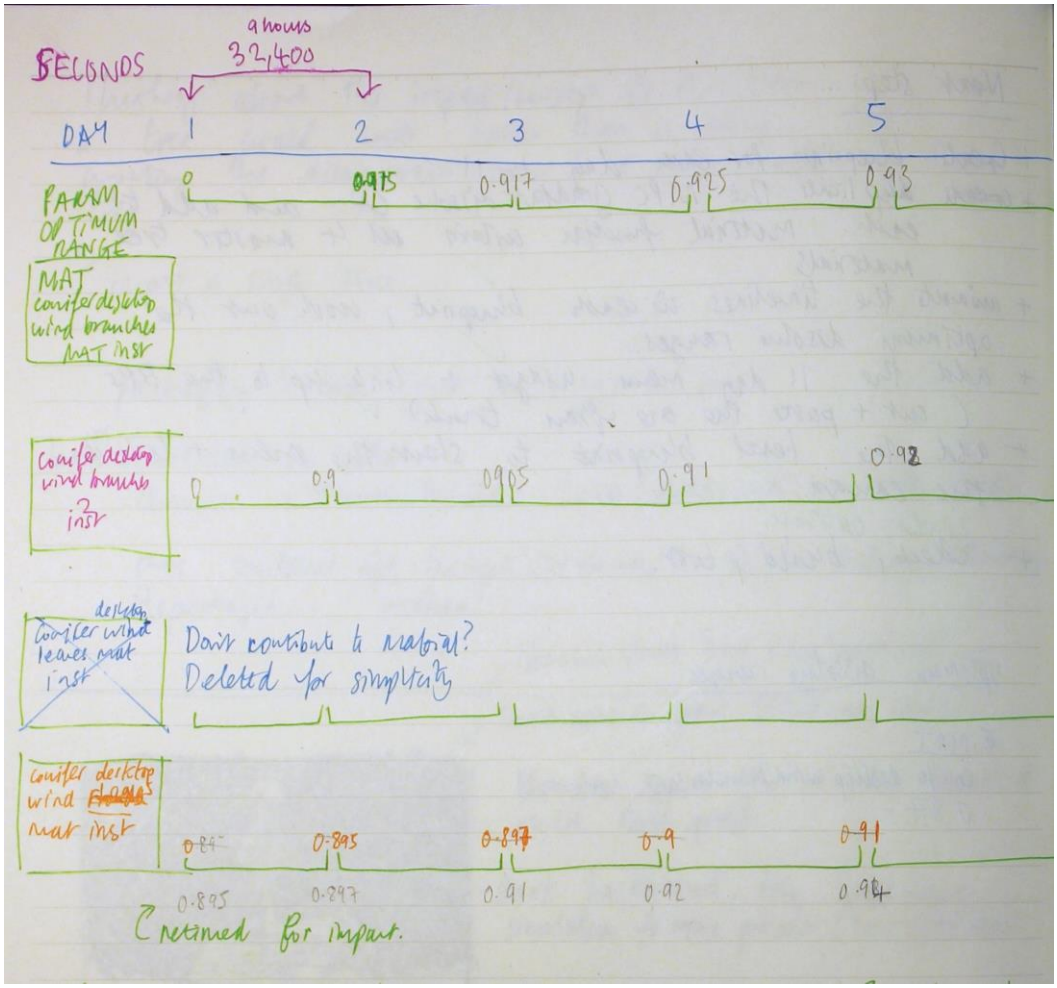


Figure 29. Photograph of a sketchbook showing how material parameters were animated over the first 5 days. The full diagram is available in the Phase 2 sketchbook on the USB documentation.

Figure 30. Exhibition view of Dolan, Paul *Wood for the Trees (2016)* at B&D Studios, Newcastle Upon Tyne, 2016.

Figure 31. Unreal Engine screenshots showing the overall process of the tree material ‘burning away’ and disappearing. In the final step of the process the tree has completely disappeared (not shown).

Floating Point (2016)

Like all of the artworks created during this thesis, there is a time-consuming element of research and development required to find out how best to realise the concepts through software. For *Floating Point*, it was important for the artwork to achieve a degree of photorealism to create a visual and ontological ambiguity. The requirement for photorealism led to the use of a terrain generation and rendering software called *Terragen* which is used within visual effects more so than games. Although it provides photorealistic results, the render time was around 1 day per frame at high quality and therefore impractical to animate extended duration scenes with. It was also difficult to control the proprietary material editor interface, which meant fine tuning the combination of ice and snow reflectivity on the surface of the iceberg was incredibly time consuming and difficult to monitor compared to other software.

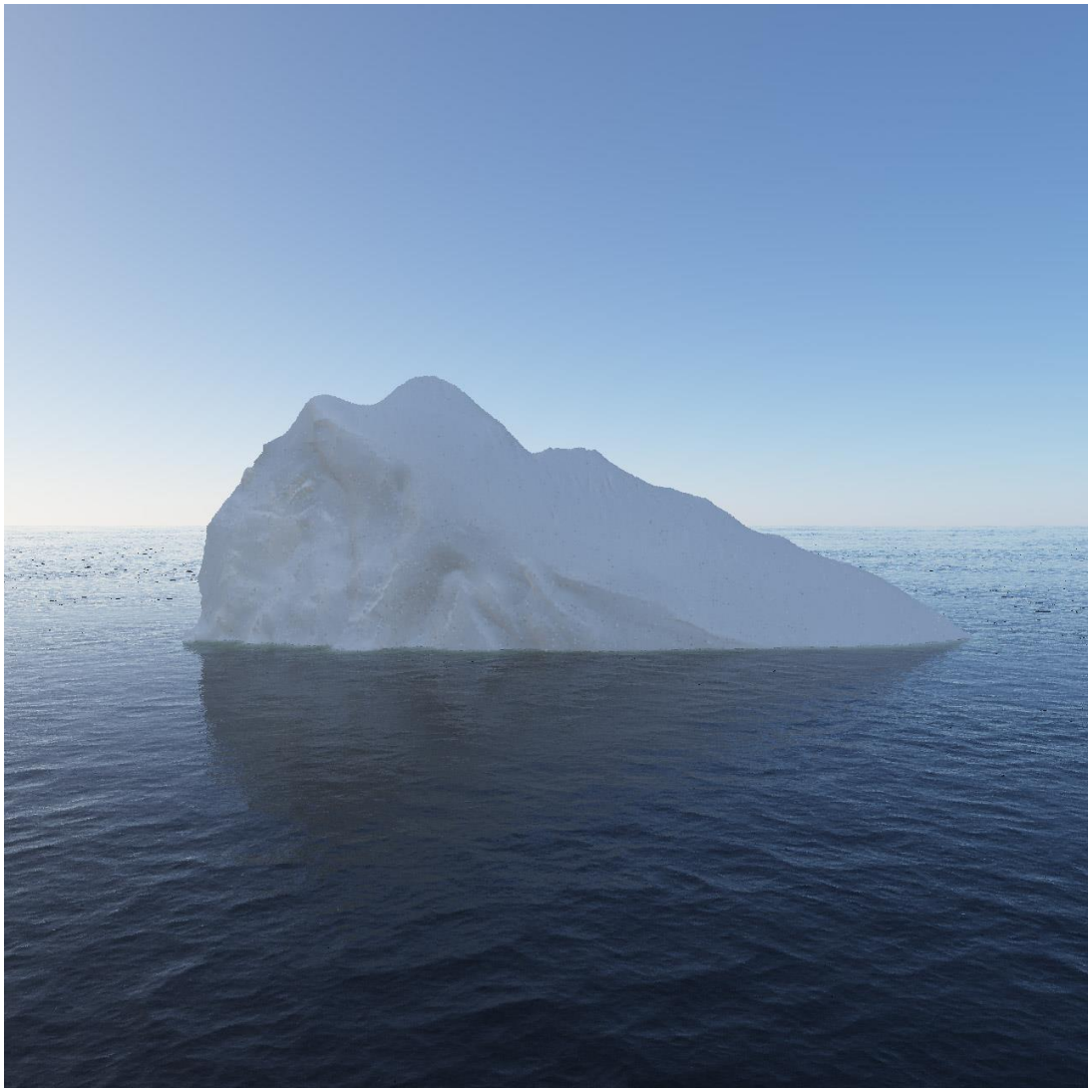


Figure 32. Low poly mesh and normal map rendered using *Terragen* with default water and slight lighting modifications to the sky and atmosphere.

I found myself debating whether or not rendering the work as a video sequence (as opposed to a real-time software) was actually necessary to convey the themes of the work. This is especially explored in *Cohort* (2016), which is a video loop. In the case of *Floating Point* (2016), however, the elongated sense of time was a primary part of the work, so it made more sense to sacrifice some of the photorealism and use a game engine instead, which would allow time to be programmed in a more complex manner. *Houdini's* water fluid simulation tools were also experimented with, although advanced knowledge of combining fluid simulations was required to achieve the effect, and there was little documentation for how to achieve this. *Houdini* would also have led to a video output, becoming subject to the same long render time issues as *Terragen*.

The sky was created using an existing 'Sky Actor' within *Unreal Engine*. Parameters were changed to modify the appearance and speed of the clouds, sky and atmosphere. The sky is comprised of textures wrapped around a 'skybox', a 3D sphere outside of the navigable area of the virtual space, with cloud textures programmed to animate at specific speeds.

Several techniques for creating a believable iceberg were tested. Eventually, a rough iceberg shape was created in *Maya* before being imported to *ZBrush* and subdivided into a high poly mesh. This process adds more polygons to a model, so that higher detailed shapes, textures, and deformations can be supported. With these additional polygons, it was possible to sculpt a high level of detail into the model to emulate the combination of smooth, snowy and eroded, icy surfaces of a chunk of iceberg.

Unfortunately, the high poly model could not be used within the game engine, as it would slow the FPS down too much. Instead, the geometry of the high poly model is converted into a two-dimensional texture capable of faking depth information, known as a normal map. This relates to the idea of dimensional hybridity explored in the first phase of the research, in which space is constructed from 2D and 3D elements.

Once the mesh and textures were created, *Houdini* was used to fracture the mesh into several pieces using a Voronoi process. A plugin created by a *Houdini* community member helped to fracture the mesh and textures at the same time (Figure 33). The plugin also added an inside and outside material node to the fragments, allowing for a wireframe material to be applied to the inside surfaces whilst retaining the photorealistic snow and ice texture on the outside surface.

The decision to use a wireframe material was an attempt to explore the iceberg as a mediated, constructed object. This relates to the way in which computer simulated evidence for climate change can be considered rhetorical. As discussed in the literature

review, the legitimacy of such data is simultaneously constructed via its mediation as much as the methods used to create it (Roundtree, 2014).

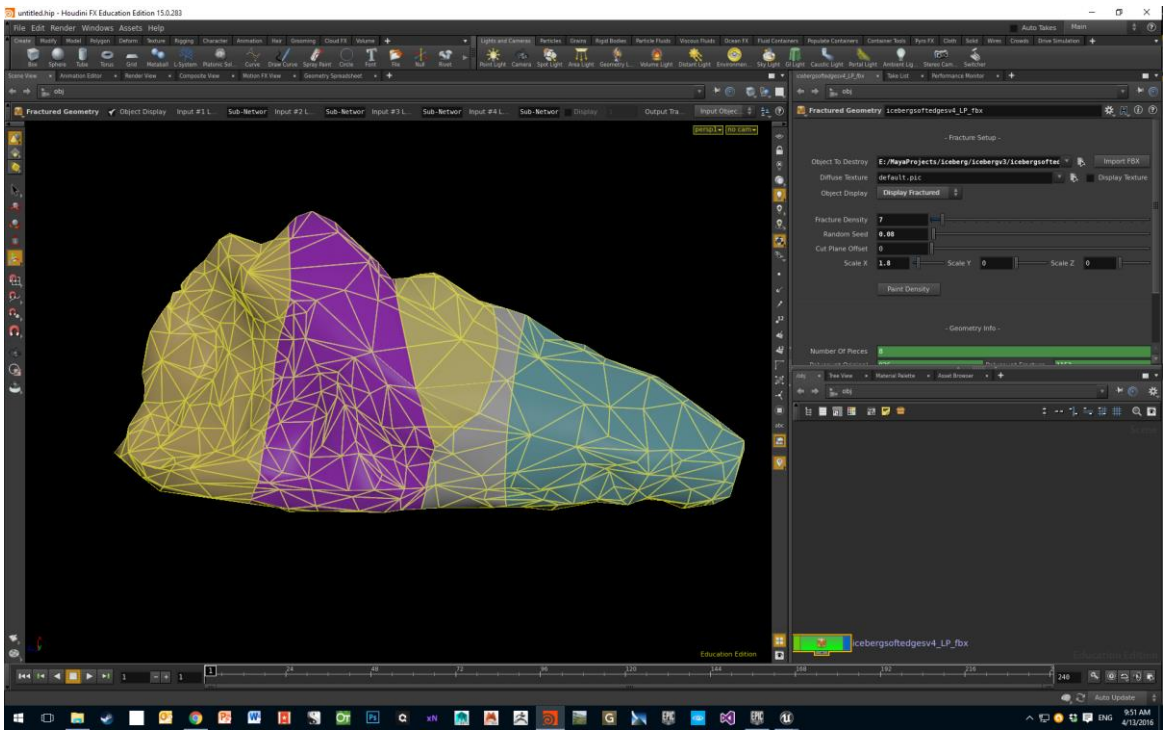


Figure 33. Houdini screenshot showing the iceberg model after a Voronoi fracture process fragmented it into several meshes

Once the individual iceberg pieces were imported to *Unreal*, I changed their position in 3D space to 0,0,0 to align them. There were problems with seams becoming visible, as light from the glowing wireframe texture applied to the inside polygons was 'leaking'. This was fixed by moving parts of the iceberg slightly so that they covered the light leaks.

The way in which time was programmed constituted a step forward from the method employed in *Wireframe Valley* (2015) which was difficult for gallery staff to restart if it crashed. As discussed in relation to *Wood for the Trees* (2016), the aim for this exhibition was to create a gallery-friendly system that could be used by gallery staff to start the work each day and to restart the work if problems occurred.

This exhibition lasted for 11 days in total, so an interface was programmed within the game engine which gallery assistants could use to select which day to 'play'. The animation data was stored in 11 separate sequencer files, one for each day.

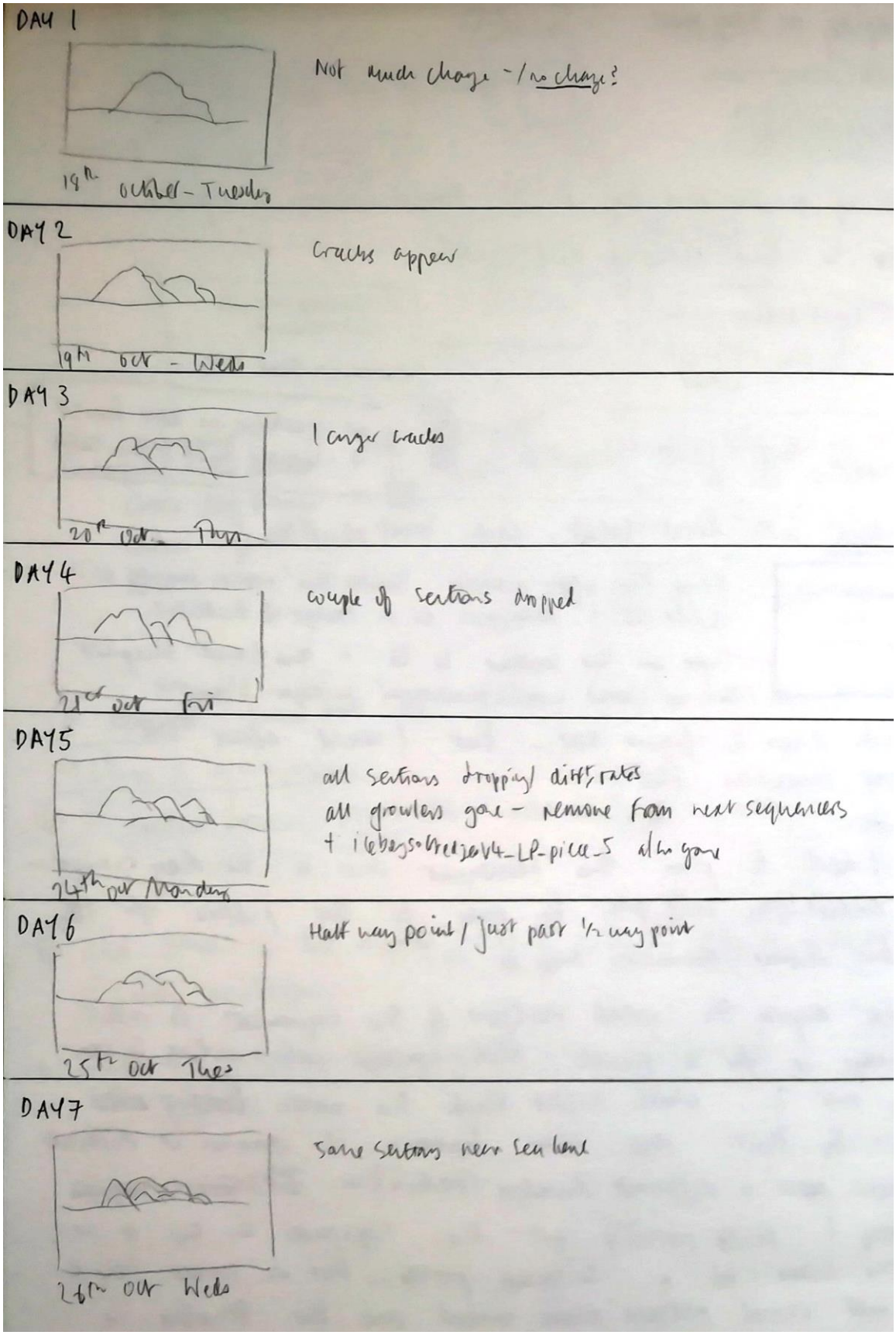


Figure 34. Page from the *Floating Point* sketchbook showing how the iceberg's movement was planned over the first 7 days of the two-week duration.

In other words, the overall timeline of the iceberg melting into the sea was separated into 11 days of activity. When the gallery assistant opened the software and clicked on ‘Day 1’, the iceberg would move to a certain position and stop, which would be continued when ‘Day 2’ was played the following day.

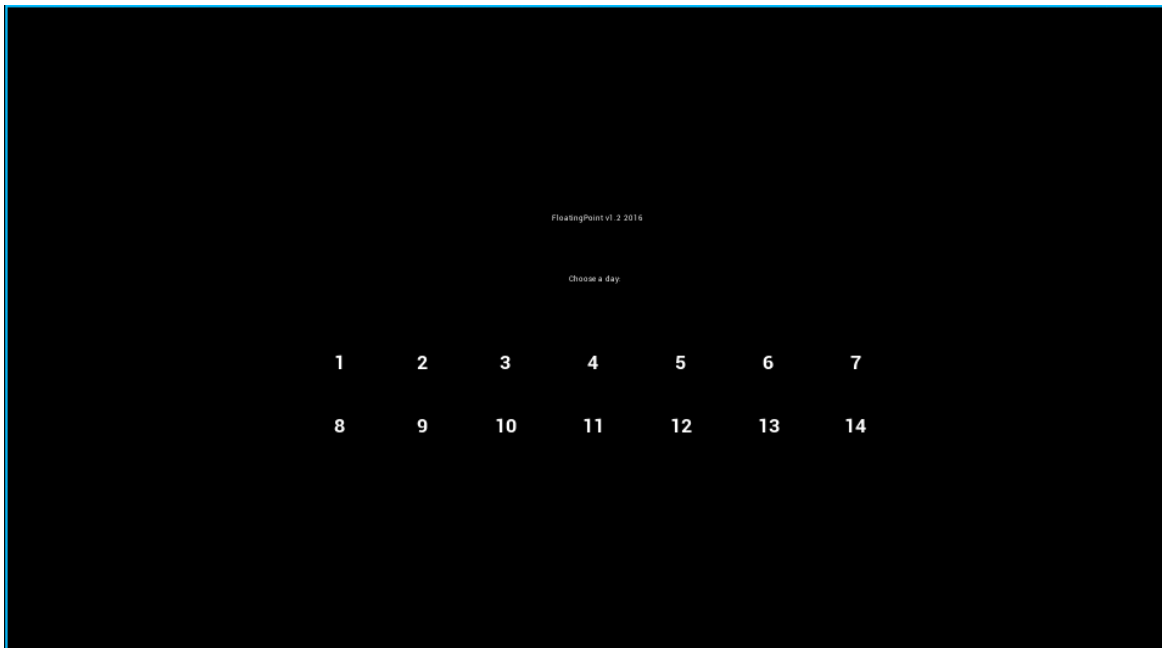


Figure 35. Screenshot of the interface that appears when the artwork’s software is executed.

Figure 36. Unreal Engine screenshot showing the 11 sequencer files that comprise the overall timeline of Floating Point (2016)

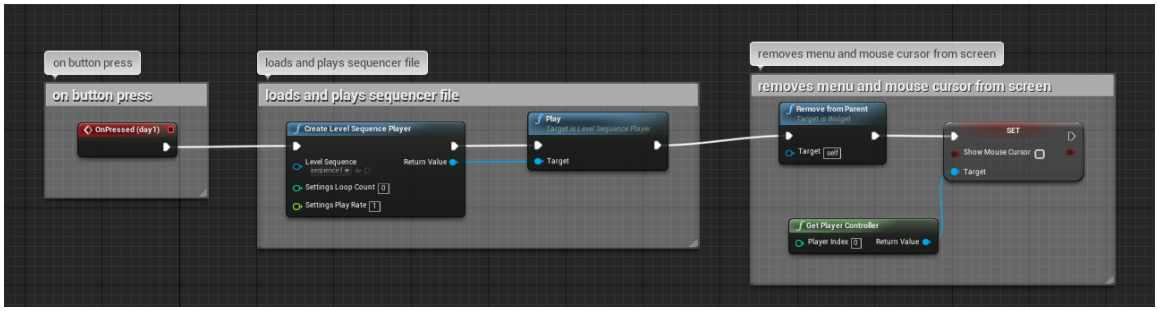


Figure 37. Detail of the logic process used for an individual day. Once a day is selected from the interface, a sequencer file is loaded with a section of the timeline, user input is locked and the cursor is made invisible

During this research phase, *Unreal Engine* incorporated a new system for creating cinematic sequences called Sequencer from version 4.12. Sequencer is a multi-track editor that allows multiple real-time animations to be organised on a time line in a similar way to video editing. This was incredibly useful for editing clips from the scene and programming time.

The animation process was recreated several times before a satisfactory movement was created within the 11 separate sequencer files (Figure 36). To retain continuity between the movement of individual iceberg pieces, handwritten notes on timings and parameters were kept. This was a fairly complex process as there were around fifteen objects moving in each scene, and each one needed to start in exactly the same place and time as it stopped in the preceding scene.

As with *Wireframe Valley* (2015), player input was disabled and a fixed camera position was programmed via visual scripting. At this time, animated camera loops were experimented with. I was wary of introducing too many aspects of visual language in to the work and wanted to simplify the behaviours and visuals, so camera animation was discarded.

The animation process was developed in a similar way to *Wireframe Valley* (2015), whereas parameter changes were choreographed over the course of the 9-day exhibition (Figure 34). The use of extended durations had been under theorised during the first phase of the research, but during Phase 2 the idea of moving events beyond the scope of human perception started to appear as a tactic for exploring digital and geologic timeframes simultaneously. This is discussed further in the next section.

The final stage of making the work involved balancing the lighting with the material parameters to create an iceberg like texture (Figure 38). This can be time consuming, as the overall visual effect is governed by an interlocking collection of values that require simultaneous tweaking. In this sense, the process of making the work often feels like being immersed in an assemblage of interconnected modules, components and parameters.

The gallery space was difficult to exhibit projection-based work in. Control over the strip lighting was limited and there was a limited number of moveable walls in which to break up the space. There was a large screen set up for projection which made sense to use for *Floating Point* (2016) as the key piece in the show, although a wall of studio doors was visually noisy and detracted from the artwork itself. The computer running the work was hidden near the screen and attached to the projector via a 20m HDMI cable. A single sofa was placed about 7 meters in front of the screen to encourage people to watch for longer periods of time. The gallery owner commented that people were drawn to the work

and members of the studio came back daily to see what progress the work was making. The gallery owner had offered to post pictures of the changes online each day, although I felt this detracted from seeing the work in person.

Figure 38. Unreal Engine screenshot showing the final material and lighting set up for *Floating Point (2016).*

Figure 39. Exhibition view of Dolan, Paul, *Floating Point (2016)*

Cohort (2016)

During the second research phase I wanted to explore the social aspects of how postmodern simulation theory related to computer simulations. It occurred to me that my other work was focussed on the natural and ecological and was not directly referencing the social, which is a large part of Baudrillard, Virilio and Debord's ideas. Working with crowd simulations seemed to be a direct way of working visually with simulation, algorithms and the social. This work marked a deviation from the natural environments in other artworks but is included here as evidence of how the practice unfolded in this phase of research. Although I was keen to explore these areas further as an artist, I ultimately discontinued this line of exploration in order to maintain a more coherent body of work for the thesis.

Research was undertaken into the artificial intelligence system in *Unreal* and a test scene with actors moving between different checkpoints was created. It is a complex system to use without intermediate or advanced reference material online or in print (some of it was out of date at the time of production). The actors were also not reacting to the intricacies of the staircase geometry accurately, with many floating directly over it and under it. The *Houdini* crowd simulation tools were more exact and had better documentation online. I chose this as an opportunity to create a rendered video piece and to observe what impact it had when exhibited alongside real-time works.

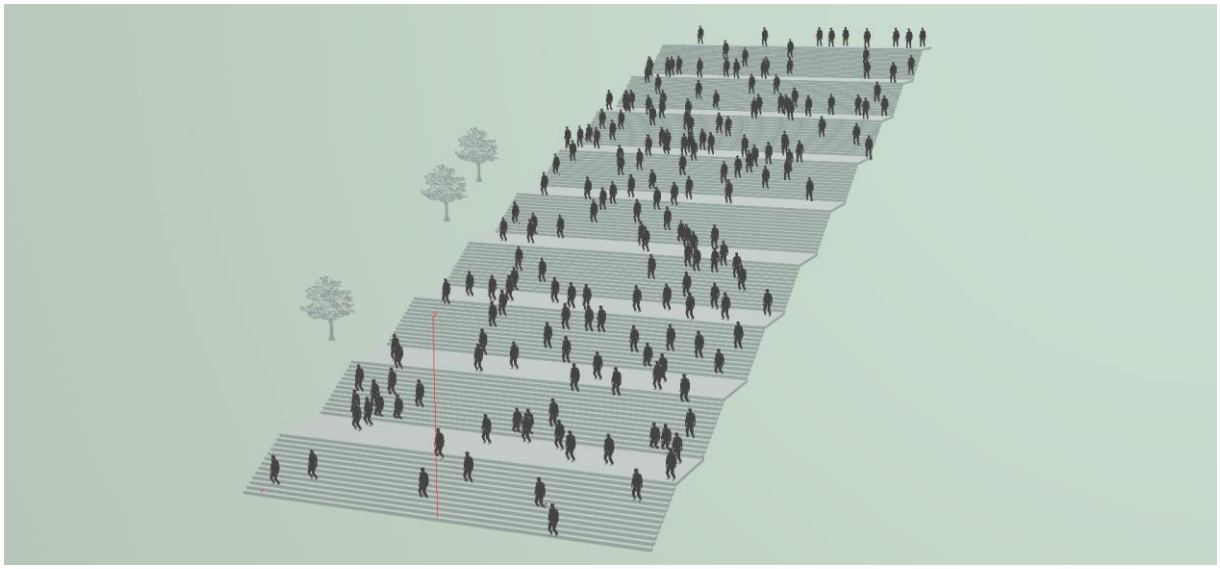


Figure 40. Houdini screenshot of the Odessa Steps work in progress.

Rossaak's writing on the *Algorithmic Turn* and moving image had led me to consider how the digital image was constituted by processes and non-visual currents of power. Figure 40 shows a work in progress from a simulation of Eistenstein's *Odessa Steps* sequence. I played with remaking classic moments from cinema history as real-time simulations where the fabric of montage and sequence existed as a parametric

assemblage rather than fixed, determined decisions. As I explored the characteristics of computer simulations, I found myself pulled in different directions, generating ideas to explore each characteristic that I would have immediately worked on as an artist, but as a PhD researcher found myself needing to exercise some curatorial restraint with.

I considered using a Möbius strip as a way of exploring the 'time loop' connotations of postmodern simulation theory. Although Baudrillard, Virilio and Debord presented apocalyptic visions of the future, the resonance of their ideas has led to a holding pattern in which culture appears to loop and re-appear at fixed intervals. This led to a period of research and development to explore the feasibility of creating a 3D Möbius strip and applying a crowd simulation to it. It was possible, although took significant fine-tuning to finesse. The crowd simulation tools in *Houdini* are straightforward for simple applications, such as animating a crowd walking over a flat surface, but anything that diverges from the stock examples requires knowledge of how to control the simulation nodes and parameters.

The process of working with *Houdini* is similar to *Unreal Engine* in that knowledge and control of multiple interconnected parameters are required in order to exercise creative direction over the software tools. It takes research and time to explore, test and refine the use of these techniques. Simple test files were used to develop components of the node structure in isolation before consolidation into the final work.

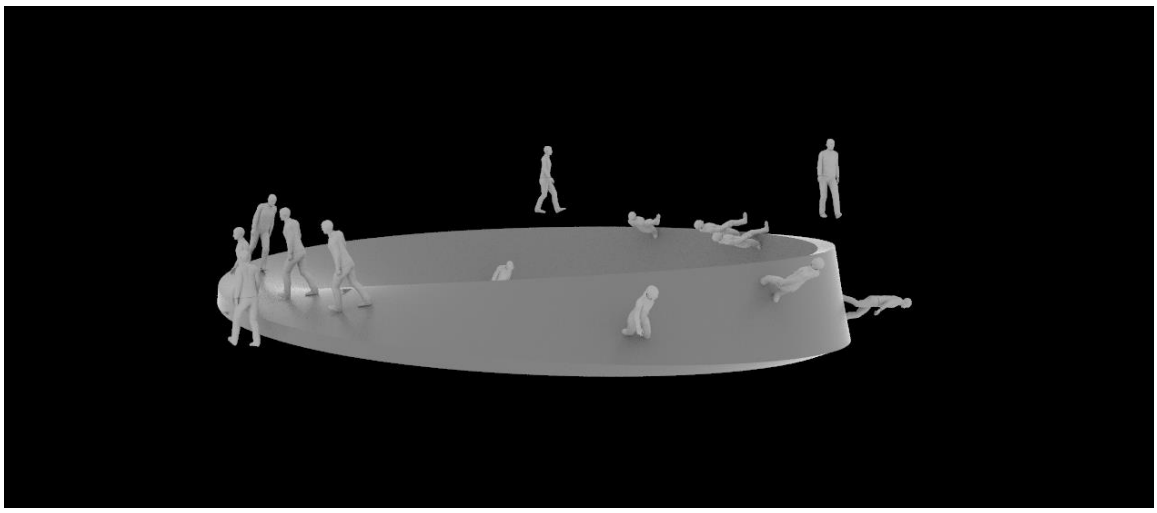


Figure 41. Unruly AI actors in *Houdini*

The construction of the Möbius strip was created using an incremental modelling process inside *Maya*. The geometry is incrementally twisted each frame in relation to a set of rotational parameters, over 360 frames. In this case time becomes space as frames stand in for the degrees. It was necessary to research the basic properties of the mesh as I needed to make sure each polygon was facing in the correct direction and forming a continuous loop for the crowd to follow.

The crowd simulation was difficult to control as the smallest parameter change could exert a significant effect on the movement of the actors (Figure 41). The Möbius strip was recreated a few times before the mesh had the correct polygon and normal directions. Initially the crowd would reach the final polygon of the strip and stop or walk back the way they came. After learning about the key nodes in the crowd simulation interface it was possible to change the method for how the crowd followed a path. The method was changed from ‘follow each polygon’ to ‘follow general direction’ to solve the problem. The extent to which the crowd would follow the path also took a lot of fine-tuning as it the overall movement of the crowd is controlled by several interconnected parameters.

I learned which parameters to change by watching video tutorials online, asking for help on the *Houdini* forums and by systematically changing parameters and checking to see what impact it had. Many parameters have an optimal range, which can make it difficult to know how much to increase or decrease a parameter. For example, software interfaces allow users to input any number into a parameter field, but the parameter may only be active within the 0-1 or 1-100 range. Some parameters have a much larger range (1-10000000) which means that the impact of any changes can only be seen after large increases in value. When testing, it is quite common to keep numbers low and therefore the impact of these parameters can be missed.

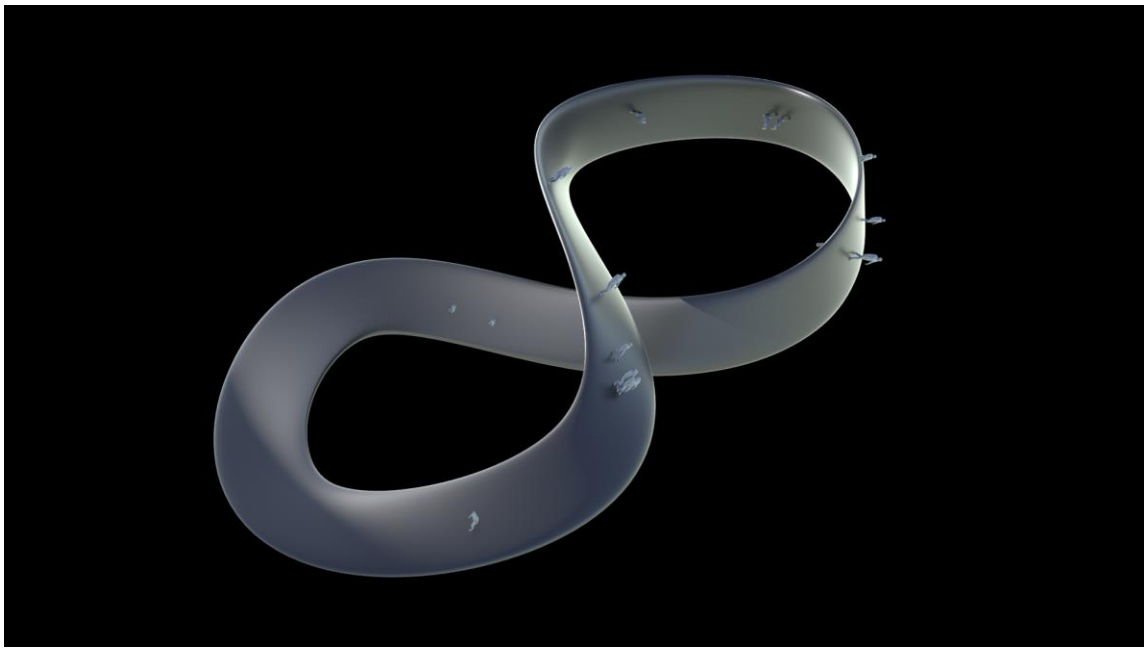


Figure 422. Final rendered still from Dolan, Paul, *Cohort (2016)*

Figure 43. Exhibition view of *Cohort* (2016) and *Floating Point* (2016)

C) Identification and analysis of emerging themes

The research questions for this phase of the research were:

- What characteristics do computer simulations have?
- How do algorithms function within computer simulated artworks?
- What impact do computer simulation practices have on our understanding of authorship and representation?
- How can the ecological aspect of the work be discussed?
- What theoretical frameworks are most suitable for making sense of computer simulated artworks?

The aims of the second phase of the research were to answer these questions, test the relationship between theory and practice through making, and to test the relevance and usefulness of ideas surrounding the computer simulation as a site for artistic practice.

What characteristics do computer simulations have?

Reflection on the second stage of making, combined with further reading and research led to a fuller mapping of computer simulation characteristics. They are particularly relevant to real-time computer simulation artworks created with game engines. Figure 44 maps the characteristics of computer simulations deemed most prevalent to arts contexts. This section discusses each characteristic in more detail. The map is intended as a starting

point to be added to. Drawing upon the language of Actor Network Theory and assemblages, each characteristic can be considered an actor, or a subnetwork of other actors. Actors and subnetworks of actors are connected in all possible combinations, although specific links are retraced more often depending on the artwork, like synapses strengthening during memory formation. This creates active and less active parts of the assemblage, in which connections lay dormant. The characteristics are relational in the sense that CS are constituted by multiple characteristics simultaneously.

Interaction and Non-interaction

Interesting ideas about videogames as simulations tend to assume interactive elements, whereas this is not a necessity in contemporary art contexts. In the sense that simulations generate reality, audience input can be viewed as a crucial way of "realising or bringing the gameworld into being in a semiotic and cybernetic circuit." (Lister, 2008, p.43). Aarseth (1997, p.29) agrees: "The distinguishing quality of the virtual world is that the system lets the participant observer play an active role, where he or she can test the system and discover the rules and structural qualities in the process." My practice has so far been deliberately non-interactive as a strategy for emphasising the non-image power of the computer simulation in comparison with human agency.

Emergent / Fixed

- Live simulations can be complex adaptive systems (non-deterministic) where unexpected behaviour can occur from relatively simple rule sets or;
- Complex systems (deterministic) in which the simulation occurs in the same way each time;
- CS production processes often involve both types of system.
- Can be presented as live simulation (software executed in real-time) or document of past event (video or still images, for example).

Agential/Lively

- In relation to Baudrillard's simulacra, CS self propagate images with no reference to a source object;
- In relation to new materialist philosophy, CS possess 'vibrancy' (Jane Bennett) or emergence (DeLanda);
- Emergent capacities are comparable with natural phenomenon such as morphogenesis.
- Agency is "…constituted in assemblages" (Casemajor, N., 2015 , p11).

Hybrid, Deferred authorship

- Artist controls parameters and machine executes accordingly;
- Dynamic and changeable relationship between the degree of control over simulation processes;
- Assemblage of different kinds of authorship (individually authored, co-authored and pre-authored) .

Interactive/Non-interactive

- Audience interaction may or may not function as part of the artwork's production or presentation.

Ontological Recalcitrance

- Ability to generate reality as well as represent reality creates an ontological disparity.

Algorithmic

- Rules and instructions processed incrementally over specified time periods to produce a result;
- Behaviours are applied to objects/models;
- Exist as (and controlled by) networks of relational parameters;
- Algorithms function as an expressive component of the work;
- Algorithmic processes can be visible or invisible in the artwork.

Representational / Productive of Reality

- CS contain representational elements (via the remediation of existing media or through simulated images);
- Whilst also existing in excess of representation via the production of reality;
- Represent real or fictional systems, objects and environments;
- Can possess high or low fidelity in relation to the world – playing Pac Man still feels like moving a real object despite the basic graphic representation;
- Representation is extended to the algorithmic components of the work.

Modelled

- CS are models in time or models in action;
- Abstract and specific systems can be modelled, from gravity to a door lock mechanism;
- CS often contain models of physical objects, environments, images, people;
- Behaviour can be modelled;
- Combination of real world data and proxy data (placeholder or stand-in data) are used to model the world or aspects of it.
- Varying degrees of fidelity to source system.

Temporal

- CS are comprised of multiple complex timelines;
- Dynamic networks of real time, key frames and simulated time;
- Often constituted as abstract time (time can be stretched, elgongated, represented parametrically and can flow at different rates);
- Static time (clouds move but time of day is fixed) and;
- Synchronised time (synchronised to real time, time zone, or the exhibition duration).
- Can be infinite or fixed length.

Spatial

- CS constitute multiple spatial modes (2D, 3D, code, software editor space, published simulation/presentation space, gallery space and data space;
- Often constituted as 3D virtual environments;
- Can be hyper-immersive (Accessed via VR headset, or installation) or immersive (projected on to surfaces or displayed on TV screen);
- CS processes involve dimensional fluidity. 3D models are 'baked' into 2D textures (terrain heightmaps, for example) and vice versa (generating terrain from elevation data);
- Can be considered a dynamic assemblage of spatial actors, which frequently change throughout the making and exhibiting process.

Modular

- Created using a variety of software, hardware, code libraries;
- game engines are especially modular in terms of consisting of a wide variety of software tools;
- simulations can contain simulations.

Figure 44. Continued from previous page. Diagram showing the Characteristics of Computer Simulations most prevalent to art contexts

Modes of Modelling

Computer simulations exist in excess of models, although do contain models as part of their ontology. CS are *models in* time, or *models in action* – without the algorithmic action applied to or enacted by the model, they cease to be simulated, and revert back to being a model.

Modelling operates at different levels within CS-related artworks. The primary level of modelling refers to the polygon structures of objects and environments, usually from photographic reference, inside a DCC software application such as *Autodesk Maya*. The modelling of terrain and environments has a dialectic dimensionality in which two dimensional images and three-dimensional objects are iteratively translated into one another and back again to simulate erosion and naturally occurring terrain features. In this sense, even conventional modelling processes do not follow a simple representational process.

Modelling exists at a behavioural level, which introduces further complexity. A modelled behaviour could be a physical system such as weather and gravity, it could be the behaviour of non-human objects such as the handling of a car, or the behaviour of humans and animals. In each of these cases, the model inside the simulation can be considered a programmable object, that possesses variables, a system and a state. “A variable is a value that represents a component of the simulation. A system is a description of how the variables interact. The state of the system is the values of the variables at any given time” (Reas & McWilliams, 2010, p.149). This description accurately describes the way in which the tree and ice berg objects were programmed in *Wood for the Trees* (2016) and *Floating Point* (2016).

Modelling may also apply to the simulation of social systems. During the making of *Cohort* (2016), I was interested in how to visually explore the social aspects of postmodernist simulation theory, by using crowd simulation software to create the animation of a three-dimensional crowd walking around a mobius strip. There is more scope for exploration of social theory via crowd simulation technology, although it can be very render intensive. Videogame AI software can also be used although requires more esoteric animation knowledge and time to implement. Although this aspect of my practice may resurface in future, the body of work created for the thesis is more comfortably contextualised within ecological and environmental terms. For example, an exploration of how computer simulated environments relate to the natural environments.

It is important to be specific and accurate about how computer simulations behave in an artwork. The way algorithms are constructed and presented in the work have implications for meaning beyond ‘being algorithmic’. There is a danger that the specificities of the work are lost via over generalising about the behaviour of the artwork.

I found that the logics used in my practice are stateless, which means that the operational logic simply reacts to the most recent input. It cannot employ different behaviours, like aggression curiosity, or dismissiveness (Wardrip-fruin, 2009, p.58).

Ian Cheng's work, on the other hand, makes extensive use of states, in which each character and object possesses different states that interact with one another, to introduce variability, indeterminacy and emergence into the simulation.

In *Floating Point* (2016) and *Wood for the Trees* (2016), despite being real-time simulations, they are still determinate, because events have been programmed in advance, and despite using randomly moving water and cloud systems, the result will always be more or less the same. This is a condition of the artwork itself – the concept requires an object or place to disappear.

It is more accurate to describe *Floating Point* (2016) and *Wood for the Trees* (2016) as event-based logics, in which certain timed events trigger other events into action. This is similar to videogame events in which certain events may trigger a door opening or new location appearing on a map (Wardrip-Fruin, N., 2009, p.73).

A connection between scientific and artistic CS was developed during this stage of the research. Whilst reading scientific literature on the ontological and epistemological makeup of CS, it transpired that scientific CS share creative and rhetorical characteristics. Scientists use *proxy systems* to stand in for other systems, as long as there is a strong enough mathematical similarity to the source system. This formed a surprising point of contact between games studies literature (Bogost, 2008) and physics literature (Roundtree, 2014), (Winsberg, 2010).

Hybrid Temporalities

Although time and duration have been extensively explored in previous media art (Andy Warhol's *Empire* (1964), Douglas Gordon's *24 Hour Psycho* (1993), it is interesting to explore how time can be modelled within a computer simulation. This is a recurring theme from the *Floating Point* exhibition.

Cohort (2016) made use of computer simulations during the making process, but was subsequently rendered as an image sequence and exhibited as a looped video. I was interested in how much impact different modes of temporal construction had on the artwork itself. Making and exhibiting *Cohort* (2016) as a video felt regressive in the context of this study, but it suited the concept of the work as a loop, mirroring the infinite loop of social time depicted in the apocalyptic theories of Baudrillard, Virilio and Debord. In this sense it is more straightforward to apply the ideas of such theorists to determinate video sequences, as they reinforce the terminal nature of the simulacra.

The movement of the crowd around the Mobius strip was simulated, meaning that their position was not animated with manually placed keyframes. During this process the

parameters were manipulated and then reformulated as a simulation, which would take into account the changes and behave differently. The simulation data was then 'baked to keyframes', which fixes the movements into determinate positions, that can no longer be simulated in the same way. In this sense, the seemingly inconsequential act of baking keyframes becomes a threshold for how the determinacy of the artwork is discussed.

Time in *Floating Point* (2016) and *Wood for the Trees* (2016) are a combination of key frame animation, algorithmically initiated events and real-time playback/execution over a two-week period. The temporal construction is more of an assemblage than any specific mode - real-time, keyframe, video, CPU time, often incorporating all of them. The capacity for game engines to assemble previously distinct modes of moving image (key frame, video, and procedural) simultaneously and immediately complicates the way in which time is considered to function within an artwork.

During the production of *Floating Point* (2016), a new tool became available for *Unreal Engine* which further incorporated cinematic concepts, processes, and interfaces into the game engine. *Sequencer* adopts the traditional video editing paradigm to structure multiple layers of time within a scene, although cannot be understood via traditional cinematic theory due to its integration with real-time, programmable objects. Editing layers can contain indeterminate simulations, creating a recursive hierarchy of simulated time. In this sense the temporal construction of a computer simulation should be considered as an assemblage rather than a singular entity. This relates to the term *abstract time* which was developed during Phase 1 of the research and describes how multiple timelines of variable length can be networked into a dynamic temporal assemblage.

Speed also needs to be factored into the discussion of computer simulation artworks. *Floating Point* (2016)*, Wood for the Trees* (2016) and *Wireframe Valley* (2016) all elapsed over a long duration (2 weeks and 3 months, respectively). Glacially paced video art has been described as reacting to the speed of commercial television (Graham, B., & Cook, S., 2010, p. 92) although the use of slowness in my work was intended to create a non-human duration that cannot be viewed in its entirety within one gallery visit. The movement on screen of certain elements in *Floating Point* (2016) and *Wood for the Trees* (2016) is imperceptible, and any differences in the scene are only visible after having left and returned to the space after a period of time.

Simultaneously, aspects of the scene such as leaves, branches, grass, clouds and waves, move as expected – in real-time and at normal speed. *Floating Point* (2015)'s dark sky forms an example of *static time,* whereas the clouds move but the time of day is fixed at 6pm).

I wanted to explore how computer simulations, and algorithmic images more generally, "…are happening at temporal levels that simply do not correspond to the timeframes of human perceptual experience" (Mackay, 2015, p.57). This connects to

Hansen's most recent book *Feed-Forward* (2015), in which he explores the ways in which contemporary media "bypass consciousness" in order to more directly solicit people, via social media, online behaviour tracking and predictive analytics. It also relates to Rossaak's ideas about how the non-image has opened up a new space for power to inhabit. There are also parallels with geologic time, which is discussed further in Phase 3 of the research.

Slowing the process of disappearance down was also a way of being able to better examine the processes at hand, to make it easier to focus amidst the frenetic speed of techno-culture. A sofa was set up in front of *Floating Point* (2016) to encourage audiences to take their time. I was surprised at how long some people stayed and were immersed in the work.

Building on terminology developed in Phase 1, the work expanded on the idea of synchronised time by synchronising the duration of the artwork with the duration of the exhibition. This decision was partly practical – it makes sense to choreograph events over the duration of the exhibition – but motivated also by the idea of the artwork existing as a pseudo-scientific experiment, with an exact timeframe.

Algorithmic Images and Non-Images

The temporal recalcitrance of the computer simulation is just one example of a broader ontological instability brought about by algorithmically produced and distributed images. The following quote was used for signage at the *Floating Point* exhibition: "Essentially the image has become an unstable object, indeed a processual object, never really at rest, always open to new computations and manipulations. Algorithms can, so to speak, manipulate the quality of the medium of the image." (Mackay, R., 2015, p.54).

One of the key consequences of Rossaak's algorithmic turn is that the edifice of the image and its power relations operate within an invisible domain, beyond, under or outside of the image. Within this non-image space the agency of the materials/semiotics of media have started to behave differently in relation to politics, society and culture. Whilst the surface stays the same, the invisible components are undergoing radical behavioural changes, like alien infected humans in *The Invasion of the Body Snatchers*. "The non-image component plays, in many ways, a much more important role than ever before, when it comes to the construction of the image." (Mackay, 2015, p.52). I wanted to explore the ideas of submerged components of the algorithmic image via the iceberg motif, and also by referencing the use of computer simulations to prove or disprove climate change. Like the self-destructive elements of *Wireframe Valley* (2015), the submerged theme was not pursued after this chapter, although it served its purpose as a way of exploring algorithmic images.

Not only are parts of the image invisible to the audience, but to perceive the image completely, complex algorithmic materiality in all, we can no longer be human (Mackay, 2015, p.52). Harun Farocki's work on operational images - that is images produced by computer for computers, unseen by humans is also relevant here. This is exacerbated by the "deep opacity" of software (Frabetti, 2015, p.xiii), in which complex processing systems are concealed behind a simplified user interface. Sometimes even understanding the interface can be difficult.

This is a worrying prospect in many ways. Invisible components of media and communication are often used to pass messages from select groups where information is sensitive, dangerous or not deemed to be 'in the public interest'. The privacy scandals of the late 2010s serve to demonstrate the global ubiquity of the public interest being violated by the commodification of user data. Concealing non-image components also conceals a world of labour and production behind the surface images. The digital nature of CS techniques creates a tendency towards immateriality, and subsequent postmodern explanation of it.

Artists must find a way of presenting the algorithmic components of work in a way which makes sense on an artwork per artwork basis. My practice has so far used algorithms in a concealed way, which is something I would like to change in order to bring the behavioural aspects of the work out into the open. I started to learn more about algorithmic categories and strategies that could help construct and decode the use of algorithms in my own and other's work.

The algorithm can be as impactful as the aesthetic components of the work. The artificiality of the virtual environment does not limit or nullify politics, be it the two-dimensional petri dish of John Conway's *Game of Life* (1970) or the lively three-dimensional environment of *Grand Theft Auto V.* This can be seen in Gerard Vichniac's *Vichniac Vote* algorithm, in which cells are programmed to change colour to match the dominant colour, simulating a process of homogeneity. Here, the algorithm is susceptible to peer pressure at a cellular level…"it looks to its neighbours to observe the latest trend. If the cell's colour is in the majority, it remains unchanged. If it's in the minority, it changes" (Pearson, M., 2011, p.137).

Casey Reas claims that although simulations make use of parameterization, their "bottom-up mechanisms … make it very difficult to predict how a particular system will behave. Each iteration will have different results, which may not be obvious from the description of the system. "(Reas, C., & McWilliams, C.,2010, p.149). This view, however, does not consider the variable algorithmic strategies that can be employed in a computer simulation.

Shiffman's *The Nature of Code* (2012) helps by exploring different types of algorithms for simulating natural phenomena. Noise algorithms can help simulate natural

variance and randomness. Vector algorithms simulate the position of objects in Euclidian space. Force algorithms simulate physics: motion, gravity, mass, friction, resistance. Trigonometrical algorithms help simulate more sophisticated movement based upon the calculation of angles. Particle System algorithms help simulate the behaviour of multiple objects simultaneously. In this sense, algorithms are not transparent replications of real world systems, but are distinct sequences of instructions.

Schiffman then separates algorithms into three levels of system complexity:

1) the control of inanimate objects living within a world of forces with desires, autonomy and the ability to take action based upon a set of rules (system)
2) objects that live in a population and evolve over time (complex system)
3) Objects with artificial intelligence, capable of learning over time and making decisions based upon analysis of their surroundings. (complex adaptive system).

This distinction is a useful way of critiquing the *Floating Point* exhibition, in that my practice operates at a system level. It also provides greater clarity to how CS can constitute different forms of system, network and assemblage.

Although I do not necessarily think that increased complexity and emergence are the only direction to take my research and practice, it is useful to acknowledge the limitations of the algorithmic strategies employed in the work.

Whether a computer simulation uses systems, complex systems or complex adaptive systems also dictates how the artwork relates to notions of artistic indeterminacy. The end frame of a 10-minute indeterminate computer simulation has not yet existed, and therefore cannot be known. The end frame of a 10-minute video has been constructed, edited and rendered. It already exists as a file on the hard drive of the computer that plays it. For computer simulations, the frame only exists when it happens, and unless a video capture device is being used, it is discarded as soon as the next frame is generated.

More significantly, John Gerrard notes that the indeterminacy of the camera position in his work increases the significance of the audience's role in observing it: "…the image, which is sent to the screen, where it exists for one fortieth of a second… But that image that's sent to the screen is not recorded, it's immediately discarded. So it's only 'recorded' in the memory of the participant, the audience who sees it". (Mackay, 2015, p.73). The images produced by computer simulations can be considered palimpsestic, continually overwriting themselves like data on a hard drive.

Authorial hybridity

Computer simulations are products of authorial hybridity. Using the videogame as an example of a multi-authored CS, it is notoriously difficult for videogame designers to

isolate their own specific input, as objects and processes are multi-authored and constantly overlapping and interacting. This is further problematised by videogames undergoing almost constant rewriting to fix bugs or add new features. CS artworks can be considered thus – as artists work with software, hardware and assistants, they form part of an assemblage of pre-authored, co-authored and individually authored actors within a network.

Many artists work in a team, which is a completely normalised practice within the art world. However, it would be easier for a team of artists painting spots or gluing butterfly wings to identify their own work. In a computer simulation the individual authored processes (writing code, animating key frames, three-dimensional modelling) all rely on aspects of one another's functionality in order to create the simulation, creating an assemblage which is difficult to accredit to a particular contributor. This point also applies to individual artists who may, like I have, purchase models, download plug ins, and assemble environments from a range of differently authored sources.

The technical complexities of creating a three-dimensional computer simulation inevitably altered the work I was making. The concept for *Wood for the Trees* (2016) was simple, but the technical production involved extensive research and testing to achieve the required behaviours. As a result, it is easy to become lost in the process of modelling, lighting, tweaking, and remaking the same scene in different ways. Knowing when to stop and how to frame a project becomes a helpful skill to possess.

During the second phase of research I discovered more about how the making process can be influenced by software. Cox (2012, p.2) argues that software users' thoughts and actions are profoundly determined by the operating system or graphical user interface. This idea forms the basis of *Auto Illustrator* (2010) by Adrian Ward, which questions the power relationship between artist and software. The work initially appears to be a vector drawing program, but begins to take increasing control over the drawing process.

For Virilio, all technology involves the deferral of decision making to a machine, and thus places human morality and ethics at risk, although the extremity of this stance is not particularly helpful in analysing the detail and quotidian points of contact between software and artist. Although further research could be undertaken in this area, this avenue of enquiry seemed to be tangential to the material properties of computer simulations and as such was left at this stage of development.

Representation vs Simulation

Computer simulations do not follow the logic of Socratic representation (Gunkel, 2000, p.51) but resist the primacy of both image and world. In other words, "neither image nor the world is first" (Morse, 1998, p.21). Anne-Francois Schmid argues that "We should

avoid placing the real and simulation in a relation of opposition. Because then, the simulation becomes just an image…We have to conserve the heterogeneity between them. I would propose another syntax between real and simulation: they are not in continuity" (Mackay, 2015, p.78). This is a helpful way of articulating the issue of representation: CS possess discontinuous representational capacities, in which there is not a direct or easy continuity between source model and simulation.

As argued in the literature review, CS exist in excess of conventional definitions of representation as a result of their processual components and their capacity to generate reality through emergence (Parisi., 2013, p.9). In addition to image-based representation, CS are also capable of algorithmic representation.

Wardrip-Fruin's (2009) term *expressive processing* describes the way processes are distinctive and convey links to histories, economies, and ideologies (Wardrip-Fruin, N., 2009, p.4) and is most helpful to understanding the algorithmic representation of CS-related artworks. A key component of expressive processing is the allocation of instructions or rules to separate actors within a computer simulation. This is an accurate way of describing the allocation of different time behaviours to different objects within *Floating Point* (2016) and *Wood for the Trees* (2016). The process of making these works was highly modular and involved working intensively on separate models before assembling them within an environment. The logic of compartmentalisation is compatible with the notion of assemblages and extends beyond the processual aspects of the simulation to include the temporal, spatial and aesthetic components.

Are CS-related artworks representational? The general consensus is yes, although not in a conventional semiotic way. Computer simulated artworks contain representational elements whilst existing in excess of being entirely defined by them. On reflection, after having made several computer simulated artworks, the non-image aspects of the work, such as the programming and node structures are not seen by an audience, and as such this amplifies the aesthetic and representational aspects of the work.

As discussed in the literature review, Frasca modifies Peirce's sign model to accommodate the 'mental model' the audience may hold of the system being modelled. In this sense there is a secondary dimension of interpretation for an audience. I found this level of representational complexity to contribute to a general level of audience confusion about what medium was used to make the work during the *Floating Point* exhibition. One of the most commonly asked questions during the opening was 'What are they?' Although this uncertainty can be problematic in terms of how the work is received by audiences and curators, the ontological ambiguity of CS should be celebrated as a way of discussing the nature of contemporary image production.

Computer simulations are in a continual, processual state of being, meaning that they exist in excess of existing semiotic models, whilst still retaining representational

qualities. This duality is described by Parisi (Cheng, 2015) as the “reality of appearance and the reality of being”. Reflecting on the *Floating Point* exhibition, it occurred to me that one reason I had been using extended duration as a way of presenting the simulation as living system, with its own life span. Extending the duration beyond the limitations of film and video is a way of allowing the work to live alongside an audience for a while.

Simulating/Representing the Natural

Although it is not a necessary part of the characteristics of all computer simulation-related art, *the natural* forms a large part of my own practice. This is not included in the mapped characteristics of the CS in order to preserve the wider applicability of the research outputs to other artists and curators. During the first stage of the research, the natural aesthetic components of *Wireframe Valley* (2015) were under-theorised. During the second phase of making I attempted to make sense of this area alongside theory.

A key emerging issue relates to the *where* of the simulations – the locations I have chosen to simulate. In *Wireframe Valley* (2016), this was a landscape scene chosen in relation to the agricultural context of the gallery and exhibition, in addition to a visual similarity to classical landscape conventions. In the *Floating Point* exhibition, *Floating Point* (2016) was a location in the arctic sea modelled from several reference images. *Wood for the Trees* (2016) denied any connection to a real place, and *Cohort* (2016) used the spatial environment as a metaphor for social progress. I purposefully dealt with ‘the natural’ in different ways to get a sense of how it was functioning within my practice.

With *Wood for the Trees* (2016), I was interested in how visual fidelity and photorealism were manifest. As documented in the previous section, the backgrounds, trees and vegetation were removed from scene, leaving only a small patch of grass with a single tree. This marked a shift in strategy from landscape to object. I was interested in focussing the meaning of the work on a single object, to simplify the visual language of the simulation. During the roundtable discussion it was remarked that the work had lost the connection to the natural, and that it was more akin to the visual language of videogames. This was partially due to the isometric perspective of the grass, which had connections to ‘god games’ like *Sim City* and the lighting, which produced a less photorealistic render than in Floating Point. More obviously, the work is made using software tools designed to create videogame environments, so it is difficult not to attract comparisons, unless the level of photorealism is high enough to seem real.

Although computer simulations are not always simplifications of reality (Wardrip-Fruin, N., 2009, p.4), non-photorealism has an immediate visual similarity with videogames. I have often tried to achieve near photorealism to create a contrast between diegetic and non-diegetic elements (for example between the rendered and wireframe

components) or in order to pull the audience into a state of ambiguity between negotiating the virtual and the real.

From a critical perspective, photorealism could be considered an unthinking proliferation of simulacra. James der Derian argues that the logic of technology is to achieve better and more accurate levels of realism (der Derian, J., in Mackay, R., 2015, 79). Photorealism is not a prerequisite for computer simulations, however. The simulation of behaviour is equally as important in terms of achieving a sense of vibrancy within the artist's work. Ian Cheng's simulations contrast with my own in their foregrounding of behavioural fidelity over visual fidelity.

Fidelity is a useful concept for computer simulations, as it incorporates behavioural and aesthetic frames of meaning, in addition to helping differentiate between scientific and cultural computer simulations. A physics lab testing the impact of a force on a virtual vehicle must accurately calculate and model the mass and velocity of the simulation components, for the simulation to generate useful knowledge. In videogames, a physics system that governs how cars move, operates on the same codified principles of mass and velocity, although is not required to accurately mimic the real-life handling of a car in order for the game to be fun. In fact, videogames that simulate real life to a high fidelity, such as *Flight Simulator* are often referred to as simulators instead of videogames.

Graphical fidelity also relates to the use of wireframes within *Floating Point* (2016). During the making process I learned of the term *breakdown,* which refers to when a simulation illusion ceases to be convincing. Wardrip-Fruin (2009, p.37) uses *breakdown* in relation to the shortcomings of the *Eliza* AI program, in which audiences gain a momentary insight into the underlying processes of the simulation.

The wireframe elements of *Floating Point* may evoke a sense of Baudrillard's simulacra in the sense that real has been displaced by the virtual. Aaron Marcus' use of wireframes within early computer artwork *Cybernetic Landscape* (1971-4) was described at the time in such immaterial terms "Computer graphics effectively interfaces with man via light. The images have no mass, no physical substance in a sense, but they are perceivable and meaningful to the viewer." (Marcus, 1975).

However, the use of wireframe aesthetics and the revealing of digital image construction processes could be thought of as anti-simulacra, in that they sabotage the hyperreality of the image and point back to an original object. This builds on the *Aesthetics of Debugging* in Phase 1 by developing a political purpose to the use of wireframes.

How do simulations function as contemporary art practice?

What is it about simulations particularly that make them interesting in our specific contemporary circumstances? There are multiple points of contact between CS and

modernist and contemporary art practices, although they resist being reduced to any specific perspective, due to the variety of art practices that employ them, and the intrinsic recalcitrance of the medium. There are, however, issues that computer simulations particularly resonate with – the limitations of human perception in light of widespread media culture, especially in relation to extended durations and programmable objects. As media corporations wield massive power through data collection, surveillance and targeted advertising and news, we live in an epoch of the non-image. The power of the non-image is at once material and immaterial. It flows through huge networks of underwater fibre optic cables and data centres, and yet is invisible within quotidian social experience.

As such, computer simulations are toolkits for artists exploring behaviour and processes, via closed and emergent systems. In this latter, emergent, sense, computer simulations become gyms, laboratories or sandboxes not only for questioning their own form, but for playing with the stuff of life. Gunkel describes VR as having the "…potential to become a laboratory in which to challenge and investigate the metaphysics of representation" (Gunkel, D., 2009, p.51).

This capacity for modelling behaviour makes them extremely useful for creating micro and mesocosms, in which simulations of the natural world can be re-programmed with behaviours that change our perspective of the real world. The game engine tools that are so useful for this purpose make such world building processes more expedient through readymade assets, and simulated components such as terrain, sky, clouds, wind, vegetation and so on.

As an artist's practice, they are one of many ways in which artists use software to explore technoculture. The practice is not medium specific as such, but a way in which to respond to the mechanics of larger cultural, social and technological systems. They are complex and difficult to use as artist's tools, incorporating a constantly updating volume of esoteric knowledge that shifts in specifics on a project to project basis.

From a curatorial perspective, they are challenging to exhibit. The where, when, what and why of a simulation can be difficult to pin down and require thinking through on an individual basis in relation to how the work should be exhibited. The additional level of ambiguity caused by programmatic nature of the works, namely the problematisation of semiotic models and potential for processes central to the concept of the work to be hidden, also provide a barrier for audiences and curators to engage with the work.

This study answers the question of how CS function as contemporary art by observing how they relate to contemporary life, and their dual interest as tool to explore other issues and as a medium in itself. Computer simulations are an ideal medium through which to explore processes and behaviours in the world, and an assemblage of processes and actors worthy of exploration in their own right. It is apparent, however, that

further study is required to answer this question in more detail. A more appropriate methodology would be via artist interviews and closer examination of their work and ideas, a process which was outside of the time frame of this study owing to the time intensive nature of the practice.

What theoretical frameworks are most suitable for making sense of computer simulated artworks?

It is difficult to discount aspects of postmodernist simulation theory entirely, which is perhaps why the concept of simulacra was so persistent during Phase 2 of the research. Postmodern ideas, however, do not exhaust the contexts for understanding and discussing computer simulated artworks. This chapter has discussed how traditional and historical understandings of CS characteristics – particularly representation and authorship, are still relevant, although only to distinct actors or subnetworks of actors (remediated or otherwise) within the larger assemblage of the CS, which subsumes such discourse within a larger relational framework. Here, the language of Actor Network and Assemblage Theory help to understand the complex network of components.

In the *Floating Point* exhibition, there was a postmodern baggage that accompanied the exhibition of virtual works. As discussed, this is the product of the "deep opacity" of software, the complexity of algorithms, the impenetrability of the work for an audience, and a general distrust of the computer-generated imagery as a poor replication of real life. Baudrillard's notion of simulacra works well as an explanation for the proliferation of meaningless culture and the common feeling of disconnect from physical reality that digital culture can often bring. When we see a sea of video-recording mobile phones held by audience members at a music concert, it is difficult not to balk at the disconnect from the 'real' performance taking place on stage.

Much of the practice and writing undertaken during this phase of the research can be understood as aesthetic and visual language-centric, exploring the characteristics of the computer simulation in order to examine the image as simulacra. An emerging issue from this stage in the research is that adopting a purely postmodern framework to understand computer simulations conceals their physicality as metals, plastics, electricity and light, as well as the labour and raw materials extracted from the earth to make them.

To adopt an exclusively postmodernist practice and perspective is to perpetuate the immaterial connotations of simulation theory a la Baudrillard, whilst ignoring the tangible, quotidian relationships between technology and nature- that of rare earth and silicon mining and processing, silicon chip production and the afterlife of computer products as waste. This criticism could feasibly be levelled at CS artworks that work with speculative locations and objects without reference in the real world. In this sense, they play into the hands of Baudrillard's idea of simulacra.

Postmodern ideas, especially Baudrilard's concept of simulacra – possesses an ontological similarity with new materialist notions of agency, such as Bennett's vitalism or "thing power" (Bennett, 2010) and DeLanda's emergence (DeLanda, 2015). The former possesses an inherently negative purpose as the invisible machinery that serves to proliferate simulacra. The latter has the advantage of being politically neutral. New materialist notions of emergence provide a more flexible structure for understanding the agential properties of CS, by freeing them from a singular destructive purpose and acknowledging wider, more complex functionality.

This partially answers the research question whilst opening up a larger, more long-term research context for exploring computer simulations in relation to the Anthropocene, ecology and geology. There are other areas of exploration that new materialist philosophy open up which are less interesting to me as an artist, at least in the short term. The 'usage' stage of simulations and media technologies for example – the times at which simulations exist on computers and mobile devices, and function within networks and assemblages of digital culture – could be another fruitful research area. This may constitute research into how simulations function within entertainment and military contexts, or, with more relevance to this study – as a way of exploring how climate change data is simulated.

D) Outcomes and Revised research aims

The second phase of research was helpful in revisiting some of the under-theorised and underdeveloped aspects of practice in Phase 1. A more thorough appreciation of time and algorithms, in particular, has surfaced through the making and reflection on the *Floating Point* exhibition.

This chapter also mapped out further characteristics of computer simulation, drawing upon literature and practice and thereby answering a primary research question. This set of characteristics generates useful curatorial knowledge and reference for artists. It does however, lack input from a new materialist perspective, which will be resolved in the following chapter. A limitation of this methodology is the bias towards my own practice and interests as artist. A tension exists between attempting to create a general map of computer simulations and documenting the progression of my own work. Although that tension exists, effort is made to signpost when the research findings may be more appropriate to my own research trajectory.

A more informed description of CS artworks was developed, using my own work as a basis. In practical terms, the artworks created as part of this research study can be described as real-time, virtual environments in which programmed, algorithmically controlled events take place. The environments are populated by programmable objects,

the rules of which are executed over time. The algorithms are connected into a system, although not a complex or adaptive complex system that could produce high degrees of indeterminacy or emergence.

One of the strongest outcomes of Phase 2 was the elucidation of algorithmic functionality within computer simulations. Algorithms are argued to be material elements, but complex and predominantly invisible to audiences. This constitutes a major rationale for the importance of this study. The implications of how power is manifest through non-visual means is a gravely dangerous proposition for culture, society and politics. As frequent mis-uses of power by tech giants emerge, the real world and quotidian implications of algorithms are becoming more widely apparent. Algorithms control the creation and distribution of information, which utilise supposedly private user data to alter beliefs and opinions. The impact of algorithms is no longer an impending doom but a ubiquitous norm.

The research outcomes offered specific language and terminology from a range of sources to help understand and differentiate between algorithm use in artworks, critiquing my own work as an example. Building on existing theories, the algorithmic behaviours of artworks were discussed as different type of representation, in which the representational components of the artwork are subsumed into a larger assemblage that cannot be reduced to an entirely representational form. In this sense, the computer simulation as *assemblage* cannot be entirely representational as it is continuously productive of reality whilst also representing aspects of reality. In some ways this suggests that the ontological paradox of computer simulations will only lead to theoretical supposition. In other ways, the proposal of using an assemblage framework in which to understand computer simulations is useful and merges to different aspects of theory together to map their ontology.

The next research outcome related to the temporal characteristics of the computer simulation. This was explored through practice, experimenting with video and real-time works side by side. Time was found to be complex, relational and abstractly manifest within CS. It is of primary ontological importance to CS, as *models in time* or *assemblages in time*.

The time logic for *Floating Point* (2016) and *Wood for the Trees* (2016) was developed from the problematic simplicity of *Wireframe Valley* (2015). Instead of the time logic being hard coded, and the artwork left to run for the entirety of an exhibition, the latest time logic separates the overall artwork timeline into separate files for each day. This significantly improves the ease with which it can be displayed within a gallery situation. There is still room for improvement, as *Floating Point* (2016) and *Wood for the Trees* (2016) are still essentially hard coded for a specific duration, they are just less

prone to crashing. Ideally the next iteration of the time logic can become completely parametric, whereas an artwork can be programmed to play over any duration without hard coding or re-compiling.

A key development in my practice after the second research phase was to reconsider the use of locations within the work. Previously the simulations had been loosely based on photographic reference, but the real-world location was not prioritised within the concept. The speculative environment of *Floating Point* (2016) is not tied to a particular place in the world but instead holds its primary reality within the parameters and execution of the software. As discussed, this could invite postmodern readings, especially in relation to simulacra.

In future I intend to work with real locations that have significance to the materials of the computer simulations – silicon mine locations, factories in which silicon chips are engineered, or locations where waste is dumped. Such a use of location is a more direct route to 'where the action is' - mining, manufacturing and waste sites, for example. Confronting an audience with one of these locations provides an immediate connection – whether immersive or not – that a larger world exists in order to serve the existence of the computer simulation.

My early practice critiques the media construction of 'the natural'. The deconstructive and destructive elements relate to Metzger, Tinguely and the criticism of the post-apocalyptic era played out especially in post war America. My practice, however, is directed at postmodern ideas about the gap between media reality and the world as we know it. Although I was aware of the postmodern aspect of my practice in conceptual terms, my hunch was that there was more to how simulations function as artworks now as opposed to in the 1990s, such as becoming useful tools for exploring the relationships of behaviour and objects in systems. Further reading is necessary in relation to new materialist philosophies and media materiality to underpin the next phase of practice.

In the next research phase I intend to explore complex and adaptive complex systems in order to move away from the determinate, fixed nature of the simulations created so far. Another central aim is to find ways of connecting the materiality of the computer simulation with the semiotic, aesthetic part of the work.

More reading around new materialist philosophies, media materiality and media ecologies will be required to reveal and stimulate new areas of practice. As such the following research questions have been generated to direct the third and final phase of the research:

- What are computer simulations in new materialist terms?
- How can these ideas be explored through practice?

Chapter 6

Phase Three: *Wireframe Valley* (remade, 2017)

a) Context
b) Edited documentation of the making process
c) Identification and analysis of emerging themes
d) Outcomes and revised research aims

A) Context

This chapter documents the context, making and discussion of *Wireframe Valley* (remade, 2017) for NEoN Festival in Dundee. This chapter marks a detour from the intended trajectory of the research, which was to create a simulation of a silicon mine for the final exhibition. NEoN Festival, however, provided an opportunity to develop the visually scripted time system within previous works, and also to contextualise an existing artwork within the curatorial theme of media archaeology. The research questions for this phase remained the same and are discussed in *Section C - Identification and analysis of emerging themes.*

Kelly Richardson curated the CentreSpace area at Dundee Contemporary Arts and wanted to show *Wireframe Valley (remade, 2017)* (Figure 45) alongside Paul Walde's *Requiem for a Glacier* (2013) (Figure 47). The skeleton of an extinct Tasmanian tiger (Figure 46) was also exhibited opposite *Wireframe Valley* (remade, 2017).

B) Documentation of the making process

Wireframe Valley (2015) was originally made in *CryEngine*, which had undergone several changes to its software and licensing terms in the past three years. It was possible to change the code from a 3 month to 2 weeks duration, although it would have taken an excessive amount of time to re-create the file within the new version of the software. Having used *Unreal Engine* successfully for the *Floating Point* exhibition, it seemed more efficient to rebuild the artwork using the visual scripting strategies developed in Phase 2.

The terrain and rock meshes were fairly straightforward to move into *Unreal Engine* (Figure 48). Some aspects of the work were impossible to extricate from *CryEngine*, such as the trees, clouds, birds and grass. The trees were recreated using *Speedtree*, the clouds were created using photographs. I couldn't satisfactorily recreate the same bird animations, so they were omitted. The grass models were purchased from the *Unreal Engine Marketplace*.

Figure 45. Dolan, Paul, *Wireframe Valley* (remade, 2017) Centrespace, Dundee Contemporary Arts, Dundee

Figure 46. Skeletal remains of the extinct Tasmanian tiger, on loan from the collection of the University of Dundee's D'Arcy Thompson Zoology Museum

Figure 47. Kelly Richardson helping to install Walde, Paul, *Requiem for a Glacier (2013)*

Figure 48. Work in progress view of Dolan, Paul, *Wireframe Valley (remade, 2017)*

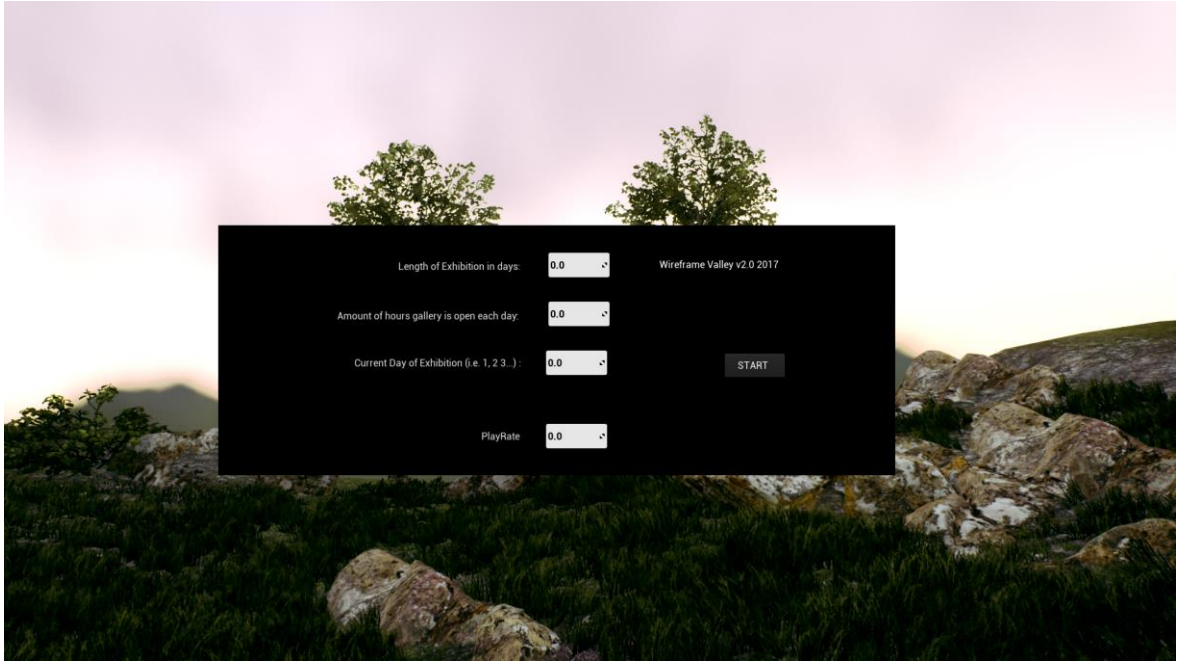


Figure 49. Updated menu system for Dolan, Paul*, Wireframe Valley (remade 2017)*

Building upon the progress with visually scripted time systems and gallery friendly menu interfaces, *Wireframe Valley* (remade 2017) was programmed to be temporally parametric. In other words, the work can exist in any different length depending on the exhibition itself. When the .exe file is opened, a basic interface (Figure 49) appears, in which data is entered to establish where on the virtual timeline it should start, how long it should play for, and at what speed. This system is easily reusable within other *Unreal Engine* projects and, once connected to different meshes and animations, could efficiently drive future artworks.

Wireframe Valley (remade 2017) more closely resembles the intended behaviours of the original, in that the materials slowly degrade to reveal the wireframe elements, rather than using a sequence of debug visualiser modes triggered to change over time. Despite the rapid developments of the game engine industry since the beginning of this research project, it was still impossible to gradually animate the opacity of a material to a wireframe mesh without hard coding it. This process was eventually created using a range of different strategies and tricks. There were two instances of each rock and tree in the scene, the material instance, which gradually became more transparent, and the wireframe instance which gradually became more opaque.

The vegetation is created from textures applied to single polygons, so it is not possible to use the same technique as the rocks and trees. In this case, the opacity parameters of the materials were animated to become more transparent over time. The terrain was divided into several sections and then subject to the same process, which

helped offset the timing of the disappearance. There was an unresolvable issue with the opacity masks on the grass objects, which caused them to look less realistic than intended.

The animation was created across 99 different objects within the scene using the *Sequencer* tools in Unreal Engine. The basis of the time logic was created on paper first. A significant amount of testing within the Unreal interface and blueprint systems was required before it worked properly. As with artworks created in Phase 2, one difficulty of animating sets of parameters is that the values are often non-linear, creating incredibly small number ranges that produce an effect. This could mean that the brightness value of an object may only be effective within the 0.001 and 0.002, which makes it difficult to keep track of decimal numbers when interpolating action over long periods of time. A 'test' script was created that played back the work at an increased speed, so decisions could be made about the timing and sequencing of animated events.

The work also made use of a *static time* set up, in which the time of day did not change. The visual set up and lighting is complicated by using day to night cycles as the materials and textures need to be checked against several different lighting conditions to see if photorealism is maintained. *Abstract Time* was also present, in the sense that multiple time frames of different speeds were present in the scene – the real-time movement of grass, wind, leaves and the slower timeline of the material animations.

A mid-range gaming computer was used to run the work outside of the gallery space, in a corridor, with a second monitor connected to make it easier to start up the computer and play the work. The projection wall was painted black around the frame to increase the contrast of the projected work. The space itself, although hidden in the basement of Dundee Contemporary Arts, was easier to light and control than the exhibition in Phase 2. A single pin light was directed at the tiger skull and the rest of the room was lit only by the projector.

Figure 50. Dolan, Paul, *Wireframe Valley (remade, 2017)* Centrespace, Dundee Contemporary Arts, Dundee

C) Discussion of emerging themes

The research questions for this phase of the research were:

- What are computer simulations in new materialist terms?
- How can these ideas be explored through practice?

This section builds upon the previously established characteristics of CS to focus on the material, curatorial and temporal knowledge generated by remaking and exhibiting *Wireframe Valley* (remade 2017). It builds towards an argument that CS should be considered within a holistic lifespan in other to fully understand their materiality.

Although it may seem reductive, the most straightforward way to conceive of a computer simulation in new materialist terms is to understand the physical materials that it is comprised from (Table 2). For a standard computer running a game engine, this would entail a plethora of metals, chemicals, plastics and compounds. This allows for research into the physicality and material of the simulation that is neglected in Baudrillard, Debord and Eco. It also creates the possibility of understanding how the material aspects of the simulation are connected to the material and natural world by considering their origin, the

manufacturing processes they are subject to, and the entanglements with human labour, usage and disposal.

Table 2. Common elements and minerals used in the manufacture of desktop computers (Minerals Used in Manufacturing Computers, 2012).

Component	Element	Element	Minerals
Printed Circuit Boards, Computer chips	Silicon	Si	Quartz, Chalcopyrite, Boronite, Enargite, Cuprite, Malachite, Azurite, Chrysocolla.
	Copper	Cu	Chalcocite
	Gold	Au	Au
	Silver	Ag	Ag, Pyrargyrite, Ceragyrite
	Tin	Sn	Cassiterite
	Aluminium	Al	Bauxite
Metal Case	Iron	Fe	Magnetite,Limonite
Plastic Case, keyboard	CaCO2 additive	Ca	Calcite, Gypsum, Apatite, Aragonite
	TiO2-white pigment	Ti	Titanite
	Amonium Polyphosphate	P	Wavellite
Liquid Crystal Display Screens, Monitors	Lead	Pb	Galena, Cerussite, Anglesite, Pyromorphite
	Thin film transistors	Si	Quartz
	Ferro Electric Liquid Crystal	Fe	Hematite
	Indium Tin Oxide	Sn	Cassiterite
		In	Sphalerite

Many of the materials used in the manufacture of computers are not contained in the final product, such as the 10,600 litres of water used in the manufacture of a single silicon wafer (Williams et al., 2002). In this sense, the media technology is only ever a temporary manifestation of the materials that comprise it.

As discussed in the literature review, a purely techno-materialist approach to understanding computer simulations does not allow space for thinking through the associated political, social and cultural issues. New materialist approaches that employ the term ‘media ecologies’ (Parikka, Fuller, Cubitt) apply the language of actor network theory to media materialism and create frameworks for understanding how computer simulations generate, but are also part of, a multitude of systems, networks and assemblages of human and non-human actors.

The theme of NEoN festival 2017 was Media Archaeology which helped to explore how a computer simulated artwork could be made and exhibited in the context of media

materialism. A valuable sense of context was also provided by sharing the exhibition with Paul Walde. His *Requiem for a Glacier* (2013) shows video footage of an orchestra performing a score created from climate change data in the Jumbo Glacier area of Canada. The juxtaposition of Paul Walde's work, and the inclusion of the extinct Tasmanian tiger's skull, created a sense that the real and digital worlds share a fading temporality.

This highlighted the importance of the curation and exhibition of computer simulated artworks within contexts that help audiences consider the nuances of the work. A discussion took place during the install about whether or not the computer running the work should be visible. In the materialist context, it could be a reminder to the audience of the material components that allow for the images to be generated. I decided to keep the desktop hidden, as it wasn't an intended part of the work. It felt crude to introduce the desktop to the space and interrupt the visual relationship between *Wireframe Valley* (2017) and the skull. The curator's notes for the exhibition, written by Kelly Richardson and Sarah Cook, described *Wireframe Valley* (remade, 2017) as such:

> "The theme of disappearing landscapes, and data as a form of media archaeological artifact, continues in Paul Dolan's real-time video work, *Wireframe Valley* (2017), which presents the gradual disappearance of a digitally constructed landscape, revealing its virtual origins. The defining features of the landscape degrade over the exact duration of the exhibition. In the context of global warming, where the physical planet is increasingly incapable of sustaining life as we know it, our refuge amongst digital environments may not placate us for long."
> (Richardson, K., & Cook, S. (2016) Appendix vii).

This was the first time that the ecological aspects of the work were as prominently discussed in the curation and exhibition. Whereas the *Floating Point* solo show had used Eivind Rossaak's concept of the algorithmic image as a unifying theme, this exhibition presented a more direct connection to global warming. During the *Floating Point* solo show it was difficult to discuss the ecological connotations of the work as the non-image, algorithmic focus had not yet been resolved within a larger framework of computer simulation materiality. In other words, during Phase 3, it became apparent that the research undertaken in the first two phases were exploring computer simulation materiality in a screen-based way – the software concepts and structures that allow the artworks to come to life on screen. Phase 3, with a larger emphasis on the physical and geological materiality of the computer simulation, created a framework in which ecological issues could be discussed more readily.

The media archaeology theme of the festival led to a reconsideration of *Wireframe Valley* (remade, 2017) in different material terms. Media archaeology is concerned with understanding the present by looking back at archival and historical examples of media.

“Archaeology here means digging into the background reasons why a certain object, statement, discourse …, media apparatus or use habit is able to be born and be picked up and sustain itself in a cultural situation.” (Parikka, J., 2012, p. 6). Here, the computer simulation becomes the product of media technologies, entangled within systems of human and non-human actors. Media archaeology leads to a focus on the usage of media technologies – how Victorian-era optical toys were used, how first wave virtual reality headsets were used, or how photogrammetry simulates rocks and vegetation in videogames, for example. This results in a less abstract definition of CS, by specifically linking CS to a snapshot of the physical devices, cultures and aesthetics of a particular era.

Although the history of media technology usage is a crucial concern of media archaeology, the approach also accommodates considerations of alternate histories, presents and futures. (Parikka, J., 2012, p.13). This anti-teleological stance is consistent with CS as complex adaptive systems, arenas of endlessly proliferating interactions and responses in which the same initial stimulus may result in different outcomes. Ian Cheng’s description of his simulated artworks as a “brain gym” (Cheng, 2015, p.113) in which different eventualities are played out over time, resonates with this idea.

A useful example of how media archaeology relates to computer simulations is *Atari: Game Over* (2014), a documentary in which filmmakers excavate a landfill site in Alamogordo, New Mexico, where thousands of *Atari* videogame cartridges were buried in the 1980s. In addition to the commercial failure of *E.T.* (1982), which was released in an unfinished state, a series of business missteps led *Atari* to dump the contents of a warehouse to landfill. This example is significant as it connects the algorithmic failures of the game code with the burgeoning videogame industry and the most high-profile case of videogame electronic waste. This one event demonstrates how videogames, one type of computer simulated experience, cut across economy, politics, culture and ecology.

Using a media ecology framework, it is possible to imagine the life cycle of a CS: mining, manufacturing, usage, and obsolescence. Each stage is temporally constituted by the age of individual and collective materials. The minerals and elements have existed since the world began. The silicon chip occupies a new temporality as a new technology, having undergone labour and energy intensive manufacturing processes. The usage temporality is defined by the quality of the materials, manufactured cycles of obsolescence, and the ebbs and flows of cultural relevance. The obsolescence temporality returns to a more materialist sense of time: how long will the materials take to degrade, what are the half-life of the toxic chemicals contained in the circuitry? How much of the device can be recycled?

The first stage, the mining and manufacturing stage, incorporates ideas of human transformation of minerals and elements into media technologies. In manufacturing parlance, the searching and extraction of raw materials is referred to as *upstream* and the processing and manufacturing of the materials as *downstream.*

Edward Burtynsky's photographs of mines and tailings lakes are impactful visualisations of both upstream and downstream processes, using medium and large format cameras to create abstract, beautiful images of the impact that mineral extraction has on the earth. The aerial perspective of the *Silver Lake Operations series, Lake Lefroy, Western Australia,* 2007, (Figure 51) makes visible the unseen scale and patterns of industrial manufacturing.

Figure 51. Burtynsky, Edward, Silver Lake Operations Series, Lake Lefroy, Western Australia (2007)

The media technology phase focuses on the active usage of the computer simulation as deployed or executed on or by a media technology. This includes computers, mobile phones, VR headsets, CAVEs, videogames and artworks produced by them. This obviously incorporates a huge amount of potential art practices. The focus on usage here may echo the concerns of human computer interaction, but it is more in keeping with the how human and non-human actors are assembled.

The final stage of obsolescence focuses on the computer simulation after its cultural use has expired or its components have failed. Although the capacity for demonstrating emergence or producing reality on screen may have ended, the computer simulations' materials continue to impact the environment, "…about 90% of the metal that goes into electronics eventually ends up in landfills, incinerators, or some kind of dump." (Grossman, E., 2006, p.3).

These markers of holistic temporality are not especially present in *Wireframe Valley* (remade 2017) but create a direction for future practice. During the remaking of *Wireframe Valley* (2017), a new time logic was created with *Unreal Engine's* visual scripting system *Blueprints.*

The original *Wireframe Valley* (2015) lasted for three months, and the visual disappearance was created by sequencing debug render modes to increase the wireframe appearance of the work. *Wireframe Valley* (remade, 2017) lasted for two weeks, and built upon the time logic from Phase 2 of the research to create a parametric duration. In other words, the work can be easily programmed to last for any duration by inputting values into a menu interface that appears when the .exe file is opened.

This means that *Wireframe Valley* (remade, 2017) is temporally unfixed until the point of exhibition. Instead of a document or a record, it becomes a set of dormant parameters ready to be enacted. The duration of the artwork synchronising with the length of the exhibition creates a sense of time being created rather than being replayed. This marks a significant behavioural change, despite fulfilling the same conceptual thrust of the artwork.

This relates to a media archaeological sense of temporal entanglements in two ways. The first is that the software used to create the work have changed since 2015, rendering the original work obsolete in its current form. This is a tangible indication of how the computer simulated artwork is only ever a temporary collection of disparate code and software iterations alongside hardware and material components. This is less a result of the manufactured obsolescence of the media technologies industry and more a result of the continual rewriting of the game engine source code and changes to payment and licensing strategies.

The temporal behaviour of the artwork, the slow disappearance of the landscape to its wireframe basis, prompts a sense of the life span of the virtual components of the work, in a critique of the finite and immaterial reputation of digital media. The parametric temporality of the work is, however, not particularly visible to the audience. It may be apparent with future exhibitions that the artwork is occurring over different time periods, and this could be made clear by documenting and sharing the duration of each exhibition.

There are opportunities to connect the duration of the simulation with the durations of processes and time frames related to its material processes. For example, a cloud simulation that grows in relation to the amount of water used in the manufacturing process of silicon wafers.

The disappearing, entropic agency of the algorithmic behaviour in *Wireframe Valley* (2015) and *Wireframe Valley* (remade, 2017) could also be considered to be negentropic, as algorithmic patterns form and strengthen. The destruction of the environment is not caused by an abstract sense of energy dissipating, but the increasing patterns that occur within the systematic plundering of the earth's resources and materials. Entropy and 'negentopy' are useful terms for tracking the directionality of connections between simulated actors. "Life is negentropic, perpetually constructing and defending order. The microcosmic density of ecosystems, human societies, and their interweaving moves toward the increasing mediation of all lives, all deaths." (Cubitt, S., 2017, p. 4).

Baudillard's description of the real world ebbing away creates an endless loop that is somehow after or outside of time. This rhetoric of the infinite can be considered a precursor to the rise of the Anthropocene within cultural studies and the arts. Cubitt (Cubitt, 2017) argues for the finitude of media, as objects intrinsically linked to the physics of time, space, matter and energy. In turn, there are a finite amount of physical resources from which to manufacture and power media technologies. Rare earth materials may be paradoxically abundant, but they are still finite. This relates to the way in which the artworks created as part of this thesis have a 'lifetime' or duration that matches the length of the exhibition.

The themes that emerged during this phase were driven by the natural accumulation of theoretical knowledge developed over the course of the research and also by the intellectual stimulus provided by the curatorial theme and exhibition at NEoN festival. The research methodology unfolded more fluidly as some of the technical and theoretical challenges of previous research phases became easier to work with.

D) Outcomes and changes to research questions

The remaking of *Wireframe Valley* (2015) was a valuable opportunity to refine the behaviour of the artwork and exhibit within a lively new media arts festival. The findings from this phase have led to changes to the 'characteristics of computer simulation' diagram (Figure 52) to incorporate physical and material aspects. The aim here is to update the material characteristics of the computer simulation to incorporate physical as well as digital form. The inclusion of a material computer simulation characteristic is hugely significant for this thesis, having dedicated much time to analysing the shortcomings of postmodern and immaterial conceptions of CS.

The representational capacity of algorithms was explored in Phase 2, although led to a deeper understanding of the CS as a rhetorical entity in Phase 3. The importance of how CS are curated and presented to an audience became clearer. Participating in NEoN Festival showed how the curation could lead to more urgent and interesting readings of the work being generated. This relates to how scientific CS (Roundtree, 2014), (Winsberg, 2010) and cultural CS (Bogost, 2007), (Frasca, 2007), (Wardrip-Fruin, 2012) can be considered rhetorical entities. It became clearer to me that the complexity and invisibility of certain CS characteristics require careful curation to amplify the most interesting parts of the work.

During Phase 3, theoretical contexts began to genuinely enrich the content and direction of the art practice. This may not have been entirely true of how *Wireframe Valley* (2017) was produced, given that it was remade, but I began to see how processes and ideas that had formed an intuitive part of my practice were now aligning with theory and practice in a productive way. Moreover, I could envision ways in which my practice could begin to function as an effective research tool beyond the doctorate, by exploring the real life locations and conditions of spaces pertinent to computer simulation production.

This phase was particularly useful for solidifying the overall concept of the computer simulation as an assemblage of hyperbolic elements – the real, virtual, slow, fast, determinate, indeterminate, representational, productive of reality, and so on. Each previously researched characteristic now became subsumed within a larger structure that existed as a condition of the relationships of the components within. This helped to better articulate computer simulations as components of a *model in time*.

Aspects of the characteristics in Figure 52 have been neglected as the temporal and material characteristics took centre stage in Phase 3. Due to the range of characteristics, it is difficult to revisit each of them at a required level of depth during each stage, although each characteristic has been fully contextualised and rationalised over the course of the three research phases.

In practical terms, I have started to work with real locations instead of speculative ones, with a focus on locations of significance to computer simulation materiality – silicon mines, laboratories, and media waste sites. This framework also has value for artists and curators, elucidating connections to art and philosophy into a flexible framework that can be added to and rearranged to help understand art practices that make use of computer simulation technologies or ideas.

The revised time logic in Figure 53 and Figure 54 show the technical node set up for how a parametric time interface was created. *Unreal Engine* nomenclature is used in case for artists wanting to replicate the same system. The nodes are difficult to

understand without knowledge of Unreal Engine or visual scripting processes, but in the interests of sharing knowledge, they are produced here in simplified form. It should be possible for others to reproduce a similar temporal logic using these diagrams. Variables were created for ‘overall days’ of an exhibition, the ‘current day’ and the amount of ‘hours per day’ the gallery was open.

These variables can be used to stretch a timeline file across any length of time. This removes the need for re-coding and re-compiling for each exhibition, and effectively future proofs the artwork as much as possible. The implications for an artwork occupying a parametric duration evokes the paradox of computer simulated time.

Time is reduced to a simplified mathematical algorithm, enacted thousands of times per second via the computer’s CPU. In this sense it is *microtemporal*. The act of modelling time also releases it from the flow of how seconds, minutes, hours and days naturally elapse. When in storage, between exhibitions, the artwork is temporally unfixed. In this sense it is *atemporal*. When the work is shown at an exhibition, a time frame is fixed and the work stretches to fill the duration. This provides the capacity for further long duration works in which the on-screen events occur too slowly for humans too see. In this sense it is *macrotemporal* and evocative of larger time frames.

In terms of an assemblage, this capacity for fluid temporality can be accommodated within the pre-established *complex temporalities* in Figure 52. Computer simulations occupy multiple temporalities at once. In *Wireframe Valley* (remade 2017), the grass, clouds and trees move at normal speed in relation to simulated wind, but the overall gradual decay of their materials into wireframes is operating on a much larger, separately enacted timeframe.

Emergent / Fixed

- Live simulations can be complex adaptive systems (non-deterministic) where unexpected behaviour can occur from relatively simple rule sets or;
- Complex systems (deterministic) in which the simulation occurs in the same way each time;
- CS production processes often involve both types of system.
- Can be presented as live simulation (software executed in real-time) or document of past event (video or still images, for example).

Agential/Lively

- In relation to Baudrillard's simulacra, CS self propagate images with no reference to a source object;
- In relation to new materialist philosophy, CS possess 'vibrancy' (Jane Bennett) or emergence (DeLanda);
- Emergent capacities are comparable with natural phenomenon such as morphogenesis.
- Agency is "…constituted in assemblages" (Casemajor, N., 2015 , p11).

Hybrid, Deferred authorship

- Artist controls parameters and machine executes accordingly;
- Dynamic and changeable relationship between the degree of control over simulation processes;
- Assemblage of different kinds of authorship (individually authored, co-authored and pre-authored) .

Interactive/Non-interactive

- Audience interaction may or may not function as part of the artwork's production or presentation.

Ontological Recalcitrance

- Ability to generate reality as well as represent reality creates an ontological disparity.

Spatial

- CS constitute multiple spatial modes (2D, 3D, code, software editor space, published simulation/presentation space, gallery space and data space;
- Often constituted as 3D virtual environments;
- Can be hyper-immersive (Accessed via VR headset, or installation) or immersive (projected on to surfaces or displayed on TV screen);
- CS processes involve dimensional fluidity. 3D models are 'baked' into 2D textures (terrain heightmaps, for example) and vice versa (generating terrain from elevation data);
- Can be considered a dynamic assemblage of spatial actors, which frequently change throughout the making and exhibiting process.

Rhetorical

- Algorithmic behaviours can be considered persuasive (Expressive Processing/ Persuasive Games/Simulation Rhetoric);
- Nuanced curation is required to amplify the most significant aspects of CS assemblages.

Algorithmic

- Rules and instructions processed incrementally over specified time periods to produce a result;
- Behaviours are applied to objects/models;
- Exist as (and controlled by) networks of relational parameters;
- Algorithms function as an expressive component of the work;
- Algorithmic processes can be visible or invisible in the artwork.

Representational / Productive of Reality

- CS contain representational elements (via the remediation of existing media or through simulated images);
- Whilst also existing in excess of representation via the production of reality;
- Represent real or fictional systems, objects and environments;
- Can possess high or low fidelity in relation to the world – playing Pac Man still feels like moving a real object despite the basic graphic representation;
- Representation is extended to the algorithmic components of the work.

Modelled

- CS are models in time or models in action;
- Abstract and specific systems can be modelled, from gravity to a door lock mechanism;
- CS often contain models of physical objects, environments, images, people;
- Behaviour can be modelled;
- Combination of real world data and proxy data (placeholder or stand-in data) are used to model the world or aspects of it.
- Varying degrees of fidelity to source system.

Temporal

- CS are comprised of multiple complex timelines;
- Dynamic networks of real time, key frames and simulated time;
- Often constituted as abstract time (time can be stretched, elgongated, represented parametrically and can flow at different rates);
- Static time (clouds move but time of day is fixed) and;
- Synchronised time (synchronised to real time, time zone, or the exhibition duration).
- Can be infinite or fixed length.
- CS are micro-temporal (produced by rapid cycling of the CPU to execute computer code and generate a virtual clock) and macro temporal (capable of being programmed to run for huge timescales).
- Can be infinite or fixed length;

Material

- Created from minerals and elements, through mining and manufacturing;
- Can be considered as assemblages of different materials throughout their lifespan – minerals, manufacturing, media objects, obsolescent waste.
- Even 'virtual data' exists as micro indentations on hard drives;
- The physical materials are an important part of CS – for example, computer hardware can impact how fast or slow the work is presented.

Modular

- Created using a variety of software, hardware, code libraries;
- game engines are especially modular in terms of consisting of a wide variety of software tools;
- simulations can contain simulations.

Figure 52. Continued from previous page. Updated *Characteristics of Computer Simulated Artworks*

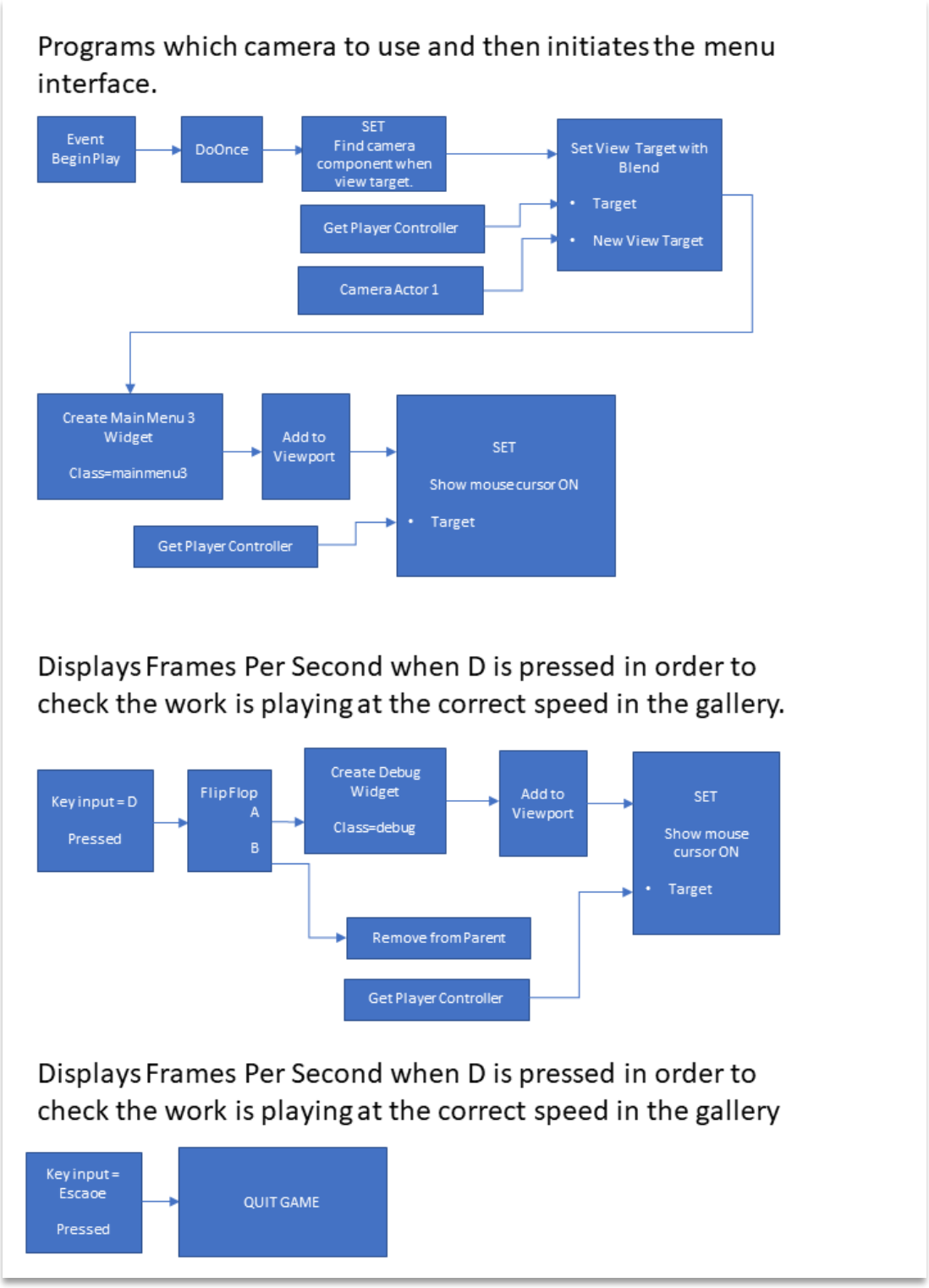


Figure 53. A Diagram showing a simplified version of the Level Blueprint for *Wireframe Valley (remade, 2017).* The node names use Unreal Engine nomenclature

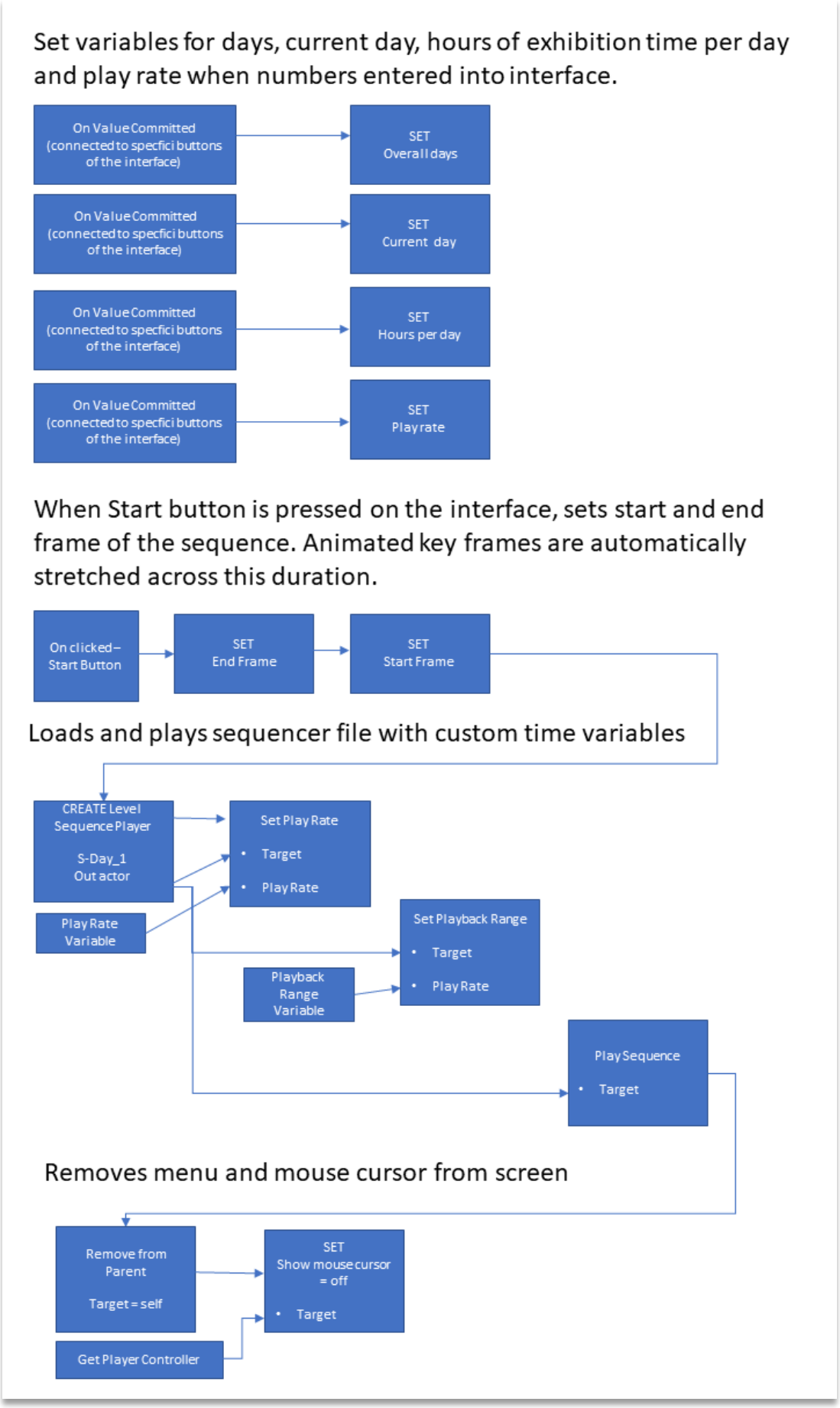


Figure 54. Menu interface blueprint for *Wireframe Valley (remade, 2017)*

Chapter 7

Conclusions

This study used practice to explore the nature of computer simulations as contemporary art practice. The characteristics of computer simulations, both in relation to software constructs and physical materials were considered, alongside a consideration of the most appropriate theoretical frameworks in which to understand them – the aspects of postmodern theory that pertain to simulation (referred to as *simulation theory* in the thesis) and new materialist philosophy.

During the three phases of research, artworks were produced alongside an ongoing literature review that fed into the reflection and discussion chapters, alongside the literature review itself. Reflection played a key part in identifying the points of contact between the artworks and the theories encountered during the study.

The research questions were modified at the end of each phase in order to identify the most appropriate direction for the research to move in. Although the research is predominantly motivated by the theorisation of my own practice, care was taken to distinguish between developments in relation to my own work and cases in which more general principles could be established, such as the production of Figure 52, *The Characteristics of Computer Simulated Art.*

This chapter takes the chronology of research questions as a structure, before considering some of the larger issues, reflections on the methodology and future implications. Care has been taken to articulate what constitutes new knowledge and the extent to which this builds on existing literature and practice.

Phase One

Practice Element: During Phase 1 of the study, *Wireframe Valley* (2015) was created over an 8-month period. It was commissioned for the *Land Engines* (2015) group show at Queens Hall, Hexham for 3 months in January 2015.

1. **What characteristics do computer simulated artworks have?**

The first question was approached primarily through the making of *Wireframe Valley* (2015) but also through researching artists working with computer simulation tools such as game engines. I intended to answer the research question by making an artwork that developed from my own art practice that could be used as the basis for analysis in relation to existing artworks, theory and frameworks.

As such, aspects of the knowledge generated had a particular bias to my own practice, such as the exploration of self-destructive artworks and the aesthetics of debugging. The remaining characteristics were more widely applicable to artists working with computer simulation software tools such as the spatial, temporal, algorithmic and representational. In the early stages of the research it was difficult to differentiate between what constituted a personal interest and what constituted useful knowledge for a larger audience of artists and curators.

The research methodology was successful, although inefficient. The first phase required intensive research and development to find out how to make the work, and intensive reading around the theoretical context. The use of practice to drive the research questions and findings was successful, however, and the intuitive decisions made within *Wireframe Valley* (2015) created plenty of opportunities for reflecting on and researching the significance of the how the work was made, and how it connected to existing theory and frameworks. As such, the first phase can be considered a partial success in terms of answering the research question, although a more detailed and considered answer was required.

Comparisons were drawn between simulations and videogames. Aspects of videogame terminology such as *diegesis*, respectively inherited from the language of film and theatre, were found to accurately describe some of the spatial characteristics of computer simulations. In this respect, the research outcomes were modest, but built on this knowledge in the following ways. Firstly, alternate modes of space such as *editor space* (how the environment appears to the artist whilst constructing it) and *run-time space* (how the work appears to an audience minus the graphical user interface) were considered, along with other concepts familiar to videogames, such as collision geometry and virtual cameras.

These findings are valuable as they apply software studies approaches to understanding software tools to the process of making CS artworks without the necessity for ludology or videogame rhetoric. This may seem slight, but it is particularly useful for artists and curators seeking to explore artworks that make use of videogame tools without conceptually exploring videogames themselves. These findings help identify the most prevalent aspects of existing frameworks, concepts and language that can be used to describe CS.

The relationship between algorithms and landscape was discussed in basic terms, although was under theorised at this point and required further investigation. This was identified as a key area of research for Phase 2, where it was pursued more thoroughly.

At this stage the theoretical knowledge of algorithmic image making was not developed enough to generate useful or novel knowledge.

The temporal characteristics were explored in depth, from a software studies perspective that considered how time is constructed within the game engine. This included the creation of new terms to describe how time was functioning in a variety of ways within *Wireframe Valley* (2015) and by extension, other artworks using similar techniques. The terms *abstract time* (to describe multiple dynamically organised and simultaneous timelines), *static time* (to describe aesthetic depictions of time that are not bound by time – for example an image of an evening sun set that never moves forward in time, despite possessing moving clouds) and *synchronised time* (in which the simulation timeline is synchronised to real-time, a time zone or the duration of an exhibition.

These terms create a more nuanced description of the different modes of time that can be at play within CS artworks, especially those created with game engines. This is of value to artists and curators as it adds detail to the complex and invisible mechanics of how CS artworks relate to time, which in turn creates broader opportunities for artworks and exhibitions seeking to understand the temporal aspects of computer simulated digital culture.

Simulated time was found to be relational, complex, and resistant to unified descriptions. The various layers of temporal construction unfolding within the same environment led to an interest in late systems theory and actor network theory. The way in which duration functioned in the artwork, similarly to the algorithmic components, was under-theorised during Phase One, although led to an interest in extended time scales and the Anthropocene.

The exploration of time as a component of a system is valuable for artists and curators as contemporary life is constituted through various temporal assemblages of digital media. On a daily basis, one might wait for an eBay listing to end, plant seeds in a virtual farm and watch them grow via a smartphone game, track the length of a run, set alerts for the most optimal time to eat and document moments in time by uploading a photograph to a social network, all while algorithmically generated notifications regulate our interaction with them. Some temporalities are abstracted, some are real-time, and we interact with all of them simultaneously.

Gibson’s Affordance theory was considered in relation to game engine interfaces and the potential for bias towards specific types of artwork being produced as a result of particular affordances, such as the hegemony of tools designed to produce first person shooter videogames. This brief exploration was not continued further as time and algorithms became the focus of the simulation characteristics.

Phase One of the research culminated with a better understanding of the characteristics of computer simulations from a software studies perspective and a better

understanding of how using such tools lead to a complex remediation of, and bifurcation from other art practices, due to the complexity and simultaneity of media processes in action. This laid the foundation for conceiving of computer simulations as *assemblages* at the end of phase 2.

2. What theoretical frameworks are most suitable for making sense of these practices?

Research undertaken during Phase One was focused around software studies, videogames studies, new media art and postmodern simulation theory. Theorists engaged with 'simulation theory', especially Baudrillard, have constituted the dominant way of discussing artistic practices of simulation since the 1980s and as such commanded the lion's share of focus. This initially broad reading of simulation-related philosophy became more focussed on Baudrillard's concept of simulacra during Phase 2. This was due to the lasting presence of his ideas in relation to new media art, and the way in which his use of natural metaphors lent themselves to exploration via visual art.

This research question led to a consideration of how computer simulations are understood in theoretical terms. Baudrillard, Virilio, Eco and Debord were considered in relation to computer simulated artworks. The immaterial connotations of these theorists was found to be overly focused on language, overstating the apocalyptic, and utilising a pre-internet concept of simulation to overstate how a speculative theory of language could explain the disappearance of the physical world. The ideas of Virilio, Eco and Debord were also explored in relation to simulation, which led to the beginning of a critique on immateriality and theoretical frameworks that attempt to understand media technologies exclusively via language and semiotics.

The main outcome in relation to the research question was the articulation of the limitations of Baudrillard's ideas about simulation and simulacra. Baudrillard's idea of simulacra hides materialism behind a self-propagating wall of signs that no longer bear resemblance to the original. This approach, although seductive in the face of mystifyingly complex digital simulations and representations of the world, ultimately fails to make room for the physical materials of the computer simulation, which are consequently entangled in a series of political, cultural, social and ecological systems.

Intensive reading was undertaken during this research phase, with a view to continuously reflecting on the making and exhibition of *Wireframe Valley* (2015). Although the research methodology worked well, a more sophisticated understanding of alternate theoretical frameworks was required before the question could be answered more thoroughly. Consequently, the research question was continued into Phase 2. Although a

criticism of the dominant framework for understanding simulation in art had begun to form, further research into alternatives to these ideas was needed.

The new knowledge generated by this phase was modest, although began to map out points of contact between existing art practices and computer simulations, form new terminology to describe how CS artworks function, and started to form a critical standpoint in relation to commonly held theoretical suppositions about the role of simulation within contemporary art. The research question itself is still relevant and useful for artists and curators, as the answer to which will create a wider and more contemporary context for artworks produced with CS tools.

Phase Two

Practice Element: *Floating Point* (2016)*, Wood for the Trees* (2016) and *Cohort* (2016) were created over the space of a year and exhibited as a two-week solo show at B&D Studios, Newcastle Upon Tyne in October 2016.

1. **What characteristics do computer simulations have?**

This research question was continued from Phase One to more deeply explore aspects of computer simulated artworks. The same research methodology was employed, whereas the artworks created opportunities for reading and reflection around the characteristics of CS. The research methodology was successful, but there was an intense switching between the practical, empirical, interpretive and critical elements which became difficult to manage and is evident somewhat in the variety of approaches and ideas explored within the artworks themselves. Despite this, the research question was answered more thoroughly, with more detail and research-informed reflection generated, especially in relation to time and algorithms. The following sections provide more detail about findings in relation to each of these characteristics.

The interactive and non-interactive components of my own practice were considered, with an argument made for interactivity not being a necessary component of a computer simulated artwork. Arguably the most well-known artist working with CS, John Gerrard, for example, does not use interaction within his work. In other notable examples, such as the work of Ian Cheng and Katie Torn, interaction with an audience is eschewed in favour of establishing algorithmic agency via the emergent capabilities of complex adaptive systems, or simpler algorithmic systems with higher degrees of indeterminacy.

The specific findings around the interactive capabilities of CS are valuable as they apply the language of systems theory to art practice in order to better describe how they behave. Exploring the emergent capabilities of CS led to the role that algorithms play in the operation of simulated behaviour, which is discussed in the next section.

The temporal characteristics of computers simulations were explored in greater depth, with the development of the phrase ‘hybrid temporalities’ to describe the simultaneity of interconnected time constructs at work. These ideas were considered in relation to real-time (*Floating Point*, 2016) and video artworks that made use of simulation tools as part of the production process (*Cohort*, 2016). My preference as an artist is to work with real-time processes, as they open up the possibility of emergence, indeterminacy and greater temporal control, tools which are useful for exploring key areas of how CS interconnect with the real world. However, video can be an equally expressive medium to work with depending on the nature and concept of the artwork.

Computer simulation temporality was found to be manifest within complex assemblages of software and hardware, with multiple layers of different time systems manifest within a single simulated scene. These findings formed the beginning of thinking about computer simulations as an assemblage, building on the way in which CS were found to simultaneously remediate and exist in excess of other media processes during Phase 1. This is a useful way of describing the compartmentalised, interlinked and autonomous nature of the computer simulation.

Further exploration of the terms *static, synchronised* and *abstract time* were considered in light of new artworks. These findings are useful for artists and curators as they being to describe the variable ways in which time is constituted within different actors within the artwork as system. This is helpful in terms of thinking about how artworks and exhibitions can be used to explore how complex temporal assemblages created via CS and more broadly, digital media, connect with our lives. The generation of such terminology is not intended to be exhaustive, given the research methodology employed, but as a starting point for considered the nuances of constructed time within CS artworks.

The function of modelling in simulations was explored, and findings from Phase One were updated to include how behaviours and social processes could be modelled. Computer simulations were found to consist of multiple, interconnected models of physics systems, physical and virtual objects, environments, characters and behaviours. These findings are of value more broadly to an understanding of how art and science intersect, as there are surprising amounts of commonality between the processes of artistic and scientific CS construction. Roundtree (2014), for example, argues that the CS processes employed in physics and biology experiments are rhetorical entities in the same way as Bogost (2008, 2010) does in relation to videogames and other culture.

In similar literature exploring the ontology and epistemology of scientific CS, Winsberg describes how scientists use ‘proxy’ models - models with “fundamental mathematical similarities to the model of the system of interest” (Winsberg, 2010, p.50). A proxy system can ‘stand in’ for a comparable real life system (such as fluid dynamics standing in for black holes (Winsberg, 2010, p.50). if the mathematical similarity and behaviour is close enough. A proxy model shares similarities with Baudrillard’s simulacra, as its replication of a source system is less important than its ability to resemble and replicate other systems that require modelling. The proxy system gains value not from its fidelity to the source, but from its capacity to stand in for other systems. This thesis did not set out to explore these ideas through practice, but they are one of several fascinating starting points for future interdisciplinary research.

2. **How do algorithms function within computer simulated artworks?**

Further reading into algorithmic culture was undertaken, with specific reference to theories from contemporary photography and new media art. Rossaak’s concept of the *Algorithmic Turn*, the era in which the majority of power relations are active within the hidden, non-image, algorithmic component of digital images was explored in relation to the computer simulated artwork. This led to the production of *Floating Point* (2016) and *Wood for the Trees* (2016), artworks that sought to connect the disappearance of the natural world with visual metaphors of the submerged and concealed parts of the non-image. Care was taken to articulate different approaches to using algorithms in computer simulation-related art beyond my own practice.

The algorithmic characteristics of computer simulations are manifest as rules and instruction processes in time, applied to actors within an environment. They provide artists with the ability to create active models of the world that can be interactive or non-interactive and highly authored or largely indeterminate.

The non-image components of the computer simulation paradoxically constitute their own illusion of immateriality whilst also providing a powerful toolkit for critiquing their own ontological recalcitrance. This area of research provided a significant contextual rationale for the importance of why this study and my practice should take place. An argument is formed that suggests the unique capabilities that computer simulations possess in order to critique the non-image power structures of digital culture in late capitalist society.

Further reading into systems theory, complexity theory and actor-network theory was undertaken, with a more specific argument made in favour of the capacity for emergence (complex adaptive systems) as the most unique characteristic of computer simulated artworks.

The research question was successfully answered through a discussion of Schiffman's (Shiffman, 2012) algorithmic categories (noise, vector, force, trigonometry and particle) in relation to CS artworks, which provided a more granular level of explanation for how algorithms behave as distinct sequences of instructions. These algorithmic categories operate within different types of systems, also defined by Shiffman:

> "1) *System* - the control of inanimate objects living within a world of forces with desires, autonomy and the ability to take action based upon a set of rules;
> 2) *Complex System* - objects that live in a population and evolve over time;
> 3) *Complex Adaptive System* - Objects with artificial intelligence, capable of learning over time and making decisions based upon analysis of their surroundings" (Shiffman, 2012).

Shiffman's language and frameworks are generated through practical knowledge of the mathematical structure, code and behaviour of algorithms. *The Nature of Code* (2012) is a textbook on how to code natural phenomena using the Processing computer language, although it is extremely pertinent to the understanding of how CS artworks operate algorithmically. Furthermore, the algorithmic and system categories can be used to add detail to the notion of a CS artwork as an assemblage.

3. **What impact do computer simulation practices have on our understanding of authorship and representation?**

Art historical notions of authorship were discussed in relation to CS artworks. Further knowledge relating to the role of authorship was generated, via reflection on the making process of artworks for the *Floating Point* exhibition. Authorship and simulation are commonly discussed in relation to artists responding to post-structuralist concerns of reproduction and originality during the 1970s and 1980s. Although there are many examples of artists appropriating videogame aesthetics and systems, I suspected authorship functioned more complexly within CS. Findings from Phase 2 suggested that due to the myriad of authored actors and systems within game engines and CS tools, that differing levels of authorship were distributed across actors in an assemblage.

The following terms were generated to describe how authorship functions in CS: *individually authored* (objects modelled or coded from scratch), *pre-authored* (models or assets supplied with the game engine or purchased through online marketplaces) and *co-authored* (models or 'starting point' templates such as *SpeedTree* models, that are designed to be modified parametrically). *Co-authored* can also be used to describe the tendency for CS tools, models and assets to be produced within small or large teams. This exploration of authorship is valuable in terms of identifying the nuances of how CS artworks relate to authorship and by illustrating how an assemblage framework helps make sense of complex and compartmentalised artworks.

The question of representation yielded interesting findings, exemplifying the ontological recalcitrance of the computer simulation. Computer simulations can be said to contain representational elements within a larger system of elements that exceed traditional understandings of representation and semiotics, due to the algorithmic components that they generate and are constituted by.

Drawing upon the Frasca's (2001) augmentation of Pierce's sign model, the limitations of a solely language-based conception of simulated representation are explored. These ideas are discussed in relation to Bogost, Frasca and Wardrip-Fruin's respective definitions of 'expressive processing', or the ability for algorithms to be considered as representational entities. The concept of fidelity was found to be a useful characteristic in that it can articulate the level of proximity the simulation holds to the real world.

The question of how CS practices impact on our understanding of representation is only partially answered by this study, by drawing upon previous research (Frasca, 2003) and articulating the representational challenges presented by the artworks produced as part of this body of research. An argument is also formed that representation can be considered as remediated images, models and behaviours operating within the larger structure of a CS that is also capable of generating its own images, models and behaviours. This is useful in terms of building an argument that CS are best understood as assemblages of distributed actors. The problem of CS representation is philosophically recalcitrant and would require a deeper and more technical handling of philosophy than is possible within the limitations of this study.

4. **How can the ecological aspect of the artworks be discussed?**

The problematisation of representation in simulation is discussed more closely in relation to my own practice and ecological themes. It is argued that computer simulated artworks do not need to be photorealistic or indicative of a real-world source system. This is discussed in relation to the meaning of the wireframe components of *Wireframe Valley* (2015), *Floating Point* (2016) and *Wood for the Trees* (2016). It is argued that the wireframe components serve as a disruption to the simulacra, as a method of pointing back to the media materiality of the simulated image. The concept of fidelity is again offered as a useful measurement of resemblance to a real world or fictional source system. Although this research question is satisfactorily answered, it is perhaps less interesting to a wider audience due to the focus on the specific aesthetics of my own work. This research question is more fully answered during Phase 3 of the research, in relation to new materialist philosophy and the geology of media.

5. **How do computer simulations function as contemporary art practice?**

This research question was answered by discussing how artists seeking to examine contemporary technoculture can use CS to do so, with sympathy to the difficulties in producing and exhibiting them as artworks. The dual interest of CS as tools to explore other issues and as an interesting medium in themselves is discussed. The artworks produced throughout the three phases of research could also be considered a partial answer to this question, as they exemplify technical and conceptual characteristics common to the CS.

The answer to this research question was considered in different ways. The first approach considers how CS function within *contemporary* art by taking care to consider its previous origins within military technology, entertainment and modernism. This was researched as part of the literature review, and the relationship between CS and modern art was continually discussed in relation to CS characteristics in Phase 1 and 2. The findings argue that CS provide tools that respond to the algorithmic condition of contemporary life, which is increasingly governed by digital technology and supposedly immaterial forces. Many facets of our lives are governed by the automation and digitisation of complex processes that originate with those in power and the software developers employed by them.

To illustrate this point, John Gerrard uses CS as a way of reconstructing locations, generally hidden from the public, that are responsible for the maintenance of digital culture, oil mining and automated agriculture. The presentation of the work as a real-time simulation presents the audience with the end-product of such hidden spaces (the digital image of the artwork itself) whilst simultaneously revealing its origin within the physical locations. Photographers who touch upon similar locations and ideas, such as Edward Burtynsky's *Manufactured Landscapes* (2003) or Richard Misrach's *Petrochemical America* (2014) are compelling artworks, but simulations can bring an audience closer to a more contemporary aesthetic experience – one that incorporates the algorithmic behaviour and complex systems that underpin our daily lives.

Another approach used to answer how CS function as contemporary art was to consider them CS in relation to other mediums. The first research phase considered CS in relation to videogames and concluded that ludology and game rhetoric were limiting frameworks for understanding CS artworks, despite sharing the same or similar production methods. The second research phase more closely considered CS in relation to photography and video, especially at an algorithmic level. It was argued that CS are a distinct medium due to their capacity to exist as complex adaptive systems, which can generate reality as well as replicate it. These distinctions are useful in a curatorial sense

as CS artworks can often be indistinguishable from videogame artworks, yet relate to different artistic and conceptual contexts.

The final approach to answering this question was by considering the ‘practice’ element in more detail. The use of CS in an artwork often involves complex and esoteric processes that require some degree of knowledge in computer generated imagery and coding or visual scripting. These practices are not commonly taught in contemporary art degree programmes, but rather as process-driven qualifications designed to secure graduates jobs in the videogame or animation industry. There is always a degree of foundational knowledge required before artists can make CS artworks, and the practice of making them within contemporary art contexts are often the product of continuous problem solving which, after time, equates to a satisfactory level of proficiency.

This research question was answered successfully and constitutes useful knowledge for artists and curators seeking to understand the broad terms of how CS relate to contemporary art practice. Although it was beyond the scope of this thesis, this research question could be more fully answered in future by interviewing artists working with CS tools and ideas. This could help test ideas developed in the thesis for wider applicability to other artistic practices.

6. **What theoretical frameworks are most suitable for making sense of computer simulated artworks?**

A stronger argument for the rejection of postmodernist conceptions of simulation – specifically Baudrillard’s - as the dominant theoretical framework for understanding simulation in art was proposed. It is argued the material characteristics of CS create meaning and value by reflecting, and allowing artists to play with, complex systems that occur in the real world. Theories that favour immateriality (either directly or by connotation) and totalising metaphors cannot account for material and the detail of interconnections in complex systems. This research question was partially answered at this stage, via reflection on and discussion of theoretical frameworks in relation to my own and other’s practice. Actor network theory, emergence and new materialist philosophies were identified as areas of interest for Phase 3 in order to more fully understand the field of new materialist philosophy and its connection to computer simulations. This occurred via an initially broad literature review and then with a focus on philosophy relating to media materiality.

Scripting Parametric Time for Real-time Artworks

In addition to the contribution to knowledge provided by the detailed consideration of computer simulation artworks in relation to theory, new knowledge was also generated

through the artworks themselves. In particular, the *Unreal Engine* visual scripting system used to program the time and events in the artworks was developed in order to be more gallery friendly and robust. This has led to the formation of a visually scripted code that can parametrically control the duration of an artwork without having to rebuild or recompile.

Working with long durations can be difficult to achieve with game engines, as they are often set up for the shorter temporalities of videogames. This parametric time system developed in this thesis is a useful mechanical starting point for artists that aim to program events over longer periods of time in gallery contexts. It is especially useful for future proofing artworks so they can be exhibited using different durations without rewriting and recompiling code. Although the software tools used to create it will inevitably change, the overall structure makes use of generic time functions within the game engine that should be applicable to a range of other software tools.

From a conceptual standpoint, the use of long duration artworks provides an opportunity to explore time scales that stretch beyond that of a human life. This idea resonates with the Anthropocene and the reconsideration of the human dominance in the world.

Phase Three

Phase 3 used *Wireframe Valley* (remade, 2017) to explore new materialist approaches to understanding the making and meaning of my own and others work, with an emphasis on media archaeological and geological perspectives. The remaking of *Wireframe Valley* (2017) was motivated by necessity, as the software used to make it had become obsolescent, and the work had been scheduled for exhibition at NEoN Festival, CentreSpace, DCA, Dundee, November 2017. The remaking of this work changed the research questions to more fully explore how new materialist philosophy – in particular ideas about media materiality- applied to the practice of making computer simulated artworks.

1. **What are computer simulations in new materialist terms?**

Computer simulations were explored in an explicitly material manner by considering the raw materials and elements used to create media devices – specifically the desktop computer – that CS require in order to operate. Caution is given to adhering to an entirely techno-materialist understanding of media, as this cannot account for the behavioural aspects of an artwork.

Although this may seem a simplistic realisation, it also indicates how profound the omission of technological materiality is from postmodern simulation rhetoric - especially Baudrillard's concept of simulacra. This realisation led me to re-evaluate many aspects of my artistic practice, such as how to create genuine connections with the real world by investigating physical locations of significance to CS and how to incorporate physical objects into exhibitions. New materialist frameworks unshackled my thinking from becoming overly software focused and reframed my art practice as a method for exploring the actual impact of CS on the physical world.

Media archaeology is explored in relation to the remaking of *Wireframe Valley* (remade, 2017) for NEoN Festival 2017, which led to a broader consideration of the material and temporal entanglements of media artefacts. This is found to be a useful framework for resolving the threads of media materiality, time and ecology that run throughout my practice, although media geology and media ecology are concluded as the most useful contexts for understanding my own work. An argument is built for understanding CS as complex assemblages of entanglements between the real and virtual, the natural and manufactured, and all manner of material actors that they simultaneously generate and are constituted by.

It is also crucial to conceive of CS as assemblages in time. The temporality of the CS is extended to incorporate the age of the materials used to create it. An argument is made for a holistic understanding of CS temporality, in which different stages of assemblage can be defined. The first is what engineers refer to as the upstream context – the sourcing and extraction of minerals and elements required to make the hardware and software upon which CS are dependent. The second stage is downstream – the manufacturing of these materials into media devices. The third is their life as media devices, used by people to create and share simulated images. This is the stage which postmodern theory has the most traction. The final stage is that of obsolescence, in which the devices are disposed of and recycled, with the materials finding their way back into the earth either via pollution, degradation or recycled object.

This broad view of the computer simulation is consistent with the rhetoric of the Anthropocene, the epoch in which humans have made a definite mark on the geologic constitution of the earth. In this sense, it is important to go beyond the phenomenological instant of the computer simulation and instead consider a broader context that allows us to identify and challenge the hegemony of immaterial media and labour.

During Phase 3 of the research, a better grasp of new materialist philosophy and media materiality theory was developed, which enabled more thorough reflection on the making of *Wireframe Valley* (2017). Although my own practice was used to answer this research question, the findings are broadly applicable to CS within other artistic contexts.

These findings are important in the overall trajectory of the research, as they

provide ontological answers to questions that are difficult to answer using postmodern frameworks such as Baudrillard's simulacra. The findings also correspond to Phase 2 research question *How do CS function as contemporary art?* by providing a contemporary philosophical definition. This is useful for artists and curators who may already be interested in the Anthropocene and looking to make connections with technologically-driven artworks.

2. **How can these ideas be explored through practice?**

Media archaeology is discussed in relation to *Atari: Game Over* (2014), and the way in which conceiving of the documentary as an assemblage can uncover the entanglements between computer simulations (in this case, the videogame *E.T.* (1982)), geology, media devices, eWaste, economics, politics and culture. Further examples are given in relation to the work of Edward Burtynsky and John Gerrard.

Figure 55. Poynter, Ben In a Permanent Save State (2012)

The holistic lifespan of the simulation is argued to be a broad but helpful context for future practice. The mining stage could provide a context for research into the political and economic relationships to the minerals and elements required for computer manufacturing. The closest that many computer users get to associating the natural world with their computer is appreciating the scenic photographs that Microsoft and Apple often use as screensavers. *Spruce Pine, North Carolina* (2018) a simulation of a silicon mine in North Carolina that supplies Intel with materials for computer processors, was created to challenge this situation (Figure 58).

Focussing on the raw materials used in the manufacturing of CS technologies

could involve research into the areas in the world which profit from an abundance of geological resources. It would be interesting to work with minerals from asteroids that could destabilise economies due to the abundance of precious metals and undertake further research into space mining.

The mining of certain materials such as Cobalt in the Congo are rife with human rights abuses and often involve child labour. This is a worthwhile route of enquiry that could lead to a better appreciation of the human and environmental costs of digital culture. Benjamin Poynter's iOS game *In a Permanent Save State* (2012) (Figure 55) explored human rights abuses in the Taiwanese Foxxcon factory where many Apple products and videogame consoles are manufactured. The app explored the nightmarish experience of a Foxxcon employee and was briefly distributed via Apple's App Store before being removed and banned.

The manufacturing stage also provides a fascinating context for future research. Such work could focus on the environmental impact of digital media manufacturing, or explore the complex processes involved in the creation of computer components in 'fablabs' and clean rooms – specialist sites that are free from dust. One such idea involves hijacking the virtual space of a clean room by geolocating a reconstruction of the mine that provided its silicon into the laboratory itself. It would only be visible through an augmented reality app within the clean room.

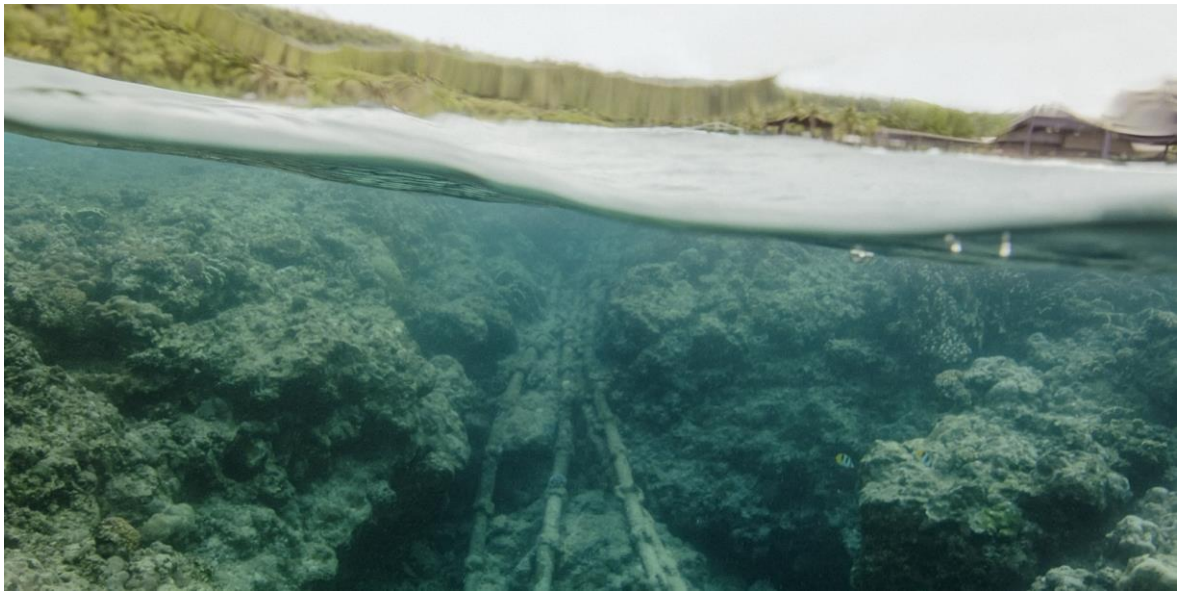


Figure 56. Paglen, Trevor, *Under the Beach (Tumon Bay, Guam) (2015)*

It makes conceptual sense to explore ways of connecting real world data with simulated systems, as a way of bridging the human, non-human, real and virtual actors of the CS assemblage. This could be an interesting way of understanding how CS and reality relate to each other in a more granular way. There are opportunities to connect the duration of the simulation with the durations of processes and time frames related to its

material processes. For example, a cloud simulation that grows in relation to the amount of water used in the manufacturing process of silicon wafers.

The stage at which CS are constituted as media technologies is perhaps the least considered stage for future practice, but perhaps the area in which other artworks may have the most impact. Perhaps future artworks could impact how media technologies are used in consideration of their material and human costs. I'm particularly interested in the undersea cables that connect fibre optic internet cables, as a particular example of how digital culture is connected materially. Trevor Paglen photographed the cables at offshore Miami and Guam for an exhibition at Metro Pictures, New York (2015) (Figure 56).

The obsolescence stage could involve research into eWaste and the lifespans of computer components once returned to the earth. Many metals and components used in computer manufacturing are highly toxic and would be worthwhile to research in relation to units of entertainment – for example – what is the environmental cost of streaming an hour of TV on Netflix?

More broadly, the ontological recalcitrance is still of interest and would be a driving force in future works. It would be interesting to pursue the idea of CS as assemblages of actors. There are clear crossovers here with the scientific exploration of CS ontology and epistemology, and the role CS play in leading policy making. Explorations around how CS are used in climate change would be of particular relevance.

This research question has been answered satisfactorily, although could easily stretch to fill a decade worth of research and practice. Although there is a bias towards my own work, it is likely that the broadness of opportunities here is useful to other artists and curators.

Discussion

This study has attempted to break down the lasting rhetoric of immateriality that surrounds CS so that artworks produced with these methods can be more easily created and understood. Points of contact have been created between art history, postmodernism, new materialisms, media materiality, the Anthropocene and the technical characteristics of the computer simulation.

There are many reasons why CS are deemed to be immaterial in nature. The scale and complexity of contemporary media technologies lie outside of popular understanding or comprehension. Intel's *Itanium 2* chips, for example, are "…smaller than a virus, too small to reflect a beam of light." (Grossman, E., 2006, p.4). The production of computer simulations via game engine software can be highly mystifying without training in computer science, and take years to become proficient in.

Scale and complexity create an aura of ambiguity around CS that invite the language of immateriality. However, as discussed in Phase 3, "miniaturisation is not

dematerialisation" (Grossman, E., 2006, p. 9) and as the effects of global warming and pollution generated from the media industry increase, it is increasingly irresponsible to claim so. Immateriality is a convenient simplification that fills the gap of uncertainty surrounding CS. It is perpetrated by manufacturers and marketers seeking to conceal the extent of environmental and labour abuses. It is also perpetrated by postmodernist ideas that favour language at the cost of materiality.

Problems of scale are also apparent at the macro level. The vast scale of industrial activity that underpins the production of media technologies is genuinely difficult to comprehend. The opening shot from *Manufactured Landscapes* (2006) (Figure 57) tracks through a huge Chinese electronics factory in a town constructed to accommodate the workers. The sense of scale is incredible, and the sheer volume of products being generated in a single day are difficult to imagine. Timothy Morton refers to objects that are too big and too dispersed through time as "hyperobjects" (Morton, T., 2013), such as global warming. A future project seeks to explore this via creating real-time simulated clouds displayed via a web browser whose volume is dictated by the amount of water required to manufacture the desktop computer being used to play it. The project aims to short circuit the micro and macro temporalities of computer simulation entanglements.

Figure 57. Burtynksy, Edward, Xiamen City Manufacturing Plant, still from Manufactured Landscapes (2006)

In addition to this extreme contrast of scale, the rate of change that media manufacturing processes undergo is also difficult to keep track of, making it difficult to effectively understand their environmental impact in an effective or timely fashion. (Grossman, E., 2006, p.7). This is also true during the 'functional' stage of the CS life cycle, where software and hardware processes are constantly in flux. Code is constantly being rewritten and recompiled. This creates a sense that CS are constantly shifting and amorphous.

In order to break down the oversimplification of immateriality and create a more detailed picture of computer simulated artworks, this study has used practice to become

familiar with simulation tools, mapped characteristics and reflected on the connections between theory and practice. An overarching conclusion is that CS should be considered within a broad, holistic temporality that incorporates the life of materials before and after their constitution as media devices upon which computers simulations operate. The hybrid spatial, temporal, authorial, behavioural and ontological characteristics of the CS are best understood as momentary assemblages of material and virtual, visible and invisible, micro and macro, human and non-human actors, the relationship between which actors are in perpetual flux.

The term assemblage, carries different philosophical baggage with it, depending on whether Deleuze and Guattari's or DeLanda's terminology is employed. DeLanda employs a more granular approach to classifying the actors that constitute assemblages. This improves upon Deleuze and Guattari's "limited social ontology that only includes three levels: individuals, groups and the social field" (DeLanda, M., 2016, p.4). This helps to understand the micro level connections between software, hardware, raw materials, artist and audience that may have been considered interstitial to Deleuze and Guatarri's classifications. Although this study made some progress towards arguing the case for assemblages as a defining term, further research into the ontology and terminology of this theory is required.

Within a similar philosophical ballpark, Sean Cubitt employs the term 'ecology' to describe how media technologies are constituted in the world. Cubitt observes that in ecologies, everything is already connected, "Every element of an ecology mediates every other." (Cubitt, S., 2017, p.4). This broadens the scope of the term *medium* to include light, energy and molecules. Although such definitions can be too broad as to be meaningless, the value of this wide-ranging definition creates a language for understanding how media technologies are more profoundly connected to the material world: "Mediation names the material processes connecting human and non-human events... Mediation is the primal connectivity shared by human and nonhuman worlds." (Cubitt, S., 2017, p.4). Further research is required to unpick the specificities of how Cubitt and DeLanda's terminology compare.

Computer simulations are unique in their capacity for emergence. This trait actualises, exemplifies and enacts the reservoir of potential actor connections and outcomes that connects with DeLanda's philosophy of simulation and Jane Bennet's use of vibrant matter. Each author attempts to describe the invisible systems of how objects and processes in the world relate to each other and come to act on those relations. This is crucial for understanding computer simulated artworks, because their capacity for emergence allows for these processes to be modelled and enacted.

Reflections on the research methodology

The practice-led methodology explored aspects of theory through the production of art works, continuous literature review and reflection. The most prescient aspects of theory relating to CS have been explored, although there is a specific trajectory towards artworks created with real-time game engines. As demonstrated with the making and reflection on *Cohort* (2016), the characteristics and theoretical frameworks identified in the thesis can still be applicable to making processes which incorporate CS but are not presented in a real-time format at the stage of exhibition.

The methodology proved difficult to maintain throughout the thesis due to pauses in momentum that inevitably occur over the course of a five-year part time PhD. At times the practice seemed under pressure to yield useful information about research questions that could feasibly be explored over a period of decades in the context of a non-academic art career. Despite the pressures of time and energy, the body of work in this thesis has a sense of burgeoning coherence as a foundation for future artworks.

The iterative structure was helpful, and the action research methodology provided a framework in which theory and practice could be discussed with an equal level of value. The research stops short of bold theoretical developments, but rather explores the claims of others in relation to an art practice in a way that is still scarce in this field. The resituating of computer simulations-related art practices within new materialist discourse makes concrete ideas that are often talked about in abstract terms and will constitutes helpful information for artists and curators treading a similar path.

Future Implications

This thesis has created a solid foundation for my own future practice. New materialist philosophies, in general, and the approaches of media materiality, in particular, allow us to *follow the materials* from the start of the computer simulation's life to the end. Along this journey, the ecological, political, social and cultural entanglements of the materials become apparent through the production of artworks. This broadens the extent of art practices that can be connected to the computer simulation beyond those created with simulation tools.

My practice became progressively more theorised and contextualised within contemporary philosophy and ecological research. As such certain judgements about the 'most appropriate' theoretical frameworks for understanding computer simulations are inevitably biased by my own research interests. There are, however, several aspects of the findings that should prove helpful to other artists and curators such as the

development of a set of art history-informed Characteristics of Computer Simulated Artworks (Figure 52).

Thinking about artworks in terms of assemblages and ecologies has profoundly changed the way I conceive of and produce artworks. Trying to connect aspects of assemblages in ways that uncover the invisibility of their entanglements can be achieved by *powercut strategies*, in which actors, or a strand of mediation between actors, are removed or replaced to expose the dynamics and relationships of an assemblage. “A power cut is an instructive event: it allows us to understand not only how much of daily life is dependent on electricity supply, but how useless so much of our equipment is without power.” (Cubitt, S., 2017, p.15). Power cut strategies can help disrupt the so-called immaterial entanglements of technologies and the material world.

Matthew Fuller writes about Jakob Jakobson’s *The Switch* (Fuller, M., 2007, p88)) in which the artist introduced an on/off switch into the circuitry of a local streetlight. The switch led to a reformulation of the social connections to the technology, with some residents taking responsibility for switching it off at night and other wanting to leave it on for safety reasons. Jane Bennett also discusses how a power cut can illuminate connections between actors in an assemblage (Bennet, J., 2009, p.24-28).

Fuller describes components of media ecologies that are no longer questioned or scrutinised “standard objects” (Fuller, M., 2007, p.93). They are a result of the human deferral of knowledge onto objects (such as mobile phones relieving us of the burden of remembering phone numbers), and also of the complexity of entanglements that dissuade human understanding. Gibson and Martelli’s *Ruined* (2018) series also exemplify this. A series of images is created by throttling bandwidth to the *Apple Maps* app, which halts the image in the process of loading, creating low resolution models akin to contemporary ruins.

Conceiving of the lifecycle of a computer simulation opens up many opportunities for research. Mining, computer hardware manufacturing, hidden labour and human rights abuses, computer simulations facilitated by media devices, eWaste, recycling, cloud storage and other ‘immaterial’ aspects of digital culture are all potential sites of research for understanding how computer simulation technologies are entangled within the world.

Since the end of the thesis, I made *Spruce Pines, North Carolina (2018)* (Figure 58) a simulation of a mine that produces high grade silicon used in the construction of microprocessors for computers and mobile phones. Satellite elevation and orthoimagery data are used as the basis for terrain creation, alongside *Houdini* heightfield tools that simulate the high-resolution detail and topographical details. As such, the landscape exists in *Houdini* as an assemblage of editable parameters. A noise algorithm is input into

these parameters which forces the images into a constant state of flux. The terrain and sandstone rocks are subject to the same forces of algorithmic flux at work behind the seeming immateriality of digital culture. The work will be exhibited online via the Art-gene.co.uk website between September and November 2018.

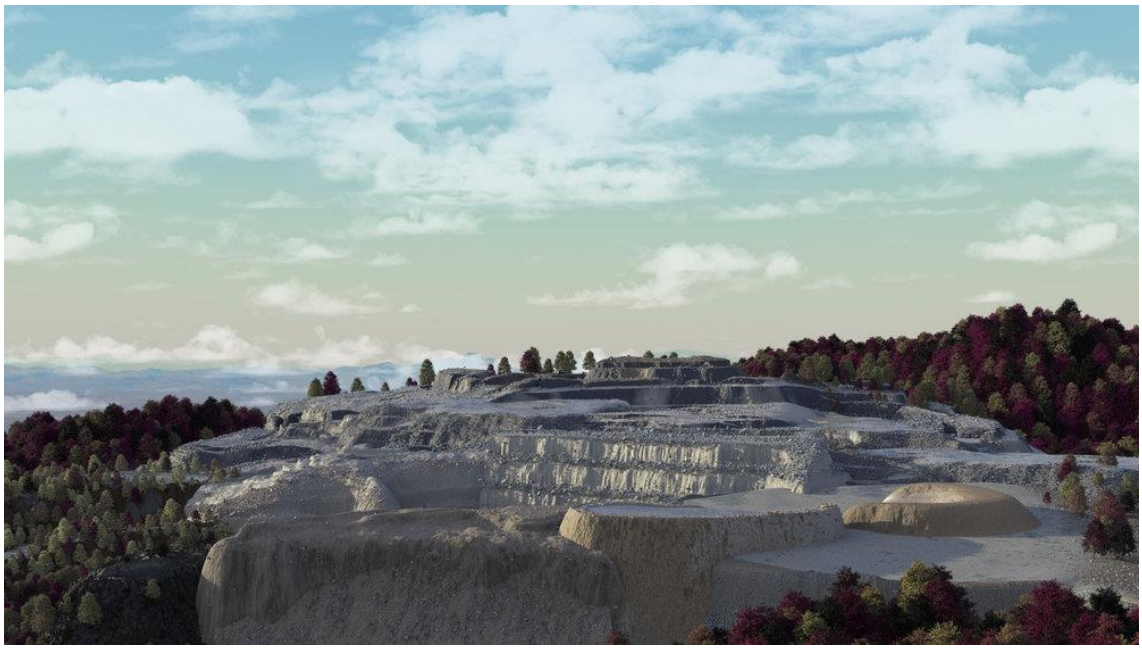


Figure 58. Dolan, Paul, Spruce Pine (North Carolina) (2018)

Computer simulated images will continue to perniciously fold into our lives through continuously developing technologies and cultures, and we will need language, theories and practices to make sense of them when they do. Although the thesis argues for an increased awareness of the materiality of media, through use of an assemblage theory, it offers a framework that can simultaneously incorporate virtual, physical, human and non-human actors.

The use of CS as an artist medium is especially useful for responding to how technology functions within contemporary society. In the wake of privacy scandals, social network algorithms being used to influence elections, the hidden processes of digital culture are more in need of debate and action than ever before. Whether this constitutes the invisibility of the algorithmic processes that govern digital images, or the hidden aspects of the mining, manufacturing and disposal of simulated culture, CS offer a way to explore how complex assemblages of human and non-human actors operate on and within the world.

Chapter 8

Synthesis: Recalcitrant temporalities

Aims and objectives

This chapter aims to synthesise the research outcomes of the thesis, with an emphasis on the temporal behaviours of the computer simulated artwork. A framework for understanding the 'recalcitrant temporalities' of the CS artwork is then discussed. The term recalcitrance is used to describe how CS are constituted in an ongoing temporary assemblage of material and virtual, human and non-human actors, which defy oversimplified and unified concepts such as 'real-time', a term often used in conjunction with CS.

Phase 1 Research Outcomes - Wireframe Valley (2014)

Figure 59. Dolan, Paul, Wireframe Valley (2014)

In Phase 1 of the research, the characteristics of CS art were explored through the production of *Wireframe Valley* (2014) with a focus on the software processes used to construct the work. In addition to spatial and representational characteristics, four types of time were identified within the creation and exhibition of *Wireframe Valley (*2014): synchronised time, abstract time, static time and exhibition time. Synchronised time simulates the clock time of a particular location and time zone. Abstract time is a broader term that encapsulates the multiplicitous and relative time lines that co-exist in relation to

physical clock time. Static time references an actor in the simulation that is fixed in a particular temporality – a sun that never sets or clouds that never move.

Similar modes of temporality, or “temporal frames” (Zagal, J.P., and Mateas, M., 2010) have been discussed previously in relation to videogames. Although this research has a stronger emphasis on ludological temporal behaviours, they are still useful in identifying the multiplicitous temporal activities of real-time simulations. “Temporal frames may appear sequentially, overlap, and coexist. They are also often embedded in each other” (Zagal, J.P., and Mateas, M., 2010, p.854).

The programming of *Wireframe Valley* (2014) to reveal its underlying software apparatus helped to uncover the behaviours of the artwork beyond its presentation as a sequence of images. Professor Chris Dorsett noted in the roundtable discussion conducted as part of Phase 2 - “You often need to break down to get to time” (Appendix vi). It was also found that the temporal logic of the artwork may not be clear from its exhibition context, due to the technology involved. This was highlighted by artist Narbi Price during a later discussion: “It's almost like the experience of the making is hidden, obviously for someone who is very much entrenched in the discipline that might not be the case but for somebody who is outside of that discipline, it's almost a hidden experience of the making, and the time, then, is only this almost codified experiential thing.” (Appendix vi).

Time Simulation Method 1

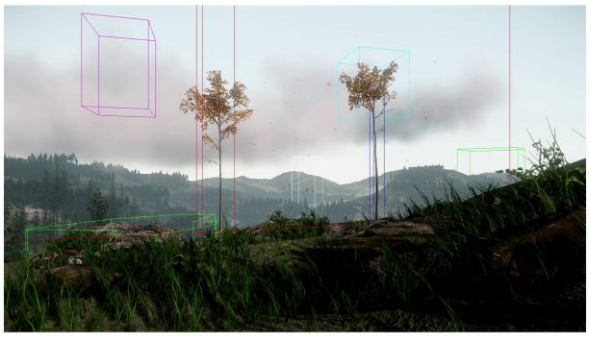
The time logic in *Wireframe Valley* (2014) was constructed from a ‘counter’ system, which used visual scripting nodes to count to a specific time and change the visual appearance of the scene when a specific time range was encountered. For example, debug mode 1, the first in the sequence of 13 debug modes, was active between 0 and 12096000 seconds, or two weeks. Figure 60 shows the debug modes and the time ranges they were active for. Debug modes are different graphical ways of rendering a virtual scene, used by developers to receive visual feedback on how actors and systems are behaving. For example, ‘texture intensity’ debug modes are used to identify which textures in the scene are too processor intensive, to speed up the task of replacing them. The most intensive textures are highlighted on screen in red, and the least intensive are highlighted in green.

Figure 60 shows the different graphical effect that each debug mode had on the scene. Some added minor wireframe elements, whereas the final debug mode rendered the entire scene in wireframe form. At this stage it was not possible to gradually change from normal to wireframe material in CryEngine without manually rewriting the shader code. In addition to sequencing the debug modes in order of ‘severity of wireframe aesthetic’, the changes were choreographed over specific time periods so that the overall effect was gradually enacted over the 3-month exhibition period. An unintended

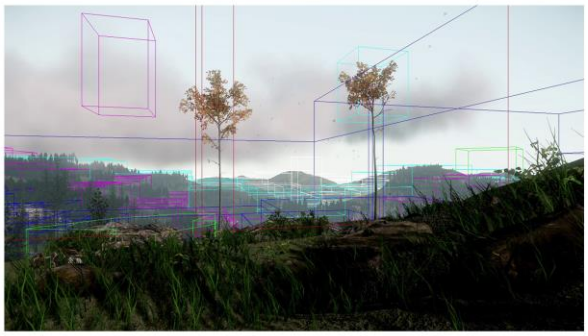
consequence of using the software tools for such long stretches of time was that real-time rendering became desynchronised over time, creating a slow-motion effect on screen, as the frame rate dropped to 5 fps.

DAY 1-7
Debug mode: none

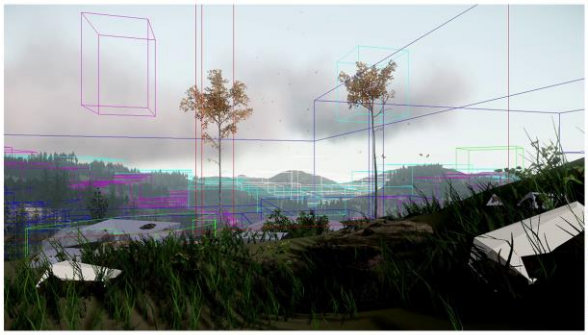
DAY 7-14
Debug mode: display pollen as polygons



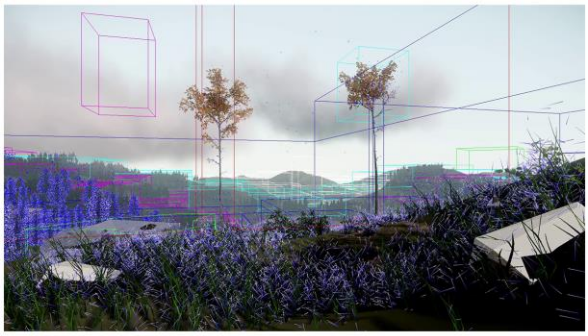
DAY 14-21
Debug mode: draw areas



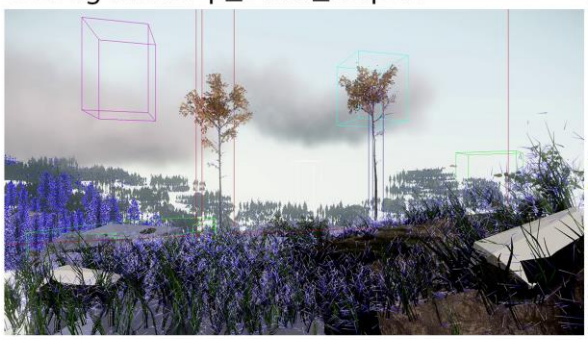
DAY 21-28
Debug mode: terrain Bboxer



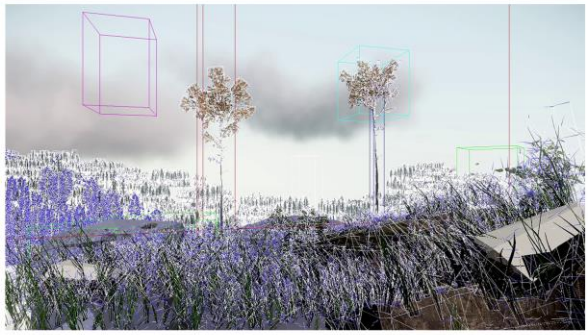
DAY 28-35
Debug mode: p_Draw_helpers



DAY 35-42
Debug mode: show lines



DAY 42-49
Debug mode: show tangents



DAY 49-56
Debug mode: show normals

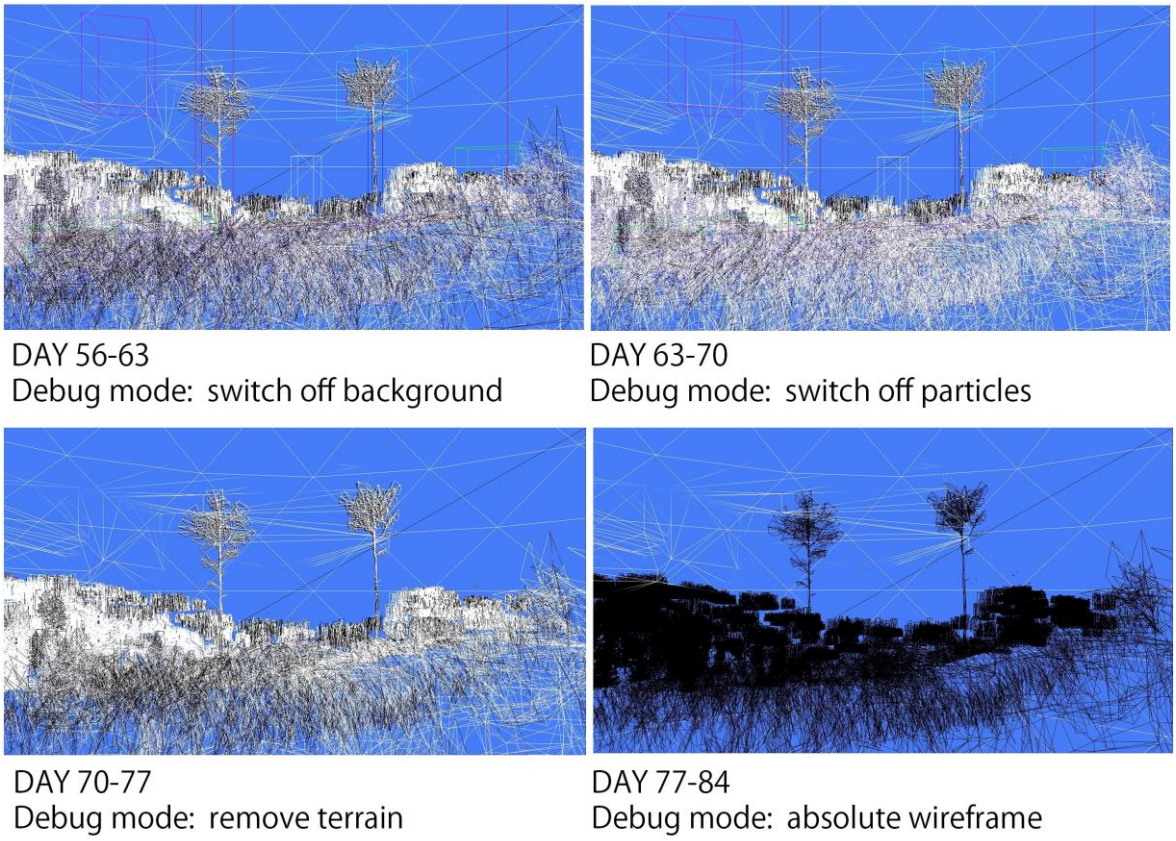


Figure 60. Diagram showing the different debug nodes of Wireframe Valley (2014) over the 3-month exhibition.

Beyond Real-time

The description of *Wireframe Valley* (2014) as 'real-time' implies a unified, singular or coherent time that conceals the technological methods by which it is constructed. As commented upon in the roundtable discussion, "real-time has become a catch-all term to describe what CS is in relation to videos – it's real-time because it is happening live" (Appendix vi). The term real-time implies an equivalence of realism via speed, although that definition is problematised by the variances of speed occurring within *Wireframe Valley* (2014).

In addition to the variable frame rates of actors within the scene, such as the clouds, trees, grass and the timing of the debug nodes, the playback of the work fell way below the recommended real-time speed of 30FPS. Real-time images are rendered to screen in synchronicity with the rate at which the human brain perceives still images as movement. This study moves beyond this definition to more closely explore simulated temporal behaviours.

Not only are there different modes or "frames" (Zagal, J.P., and Mateas, M., 2010)

of time in CS, they are also constituted within complex adaptive systems and undergoing constant change. This complex system of multiplicitous temporal actors gives way to a temporal recalcitrance, in which any attempt to unify or sample a snapshot of time is undermined by the constant interactions and constant changes between different modes of time. *Wireframe Valley* (2014) consists of differential changes and speeds of entanglements, where temporary configurations are created, evolved and destroyed with complex degrees of variation.

The hybrid authorship of the human/computer over temporal processes further underlines the recalcitrant nature of CS temporality. The temporal behaviours of the artwork and its software actors constitute events planned and timed by the artist in addition to indeterminate, autonomous animations and movements controlled by algorithms. As such, it is difficult to consider CS artworks, even with low levels of indeterminacy, as temporally unified or occupying the same temporal logics. *Wireframe Valley* (2014) has a fixed time logic, in which the events are mostly the same each time. However, its constituent actors are moving at different frame rates, interacting with each other, and occupying different time instructions via visual scripting and code. They are also subject to constant change via microtemporal code executions at a code and rendering level.

Phase 2 Research Outcomes– Floating Point (2016), Cohort (2016), Wood for the Trees (2016).

Phase 2 developed the use of systems theory and actor network theory as a framework for exploring the characteristics and behaviours of simulated time more closely, through the making of *Floating Point* (2016), *Cohort* (2016) and *Wood for the Trees* (2016). The term ‘hybrid temporalities’ was employed to describe the multiplicitous temporal interactions within the CS artwork.

A broader research outcome from Phase 2 was that CS are not just temporally but ontologically recalcitrant – they represent yet exist in excess of representation; they are models yet exist in excess of models. Both points of excess are related to their capacity for emergence, and how the algorithmic production of reality problematises existing definitions. This recalcitrance is described in Eivind Rossaak’s notion of the algorithmic turn, which was used as part of the signage for the *Floating Point* solo show: “Essentially the image has become an unstable object, indeed a processual object, never really at rest, always open to new computations and manipulations” (Mackay, R., 2015, p.54).

Figure 61. Unreal Engine screenshots showing the overall process of the tree material ‘burning away’ and disappearing in *Wood for the Trees* (2016)

Time Simulation Method 2

Time in *Floating Point* (2016) was ‘real-time’ in that the software was ultimately running the scene at 60 FPS. Beyond that generalised description of time, the temporal behaviour is more complex than the speed at which images are rendered on screen. In order to avoid the slow-down of the scenes, 12 copies of the same environment were made, with each exhibited for a day. This allowed the scene to run at the intended 60 FPS without slow down. The impact of this on the animation process was that the opacity parameters of each scene had to be set 13 times, synchronised with the 13-day exhibition. One set of realistic texture parameters for each model in the scene was animated from 100% to 0% opacity. A duplicate set of models with wireframe textures was animated from 0% to 100% opacity, creating the illusion of a gradual disintegration into wireframe form.

For the first instance of the scene, the opacity parameters were set at the start and end of a 9-hour duration (the amount of time the gallery was open for). The software automatically interpolated between the keyframes. At the start of the next day, a new sequencer file would be opened and the exact keyframe values from the end of day 1 were copied and pasted into the start of day 2. This created a seamless timeline between days, despite the projector and computer having been switched off overnight.

Figure 62. Floating Point (2016)

Time in *Floating Point* (2016) and *Wood for the Trees* (2016) are a combination of conventionally key framed animation, algorithmically initiated events and real-time playback/execution over a two-week period. The temporal construction is more of an

assemblage than any specific mode – real-time, keyframe, video, CPU time, often incorporating all of them.

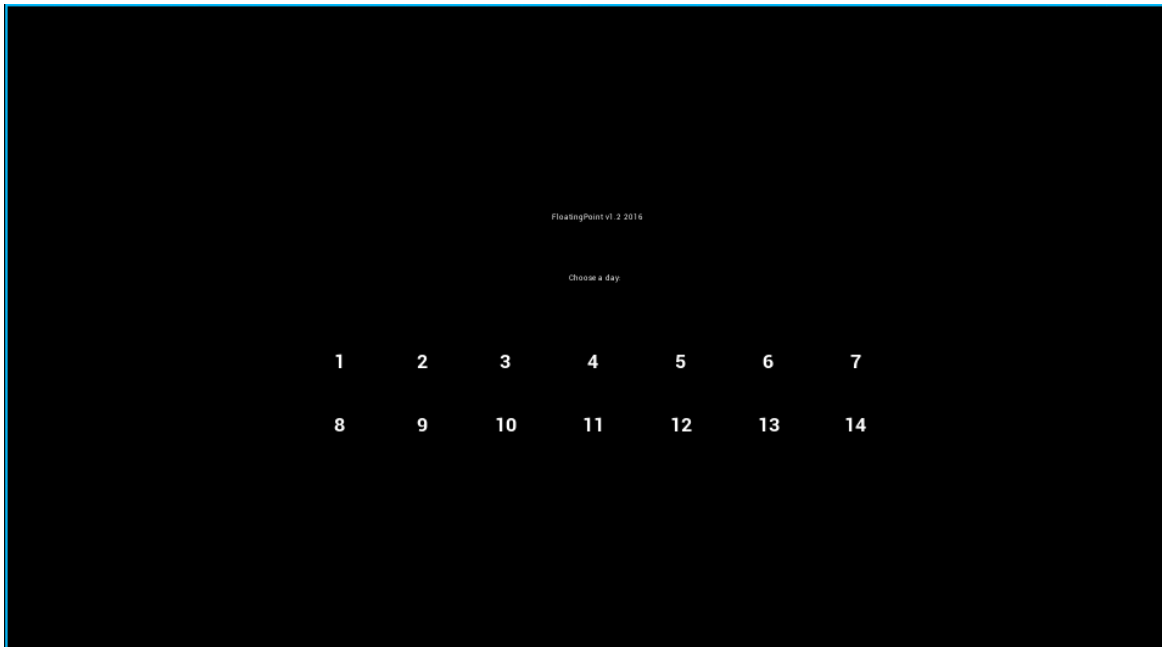


Figure 63. Screenshot of the interface that appears when the artwork's software is executed.

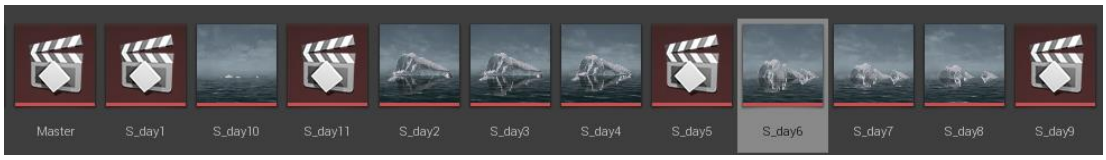


Figure 64. Unreal Engine screenshot showing the 11 sequencer files that comprise the overall timeline of Floating Point (2016)

The capacity for game engines to simultaneously assemble previously distinct modes of moving image (key frame, video, and procedural) immediately complicates the way in which time is considered to function within an artwork. It also provides artists with a temporal tool kit for playing with time as a conceptual and sculptural material. Artist and curator Dominic Smith said of *Floating Point* (2016) "There's more than one time frame in each piece, so as a painter would kind of build layers of material and form, you're using time as one of those components" (Appendix vi).

Building on terminology developed in Phase 1, the work expanded on the idea of synchronised time by synchronising the duration of the artwork with the duration of the exhibition. This decision was partly to move the duration of the artwork beyond the smaller loops and increments commonly found in video installations – to move it beyond the convenience of the expected video duration and towards a more geologic sense of time.

Time Simulation Method 3

Phase 1 indicated that the human and non-human hybrid authorship of time contributes to the difficulties in establishing what time is and how it behaves in CS. This was explored further in *Cohort* (2016), which functioned as a test to determine the impact of using rendered video as opposed to 'real-time', live rendered images, had on the temporal and behavioural characteristics of the simulated image. The research indicated that specific and nuanced processes can alter the balance of human/computer efficacy and impact the level of determinacy within the artwork.

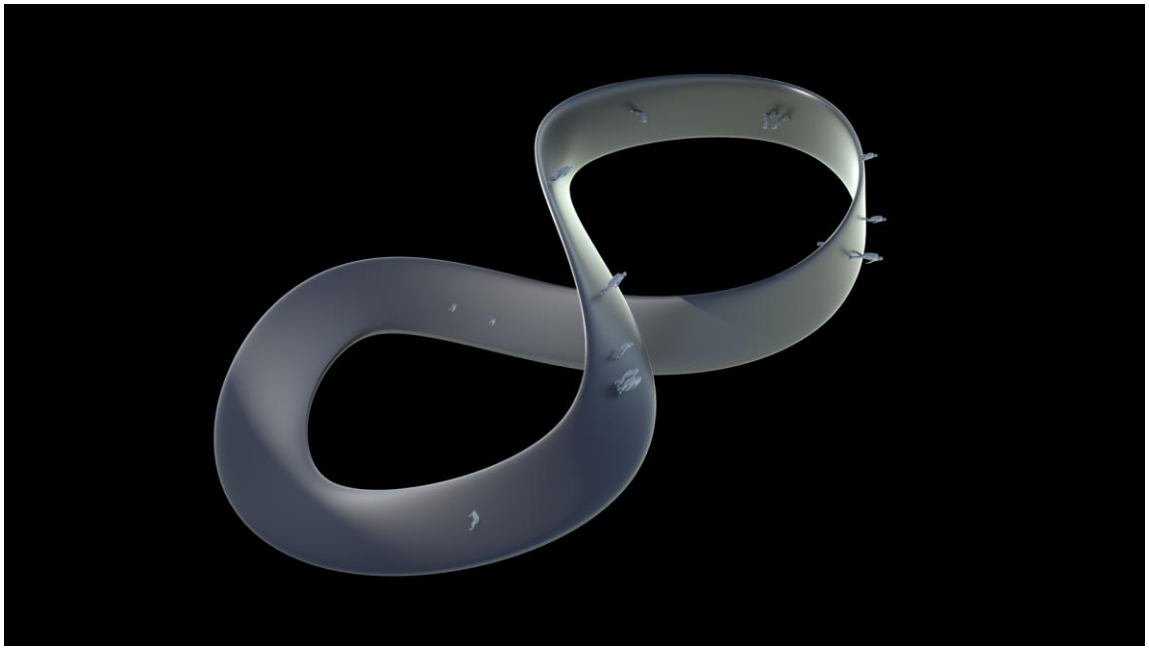


Figure 65. Cohort (2016)

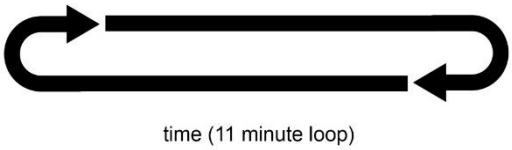


Figure 66. diagram showing the eventual looped time logic of Cohort (2016).

Whilst being developed in *Houdini*, the crowd simulation in *Cohort* (2016) varied each time it was simulated. Actors would walk off in different directions and although the actors were following a set path around the Mobius strip geometry, the nuances of their movements were always slightly different. Once rendered to video for the exhibition, one particular timeline of this simulation assemblage was fixed into place, as a sequence of fixed images within a video file. This process of reconfiguring the software project file into a sequence of rendered images shifts the system of the artwork from an indeterminate process to a determinate one, via a threshold of indeterminacy. The video file was

exhibited on an infinite loop.

The variable levels of indeterminacy in this work highlight the different reconfigurations of the simulated image assemblage. Specific actions in software (such as ‘baking’ and rendering) break the emergent potential of the images as they take on the behaviour of previous media such as video. This movement across media – the potential for simulated images to simultaneously exist as and alongside previous media – indicates a level of recalcitrance in their form. They shift and come to be within temporary configurations of actors. As the agency and push-pull of specific actors gain or reduce in strength within a given assemblage, we perceive the changes that fall within the limits and ranges of human perception.

Phase 3 Research Outcomes – *Wireframe Valley* (remade, 2017)

In Phase 3 of the research, CS were considered in a more directly material way, by considering computer hardware, their associated minerals, manufacturing processes, and the points of contact between CS and the physical world. This approach was underpinned by media materialists with an ecological interest (Parikka, Cubitt, Fuller) and the media archaeological context of the *Wireframe Valley* (remade, 2017) exhibition at Dundee Contemporary Arts.

The two main outcomes of Phase 3 were the development of a ‘lifespan of CS’ – an extended timeframe that expands before and after the electronic media configuration of the simulation, and the creation of a scalable, parametric time system in *Wireframe Valley* (remade, 2017) which better articulates the recalcitrant temporalities of the CS through practice – mutable, interdependent complex temporal systems manifest as temporary configurations of human and non-human actors.

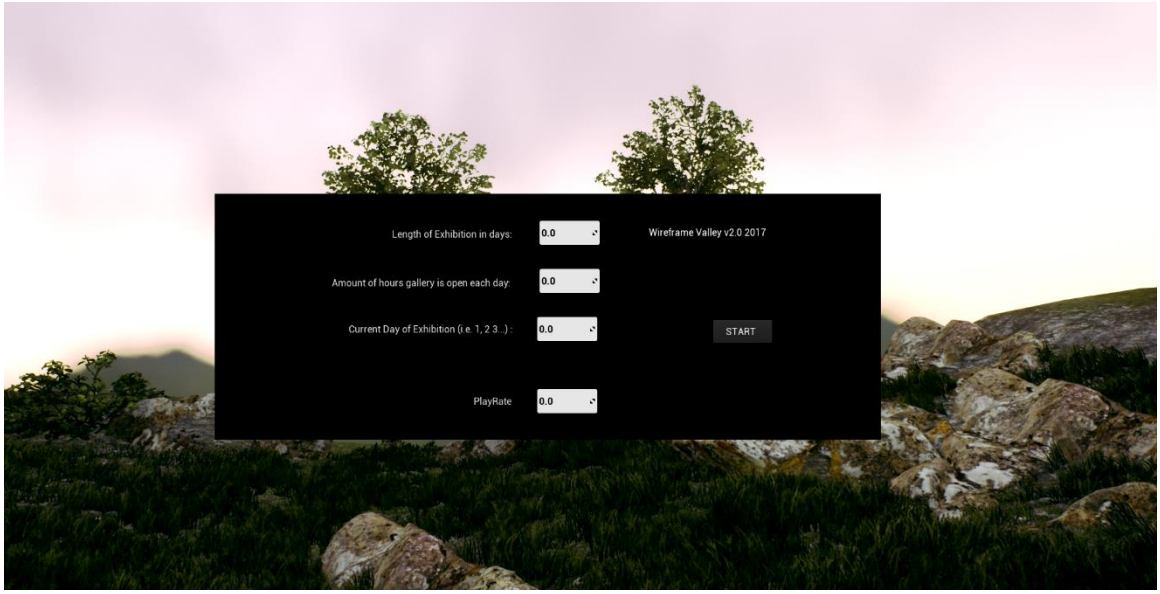


Figure 67. Diagram showing the menu interface used to set the duration of Wireframe Valley (remade, 2017).

Time simulation method 4

In comparison to the continuous time logic of the original *Wireframe Valley* (2014) the fractured time logic of *Floating Point* (2016) and the looped time of *Cohort* (2016), the timeline of *Wireframe Valley* (remade, 2017) is parametrically scalable. A single abstract timeline is re-entered at different points on each day of the exhibition, controllable via a menu interface that appears when the work is launched (Figure 67). Instead of using hard coded, fixed values for the duration of the work and the triggering of events, variables are used to represent each of these values. The duration of the artwork is now mutable until executed within the gallery. At that stage, the assemblage reconfigures to match a specific duration. The events within the artwork will scale to accommodate a shorter or larger duration, maintaining the same distances between them. The artwork could be programmed to last any duration and still the animations of trees, vegetation and other elements would move at a normal, realistic speed. Only the material opacity change would speed up to match the different duration, so the materials could fade over 1 day or 1000 days.

All of the time logics developed within this study can be said to be parametric – they are constituted by manipulating sets of software parameters that interact to create specific temporal outcomes. This may not be evident in the exhibition of the work or its behaviours, however. *Wireframe Valley* (remade, 2017) moves closer to the temporal logic of assemblage theory, by possessing a parametric duration – that is – it exists in a state of unfixed temporality until programmed to take on the duration of the next exhibition. The behaviour of the time logic more explicitly follows a parametric time logic in the layout and behaviour of the visual scripting nodes. There are of course many ways of developing this through art practice so that the temporal aspects of the artwork are more prescient within the assemblage of actors – especially in relation to what can or cannot be sensed by audiences.

In addition to the temporalities created within the software interface, this research phase directed attention to the temporalities of the material components of the CS, framed by research into the ecology of media (Fuller, Parikka, Cubitt). The temporal aspects of minerals and materials are important for understanding the time of the CS. It can be difficult to track specific materials through the lifespan of the CS as they are physically and chemically merged and separated via complex industrial processes (silicon wafer production for example, is particularly complex) - but time continues to offer a particularly human way of comparing and understanding the kinds of inter-related non-human processes that bring computer simulations into the world.

Phase 1 indicated that the complex software systems contribute to a temporal recalcitrance of CS. Phase 2 suggested a larger ontological recalcitrance of algorithmically generated images, and the intractability caused by the human and non-

human points of contact in the simulation. Phase 3 added further complexity by acknowledging the time frames of the raw materials, such as manufacturing processes, the lengths of shifts undertaken by labourers, manufactured obsolescence cycles and the half-life of toxins feeding back in the soil from discarded computer equipment.

The formulation of a CS lifespan helps move away from the dangers of thinking about time as a predominantly immaterial and software-related concern, and towards a context that can acknowledge its political, social, ecological and material connections. Here, recalcitrance becomes inversely helpful as a situational and flexible research methodology that allows for process and complex agential networks to come into view.

This phase highlighted the extreme scales of CS temporality – the macro scale of geologic time and the Anthropocene and the micro scale of parametric, algorithmically produced time. The life span of the CS is in keeping with its recalcitrance – the durations, systems and interconnections involved are so broad that we can only really approach the CS with the knowledge that it is in varying degrees of temporary configuration. Instead of focusing explicitly on time as an abstract ontological entity, time functions through emergent changes within assemblages constituted by the virtual and material actors of the CS.

Recalcitrant Temporalities – A Framework

The artworks discussed in the previous section where created in parallel through an exploration of postmodern simulation discourse and later through the lens of new materialist philosophies – media materiality in particular. Theory was employed in a summative manner (the exploration of postmodernist discourse) and in a formative manner (the exploration of new materialist philosophies). This section builds upon this philosophical trajectory to propose a framework for understanding the temporal behaviours of simulated artworks through discussion of the social, political, material, human, technological, ethical and ontological implications. The overall suggestion is that CS time is recalcitrant in nature and it always understood in relation to the other actors within its assemblage configuration. The philosophical implications of the framework are considered in relation with reference to assemblage theory, media materiality and horology.

Figure 68 shows a spatialised description of the recalcitrant temporalities of CS. The key domains of temporality – human, non-human, virtual and material – are adapted from the language of assemblage theory. Each actor within an artwork is interrelated to one another, in multi-directional lines of agency that cut across all four domains. The connections stretch off in all directions, meaning that the diagram illustrates a selection or configuration of actors that comprise a temporary temporal assemblage. The duration of the temporary state is dependent on the speed and agency of other actors in the

assemblage.

The next section considers the significance of each temporal domain and the nature of connections and agency between domains. The social, political and ethical connotations of the framework are discussed before more directly considering time and ontology in this particular application of assemblage theory to CS temporality.

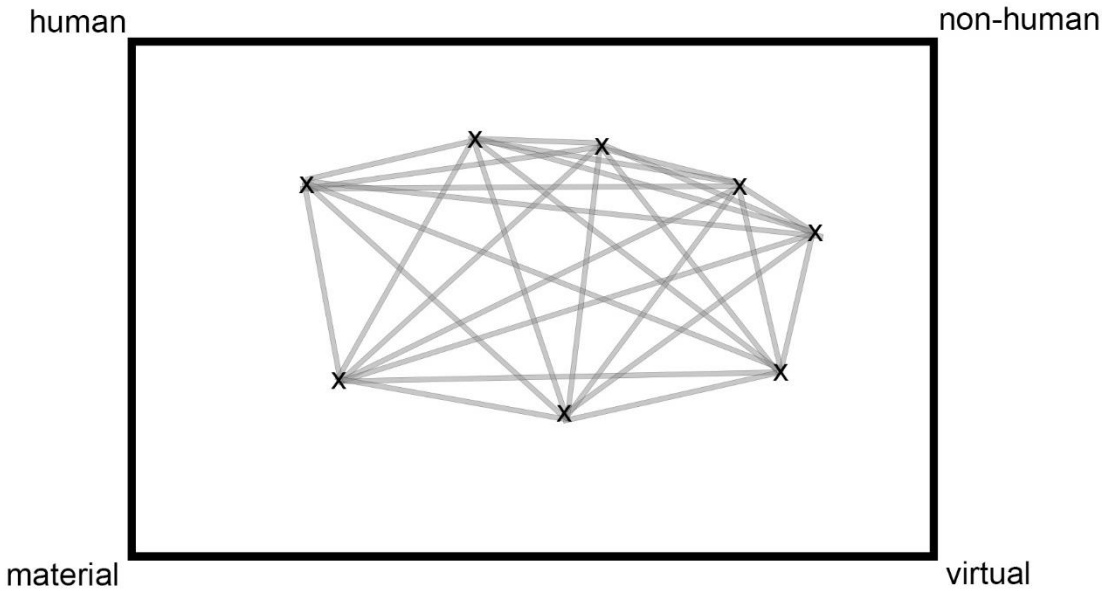


Figure 68. Diagram depicting a temporary configuration of temporal multiplicities across the temporal domains of the human, non-human, material and virtual.

Virtual time

The term real-time, commonly used in relation to CS, implies reality via an equivalence of speed, although speed is not time, and the use of a singular definition masks the complexity of temporal mechanics and interactions at play. Phase 1 research outcomes demonstrated that there are multiple time frames, durations and logics manifest within the CS, and they cannot be accounted for by the overarching and singular ideas of time in Baudrillard and Virilio. Although Dromology provides a route into thinking about how time relates to our contemporary lives, it does not possess the granularity required to account for varying speeds and temporal difference. This is especially true of time frames that sit outside of Virilio's military, capitalist and cinematic contexts - the extended durations of geology and biodegradation, for example.

The way in which multiplicitous temporalities cut across virtual and material actors is also significant. It is not only virtual time that manifests in multiplicitous and complex ways. The complex biological systems that manage our perception of time are similarly distributed across multiple areas of the brain and body (Hammond, C., 2013). Furthermore, our daily experiences of time are assemblages of real and virtual actors that exhibit such complex agential interactions it is difficult to disentangle the two. The inherent

shared relativity of computer and human time cannot be considered in isolation from its connected actors and their requisite domains.

The multiplicitous and distributed nature of CS time within a complex adaptive system form the first characteristics of temporal recalcitrance, as time cannot be singularly defined, nor attributed to any particular domain without reference to another.

Material time

In order to understand the nature of CS temporalities, it is necessary to adopt a materialist viewpoint that can cope with the different time lines, logics and durations of the computer materials, processes and human experiences of them. Geology has played a significant role in identifying the natural processes involved at the various points of the CS lifespan, despite being largely neglected "…in the 50+ years "…since commercial semi-conductor and computer manufacture began" (Grossman, E., 2006, p.xi).

The broadening of media to include geology is a tactic developed by Jussi Parikka and connects to the way Sean Cubitt suggests "Mediation is the primal connectivity shared by human and non-human worlds." (Cubitt, S., 2017, p.4). Materials support and construct the interactions of the assemblage. This is one way of thinking about *Spruce Pine, North Carolina* (2018) – the sand mined from this location is a direct mediator between the earth and digital processing. "On its own, silicon is not electrically charged, but its chemical structure makes it ideally suited to transformation into a semiconductor - a device that can be made to carry highly sophisticated patterns of charges by adding various chemical "impurities"." (Grossman, E., 2006, p.35).

In *Chronometers for Time Travellers* (2011) - Elaine Gan and Nik Hanselmann demonstrate a way of exploring the particular temporalities of individual actors within an assemblage. "Each container holds a different material from which a different speed of time is derived: water, earth, grains, air. Each runs with a microcontroller, a sensor, a potentiometer, and a vacuum fluorescent display (VFD). Each VFD visualizes two registers of time: the top line corresponds to watch time (thus, all four display the same data); while the second line calculates a time based on change in the substance contained (thus, each is different)" (Gan E., & Hanselmann, N., 2011).

The manufactured components of the computer also impact temporal capacity. The era in which videogames/simulations are programmed to work with particular operating systems and hardware means that older games played on faster computers are sometimes too fast to play, whereas new games on old computers can be too slow to play (Zagal, J.P., and Mateas, M., 2010, p.855). This is the result of an imbalance between the clock speed of the CPU and the way in which the code was written to work with particular hardware speeds. This underlines the CS as a recalcitrant assemblage that is always temporally dependant on its material entanglements.

Thinking of time in material ways offers an advantage from the language and speed-oriented apocalypses of Baudrillard and Virilio in which human agency is nullified by overarching abstraction. In the dire ecological circumstances we currently inhabit, a focus on specificities and materials are crucial tools in reconfiguring the way in which humans exist in the world – particularly in relation to media. Media devices require large amounts of energy and natural resources to make and operate. They are not infinite or immaterial, but entirely dependent on the natural resources of our planet. (Cubitt, S., 2017).

Whilst active as media devices they hide the ecological problems of global commerce behind convenient software interfaces. The aura of immateriality that surrounds CS, whether cultivated via ecologically destructive media conglomerates and their marketing departments - or through the collective disinterest of audiences – serve to hide material connections to the physical world. This forms the second aspect of temporal recalcitrance – that CS temporality is material. Reconfiguring the focus on the non-human actors within their assemblages is crucial for fighting against the persistent aura of immateriality that surround them.

Non-human time

In Phase 2 of this research, extended duration was used as a method for moving the time frame of the simulation beyond human perception. The non-human domain of time is a key part of the recalcitrant temporalities of the CS – principally through the extreme differences in scale and speed that exist outside of human spatiotemporal perceptual ranges. These ranges negotiate the level and scope of human access into non-human assemblages. For example, the micro temporal electronic frequencies of computer processors that occur in milliseconds, and the macro temporal ranges involved in geological activities such as stratification of rock sediment, form the lower and upper ranges of temporal activity accessible to human cognition.

The subjectivity of human temporal perception is a key factor in what makes CS time ‘recalcitrant’. Human temporal perception – the ability to count, measure and conceive of time is limited to particular time frames (Hammond, C., 2013). The lower threshold of human temporal perception - “the now” is around 0.3 seconds -anything less is “the time of digital information flow” (Hansen, M., 2004, p.235).

The difficulties humans face in attempting to comprehend micro and macro timeframes also applies to visualising volume. The colossal volume of natural resources involved in the production of CS are too large to comprehend, which are often conflated with being infinite (Cubitt, S., 2017, p.7). Conversely, micro scales are equally difficult to comprehend and become conflated with being immaterial – although as Grossman reminds us “Miniturization is not dematerialization” (Grossman, E., 2006, p.9). Both issues

relate to the perceptual points of contact between humans and the material world – and how the limitations of human perception can tend towards understanding CS as immaterial entities.

This leads to the third aspect of temporal recalcitrancy. Conceiving of CS as being in excess of human perception indicates that we only ever experience a specific temporary configuration of their form. The extremes of scale in the non-human time domain also limit our understanding of time to the ranges of human perception.

Human time

Simonetti's ethnographic research into how archaeologists talk about time poses multiple points of insight for this study. Firstly, the language and methodologies of archaeology are of interest to the geologic associations of this thesis, particularly the spatial ways in which time is discussed. Secondly, Simonetti's research shows the ways in which socially constructed (or 'grown') practices tie in to concepts of time (Simonetti, C., 2013, p.301). This is useful in thinking about the role of the artist when using game engines to construct temporal artworks.

Simonetti suggests our ideas of time are situationally dependent environmental factors - such as gravity (Simonetti, C., 2015, p.69) and on shared language that we use to describe our processes and engagement with materials and tools. He uses verbal and gestural analysis to show how English and Spanish archaeologists talk of time "being under their feet" and Japanese archaeologists of "going up in time" (Simonetti, C., 2013, p.297). Such an approach could help makes sense of the connections between artists and software. Is time at the fingerprints of the artist/simulator opposed to under the feet of archaeologists?

The experience of choreographing time in 3D animation software such as Maya can feel horizontal, owing to the historic design conventions of the timeline interface. Frequent animation tests occur in periodic bursts of simulated time. The playhead is 'played' or 'scrubbed' on the timeline to get a sense of the movement or activity in the scene and is then returned to the start of the timeline to start another test from the first frame in the sequence.

The experience of creating time in the visual scripting interface of a game engine is different. Nodes are plugged into each other to form a network. The sequence and connections between each node is significant and each node can reference another node. In this sense, time is more clearly visualised as a system or network. Using the debug functionality of *Unreal Engine's* Blueprint system, one can see dotted lines visualise the flow of activity between each node. Each test, depending on the level of emergence or indeterminacy in the scene, can lead to completely different outcomes. Key frames and parameters are also set for specific actors in the scene via a separate Sequencer

interface, which fractures a coherent sense of direction between past, present and future.

There is a disconnect between the control of time via software tools and the embodied personal experience of sitting in front of a computer for long stretches of time. Choreographing the artworks in this study required consideration of micro temporal increments (how many frames per second each actor moves at) and macro temporal increments (how many weeks a phase of an artwork should elapse over). The variations in scale and time logics feel more like a spatialised network of grids and points, with different levels of agency flowing between them, rather than as possessing a particular directionality.

Simonetti's work helpfully bridges notions of geologic time with the corporeal experience of working with materials in specific environments (Simonetti, C., 2015b, p.141). He calls for an embodied sense of time, an increased awareness of how scientists' involvement with their material surroundings influences the circulation of temporal concepts. He argues that "concepts of time are not abstract entities, fixedly stored inside the mind, but sentient acts of conceptualization that depend on the dynamic field of forces in which things and people become entangled" (Simonetti, C., 2015, p.69). This approach is in keeping with the language of Assemblage Theory (Deleuze and Guattari, DeLanda) and the vital materialisms of posthumanist philosophy (Braidotti, R., 2013, p.2).

This leads to the fourth aspect of temporal recalcitrancy – that CS time is highly situational, dependent on the practices, language and concepts employed by the artist. It is also often spatialised in order to make sense of it.

Human Agency

After discussing each domain of Figure 68, the next step is to discuss the flows of agency between each actor in the diagram. The diagram shows all possible connections and flows of agency between all actors in any given assemblage. This problematises Virilio and Baudrillard's views on human agency. For Virilio, speed changes reality at a fundamental level - as the compression of time removes the capacity for causality to exist. Events therefore become instantaneous and things happen before we can respond to them. This creates a "landscape of events" (Virilio, P., 2000) where 'accidents' happen. This removal of human agency resonates with Baudrillard's more language-based concept of 'the code' (Baudrillard, J., 1994), in which the machinery of language seeks to mask reality through the proliferation of simulacra.

This framework is based on the vitalist aspects of actor network and assemblage theory, in which human and non-human actors are capable of multi-directional agency. Instead of conceiving of human agency as entropic, agency is distributed across all connected actors in an assemblage in a negentropic state – always reconfiguring itself and always becoming. These agential relationships can be discussed

in relation to specific artist decisions. In Cohort (2016) for example, there are thresholds of determinacy, in which specific software processes or artist decisions can reconfigure the balance of human/computer agency in the work, and create different degrees of indeterminacy and emergence. In each artwork, the time logics are triggered through a combination of human and computer decisions and logics.

The push/pull of temporal agency is also explored in Sarah Sharma's research. Sharma interviewed people who inhabit different temporal regimes and structures, such as business people in airports that move through time zones and rest in the liminal temporalities of airport lounges and taxi drivers who are bound to the monetisation of each journey. She found that "…certain bodies recalibrate to the time of others as a significant condition of their labour. As a result, specific temporal regimes and strategic dispositions are cultivated in order to simply survive within the normalizing temporal ordering of everyday life" (Sharma, S., 2014, p.20).

Our lives bend around CS temporalities that push us to be constantly contactable, constantly awake and constantly moving between virtual and real experiences. This relates to Virilio's suggestion that "…technological development has carried us into a realm of factitious topology in which all the surfaces of the globe are directly present to each other" (Virilio, P., 1988, p.58). The temporal inequality of the CS is manifest within the long gruelling shifts of miners and media manufacturers necessary for others to spend time playing videogames, talking and shopping online.

Future research could be undertaken in the temporal experiences of people associated with CS processes, such as lab technicians in semi-conductor manufacturing plants. A worthwhile example of artists working with the temporality of processes is *The Coniferous Clock* (2014) by Bril Collective. It is a clock made from a cedar frame, filled with leaves that die over the course of a year. This enacts the temporalities of sake fermentation process - after the leaves are all dead the sake would be ready to drink (Bastian, M., 2016, p.13).

The Politics of Duration

The variable agential flow of temporal assemblage, and the cutting across of multiple temporal domains opens up a space for thinking about the political, social and ethical implications of time and simulation.

Sharma's research into different social experiences of time builds upon ideas of political speed to form a more lucid and convincing account of complex and uneven sociopolitical temporalities than Virilio's Dromology. For Sharma, time exists in multiplicitous "temporal power relations" (Sharma, S., 2014, p.9) – a viewpoint that forms a critical alternative to Virilio: "gender, class, race, and sexuality were either un-acknowledged or lost from the view of the disorientated postmodern gaze into social

spaces affected by the acceleration of capital and time-space compression" (Sharma, S., 2014, p.9).

Sharma provides a blueprint for moving away from the software-focussed temporal experiments of *Cohort* (2016) and towards a practice that actively engages with the temporalities of contemporary social life. Sharma suggests that we bend our lives to match different temporal regimes (Sharma, S., 2014, p.20). *Cohort* (2016) attempts to make a generalised comment on social time, whereas it would be more valuable to explore the quotidian temporal experiences of the human and non-human actors involved in CS – how long it takes to extract silicon from a mine, the time it takes to manufacture a semi-conductor, the shift length of a labourer, the half-life of toxins seeping into the soil from a discarded circuit board.

Another possible route for understanding the nature of agency across assemblages, and how this connects to time, is via Barad's concept of "agential cuts" - the exclusion of one reality by another coming into existence (Hollin, G., et al, 2017, p.5). For Barad, agential cuts are controllable, and form the basis of an ethical discussion about how we produce reality through inclusions and exclusions. Instead of conceiving of the flows of agency between actors as invariable and consistent, agential cuts are a call to arms to reconfigure the assemblage (and by extension, the world) in ethical ways.

"A focus on agential cuts is, therefore, generative of particular sets of ethical responsibilities; though matter itself has stability, it is still necessary to be accountable for the cuts that created this stability and grapple not just with the ethical consequences of these cuts, but with the constitutive exclusions that underpin them." (Hollin, G., et al, 2017, p.20).

Ontology and Time

The recalcitrant properties of time are deeply interconnected to the broader ontological instability of the CS. It is argued that assemblage theory is particularly useful in conceiving of time as complex material interactions between material and virtual, human and non-human actors. This section seeks to address speculations about how time may be constituted at an abstract, ontological level.

Time is often determined through spatial metaphors or descriptions (Innes, Simonetti, Sharma). This is evident in Figure 68, which attempts to visualise the CS assemblage as a rhizomatic network of actors. The rhizome challenges the pervasive hierarchical arborescent 'Tree of Life' theory of evolution on the principle that lateral or horizontal agency occurs in the world.

CS time is distributed between multiple connections between actors. The "temporal frames" (Zagal, J.P., and Mateas, M., 2010, p.854) of videogame studies are compatible with this approach, identifying instances of temporal configuration without

claiming for a unified or overarching limit to how time can exist. In the case of CS, the programming logics mirror such an organisation, via the ability to create multiple, overlapping and interconnected time logics, with the ability to specify the impact of each logic on other actors in the scene.

Simonetti acknowledges the shape of the rhizome, and by extension, the assemblage, although questions what shape time may be if it is to include both hierarchy and horizontal rhizomatic (Simonetti, C., 2015b, p.156). “It also has the risk of erasing the constant influence of the forces of the environment, particularly the vertical gravitational axis that most life has to deal with, we lie forward to excavate, down to rest or move across with our pens to write” (Simonetti, C., 2015b, p.157). Perhaps the rhizomatic structure of time in the CS assemblage does not have to indicate that all time is subject to the same spatial direction, but each actor can contain a nested directionality – such as the horizontal timelines of 3D animation software and the networked, multidirectional nodes of game engines.

The question of what time is in the assemblage is difficult to address directly, although the experience of making the work in this study suggests that time is distributed within and across actors, in the virtual, material, human and non-human actors and their interconnections. Time can be said to be the mechanism of difference in the CS assemblage. Through constant reconfiguration of actors via multidirectional agential flows, difference is propagated. This is consistent with the auto-poietic and vitalist nature of matter in new materialist philosophies (Braidotti, R., 2013, p.60) (Bennet, J., 2010).

In this sense, time can be considered as the connecting force between actors, the lines of travel between different scales and durations of activity within the assemblage. There is no part of the assemblage outside of time – it is manifest within objects and between them. Time is inherently difficult to materialise in isolation of the effects it has on the world. This links to the function of assemblage theory as a focus on process rather than object. We can continue to search for an ontology of time, but the processes which it enacts, transports, starts and ends are worthy of our attention in the meantime. By researching them we gain access to insight into the human, machine, and hybrid temporalities that contain imbalances of power and equality.

Conclusion

Chapter Eight used the production of simulated landscapes to explore how the mechanics of time within software interfaces, and the performance of time through simulated artworks, relate to notions of time within the material world. New materialist philosophies were used to develop a framework for understanding the recalcitrant temporalities of the computer simulated artwork.

Computer simulations are often conceived of as real-time, an over simplified term that masks complex interrelated temporalities. The research outcomes of this study indicate that CS possess recalcitrant temporalities - they are complex adaptive systems undergoing constant change and entanglements of human, non-human, material and virtual time logics. The temporal intractability of CS can be explored through the use of duration in art practice, and also used to address the ethics and politics of duration – the exploration of entangled, material temporalities that occur within the CS and its lifespan.

Thinking about computer simulations in terms of lifespans is a simple but significant way to consider temporalities beyond the screen, and the time frames in which simulations exist as functioning media devices. Mining, manufacturing, labour, computer simulations facilitated by media devices, eWaste, recycling, cloud storage and other 'immaterial' aspects of digital culture are then activated as potential sites for understanding the ways in which time and materiality connect simulations to the world.

It is important to acknowledge my role as an artist-researcher in the research. This framework has been situationally developed by an artist embodied within a specific set of software and ecological circumstances – which is to say that it could be alternatively defined by others with different perspectives. The hope is that the underlying framework of recalcitrant temporalities provides a useful example of the application of assemblage theory to CS artworks and is flexible enough to be applied under different conditions.

It is dangerous to overstate the temporal and ontological recalcitrance of computer simulations; in that it can lapse into the ultra-relativity of simulacra that this study has criticised at length. Instead of making the invisible visible, and drawing out the mechanics of CS temporalities, CS become too complex and changeable to understand or know. This is where agency and ethics are important contexts – via the work of Barad and Sharma, there are ways of operationalising an ontology of CS for useful purpose in the world.

The complexity and relativity of time should serve the flexibility and applicability of a deployable research methodology and art practice rather than obfuscate. The temporal recalcitrance of the CS is its greatest gift to artists, as it offers a temporal toolkit for exploring complex temporal interactions in the world.

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Appendices

i. Approval confirmation
ii. Ethics Proposal form
iii. Consent Forms for Participation in the roundtable discussion
iv. Wireframe Valley (2014) Press Release
v. Land Engines Exhibition Gallery Plans
vi. Wireframe Valley (2014) Time Logic
vii. Roundtable Discussion Transcription
viii. NEoN Festival PR

Appendix i: Ethics Approval Confirmation

From:	Jacci Burton
To:	Paul Dolan
Subject:	Ethics Approval
Date:	29 April 2014 09:11:00

Dear Paul,

I am pleased to confirm that the Ethics Committee have reviewed your paperwork and have **approved** your proposal.

You may now continue with your intended Research.

Please note that if the focus and methodology of your project change substantively, you will need to seek new ethical approval prior to conducting any primary research.

Good luck with the rest of your course of study.

Best Wishes

Jacci

Jacci Burton
Departmental Coordinator (Design) &
Faculty Ethics Coordinator
Arts, Design and Social Sciences
Northumbria University
City Campus East 2, Room 207
Newcastle Upon Tyne
NE1 8ST

Telephone: 0191 227 4057
E-mail: jacci.burton@northumbria.ac.uk

Appendix ii: Ethics Proposal Form

Depending on your research study, you may need to include supporting documentary evidence as part of this form. Please refer to the University Research Ethics and Governance handbook, or those provided by your Faculty or Service Department for information about the type of evidence you need to provide.

Project title:	Floating Point Exhibition

Submitter information

Name:

Status: [x] Staff [x] PG research [ ] PG taught [ ] Undergraduate

Faculty: Arts

Department: Animation

Email: paul.dolan@northumbria.ac.uk

Principal Supervisor (if relevant): Stephen Gibson

Please list your co-investigators:

Data Source

Tick all relevant boxes that apply to your proposed research and then make sure that you also complete **all** of the relevant sections.

1. People and/or personal data of a living individual [x]

Participants are defined as including living human beings. This also includes human data and records (such as but not restricted to medical, genetic, financial, personnel, criminal or administrative records including scholastic achievements). Personal data is defined as any identifiable information that affects a person's privacy such as information which is biographical in a significant sense or has the relevant individual as its focus rather than some other person or some transaction or event. This includes video/audio and photographic materials.

PLEASE COMPLETE SECTIONS: 1, 6, 7, 8, 9

2. Secondary data (not in public domain) [ ]

Secondary data involves the use of existing data (not in the public domain) with the permission of the Data Controller for purposes other than those for which they were

originally collected. Secondary data may be obtained from many sources, including surveys, computer databases and information systems.

PLEASE COMPLETE SECTIONS: 2, 6, 7, 8, 9

3. Environmental Data ☐

Any outdoor fieldwork in rural, coastal, marine or urban environments and the temporary or long term effects the research study may have on people, animals or the natural or built environment.

4. Commercially sensitive information ☐

---

1. PEOPLE AND/OR PERSONAL DATA

If you are involving human participants, or are gathering personal data about a living individual then please complete all of the sub-sections in section 1.

A: RESEARCH AIMS

State your research aims/questions (maximum 500 words). This should provide the theoretical context within which the work is placed, and should include an evidence-based background, justification for the research, and clearly stated hypotheses (if appropriate):

I am conducting a practice-led fine art PhD. The research aims to test aspects of critical theory relating to computer simulations via the making and exhibition of artworks. I am undertaking three iterations of making work, each with an accompanying chapter of critical reflection.

The exhibition of work is important as it allows me to check whether the way I talk about and present my work is clear to an audience. In order to capture this I need to collect qualitative data from the audience to support my critical reflection.

B: STUDY DESIGN AND DATA ANALYSIS

Please provide a description of the study design, methodology (e.g. quantitative, qualitative), the sampling strategy, methods of data collection (e.g. survey, interview, experiment, observation), and analysis

I am using a qualitative design which consists of two data capture methods. The first is a roundtable discussion around my exhibition which will be audio recorded and transcribed. It will take place in the gallery itself (B&D Studios, Commercial Union House, Pilgrim Street, Newcastle Upon Tyne). A small number of colleagues peers have been invited to take part (6 people). Consent forms will be provided for participants. Key theme and key word analysis of the transcription will feed into the reflective chapters of my thesis. The second method will involve reflective writing templates, distributed on the night of the opening and also left in the gallery for the two-week duration of the exhibition. The reflective writing templates will contain basic questions that elicit reflections on the themes of the exhibition. They will be anonymous and collected via a box in the gallery. They will also be analysed by identifying the frequency of key words and themes that occur. The aim of both methods is to gather responses and reflection on the pieces in the exhibition, to check whether my practice is outwardly communicating what I think it is to an audience.

Ci SAMPLE

Provide details of the sample groups that will be involved in the study and include details of their location (whether recruited in the UK or from abroad) and any organizational affiliation. For most research studies, this will cover: the number of sample groups; the size of each sample group; the criteria that will be used to select the sample group(s) (e.g. gender, age, sexuality, health conditions). If this is a pilot study and the composition of the sample has not yet been confirmed, please provide as many details as possible.

The discussion panel will consist of academic and artist peers who are known to myself. Each has offered to help and be part of the discussion. Six people are expected to attend. The reflective writing templates will be offered to audiences attending the gallery. The gallery is on the 3rd floor of a building with a concierge, so it is likely they will largely constitute people who have chosen to visit the exhibition. I expect around 200 people to visit in total and around 30 to fill in forms.

Cii If you will be including personal data of living individuals, please specify the nature of this data, and (if appropriate) include details of the relevant individuals who have provided permission to utilise this data, upload evidence of these permissions in the supporting documentation section.

The names of the discussion panel will be recorded to aid with transcribing the discussion. This has been made clear to them and they will also be provided with a permission form. No personal details about the audience will be recorded on the reflective writing templates.

Ciii. RECRUITMENT

Describe the step by step process of how you will contact and recruit your research sample and name any organisations or groups that will be approached. Your recruitment strategy must be appropriate to the research study and the sensitivity of the subject area. You must have received written permission from any organizations or groups before you begin recruiting participants. Copies of draft requests for organizational consent must be included in the 'Supporting Documentary Evidence'. You must also provide copies of any recruitment emails/posters that will be used in your study.

The participants of the discussion panel are colleagues and artists who have agreed to contribute to a discussion about my work.

Will you make any payment or remuneration to participants?

[ ] Yes [x] No

If yes: Please provide details/justifications. Note that your Faculty may have specific guidelines on participant payments/payment rates etc and you should consult these where appropriate:

D. CONSENT

Please indicate the type of consent that will be used in this study:

x	**Informed consent**

Please include copies of information sheets and consent forms in the 'Supporting Documentary Evidence'. If you are using alternative formats to provide information and /or record consent (e.g. images, video or audio recording), provide brief details and outline the justification for this approach and the uses to which it will be put:

The consent form is attached.

	If using an alternative consent model (e.g. for ethnographic research)

Provide a rationale that explains why informed consent is not appropriate for this research study and detail the alternative consent arrangements that will be put in place. Add any relevant supporting documentation to the 'Supporting Documentary Evidence' section.

E. RISK

Please identify any risks associated with your project and how these risks will be managed. If appropriate refer to any Risk Assessments (RA) you have consulted to ensure the safety of the research team and your participants. Please state the level of risk for each RA.

There are few risks associated with the discussion panel. The physical location is a safe office meeting space within the gallery, with their own health and safety protocols. I will make sure to discuss fire exits and housekeeping matters before we start.

F. TASKS AND ACTIVITIES FOR RESEARCH PARTICIPANTS

I. Provide a detailed description of what the participants will be asked to do for the research study, including details about the process of data collection (e.g. completing how many interviews / assessments, when, for how long, with whom). Add any relevant documentation to the 'Supporting Documentary Evidence' section of this form.

The discussion panel is a one off, one hour event, in which artists and academics will be asked to reflect and talk about the work in the exhibition. I will chair the meeting and occasionally direct or prompt participants as necessary. They may be emailed afterwards to clarify statements. Audience members who complete reflective writing templates will complete the template (if they choose to) and then their contribution ends. The forms will be collected at the end of the exhibition (2nd November).

II. Provide full details of all materials that will be used (including consent documentation). If you are using newly developed or unpublished materials these must be provided as Supporting Documentary Evidence

Consent form for discussion attached.

III. If the task could cause any discomfort or distress to participants (physical, psychological or emotional) describe the measures that will be put in place to reduce any distress or discomfort. Please give details of the support that will be available for any participants who become distressed during their involvement with the study.

It is an open discussion and therefore not possible to foresee the direction or content, although it will be structured loosely around a few themes. It is unlikely that simulation theory and postmodern concepts of time will cause anything other than boredom to the participants, but I will still give them the option to leave at any time if they feel the discussion is offensive or they do not want to contribute. Participants will also be given the right to opt out of having their contributions transcribed, which they can do so by emailing me discretely (my email address is on the consent form). Details of who to contact in order to make a complaint are also on the consent form. The question prompts on the reflective writing templates will be open questions to elicit reflection and unlikely to cause offense.

2. DATA FROM SECONDARY SOURCES

If your research will be using data from secondary sources (i.e. data about people that has not been gathered by you from the research sample and which is not in the public domain) then the following sections must be completed.

A. DATA SOURCE

What is the source of your data?

Describe any measures that will be put in place to meet the supplier's terms and conditions. (Note: arrangements about anonymising data, data storage and security should be provided in section 6). Where permissions are required to access data, provide evidence of the relevant permissions you have obtained in the supporting documentary evidence.

If your research involves the cooperation of external organizations then relevant permission should be provided in the 'Supporting Evidence Section'.

3. ENVIRONMENTAL DATA

If your research study involves taking samples from the urban or natural environment (e.g. (soil, water, vegetation, invertebrates, geological samples etc) all of the questions in this section must be completed.

A. SITE INFORMATION

List the locations where the data collection will take place including, where appropriate, the map reference. State if the location is protected by legislation (e.g. Area of Outstanding Natural Beauty (AONB), Site of Special Scientific Interest (SSSI), National Park etc).

B. PERMISSION AND ACCESS

Do you need permission to include the location(s) in the research study or to gain access to the site(s)?

☐ Yes ☐ No

If yes: State the job title and contact details (address and telephone number) of the person you will contact to request permission. If you have already received permission, please include a copy of the letter or email confirming access under 'Supporting Documentary Evidence'.

C. SAMPLES

Provide details of: the type of sample(s) you will collect (soil, water, vegetation, invertebrates etc); the size of each sample; and the spread of sampling across the location(s). Explain how the samples will be disposed of after the research is complete

Briefly explain why collecting the sample(s) is essential to the research study.

D. COLLECTION

Describe how you will reach the site and any potential pollution, noise, erosion or damage that could occur. Detail the measures you will take to reduce any impacts.

Detail any impacts caused by extracting the sample (e.g. disturbance of animal or bird populations; use and disposal of chemicals in the field; trampling or removal of vegetation; visual or aesthetic impacts caused by markers left on the site). Detail the measures you will take to reduce any impacts.

4. Commercially sensitive data

5. Data security and storage

A. **ANONYMISING DATA**

Describe the arrangements for anonymising data and if not appropriate explain why this is and how it is covered in the informed consent obtained.

Participants who fill in questions sheets will not be asked to write any identifying data on the sheets. Participants who take part in the discussion will not be anonymised, as the aim of the discussion is to capture feedback from specific people in the field.

B. STORAGE

Describe the arrangements for the secure transport and storage of data collected and used during the study. This should include reference to 'clouds', USB sticks.

All data will be scanned and stored on an encrypted university hardrive, secured with my own log on and password.

C. RETENTION AND DISPOSAL

Describe the arrangements for the secure retention and disposal of data when the research study is complete.

Electronic data will be kept until October 2019, 12 months after the end of the PhD. Paper copies will be destroyed once digitised.

---

6. Intellectual property

Please provide details of any Intellectual Property issues or commercial implications arising from the proposed study. Please describe the agreements that are in place to protect / exploit the Intellectual Property.

The work being discussed is my own so there are no IP issues with researching this area.

---

7. Timescale

Proposed start date of data collection: 18/10/2016

Proposed end date of data collection: 01/11/2016

---

8. Supplementary information

Please tick the boxes that relate to the supplementary documentation that you will attach as part of your submission:

- [ ] Participant information sheet
- [x] Consent form(s)
- [ ] Debrief sheet
- [x] Participant recruitment email/poster
- [ ] Unpublished (in-house) questionnaire(s)
- [ ] Interview / observation / focus group schedules
- [ ] Risk Assessments / Standard Operating procedures
- [ ] Permission letters (e.g. from school, organization, team etc)
- [ ] Other documents. Please specify below:

Appendix iii: Consent Forms for Participation in the roundtable discussion

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Website http://northumbria.ac.uk

Consent for Participation in Discussion

About the research.

This research is part of a fine art PhD. The research aims to test aspects of critical theory relating to computer simulations via the making and exhibition of artworks. There are three iterations of making work (and exhibiting), each with an accompanying chapter of critical reflection.

The data from this discussion will be transcribed and digitised, and stored until 12 months after the PhD ends (October 2019). It will be safely stored on an encrypted harddrive. The discussion will be used to support the reflective writing elements of the thesis.

Permission.

I volunteer to participate in a research project conducted by Paul Dolan from Northumbria University. I understand that the project is designed to gather information about academic work of faculty on campus. I will be one of approximately 30 people being interviewed for this research.

1. My participation in this project is voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one on my campus will be told.

2. I understand that most participants will find the discussion interesting and thought-provoking. If, however, I feel uncomfortable in any way during the interview session, I have the right to decline to answer any question or to end the interview.

3. Participation involves taking part in a discussion about the *Floating Point* exhibition. The interview will last approximately 1hr. Notes may be taken during the discussion. An audio tape of the discussion will be made. If I don't want to be taped, I will not be able to participate in the study.

4. Faculty and administrators from my campus will neither be present at the interview nor have access to raw notes or transcripts. This precaution will prevent my individual comments from having any negative repercussions.

5. I understand that this research study has been reviewed and approved by the Ethics Committee for Arts, Design and Social Sciences at Northumbria University. For research problems or questions

For further information, please contact:

Paul Dolan, Senior Lecturer of Animation, Room 013 Squires Annex, Northumbria University, NE1 8ST

Paul.dolan@northumbria.ac.uk

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regarding subjects, the Ethics Committee may be contacted at: Jacci.burton@northumbria.ac.uk, Tel: 0191 227 4057

7. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

8. I have been given a copy of this consent form.

9. I understand that I can withdraw consent after participation by emailing Paul.dolan@northumbria.ac.uk

21-10-16

My Signature Date

21/10/16

Paul Dolan Date

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Oct. 21 / 2016

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7. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

8. I have been given a copy of this consent form.

9. I understand that I can withdraw consent after participation by emailing Paul.dolan@northumbria.ac.uk

Christopher Dancett

My Signature Date 21 · Oct - 16

P. D

Paul Dolan Date 21/10/16

For further information, please contact:

Paul Dolan, Senior Lecturer of Animation, Room 013 Squires Annex, Northumbria University, NE1 8ST

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Consent for Participation in Discussion

About the research.

This research is part of a fine art PhD. The research aims to test aspects of critical theory relating to computer simulations via the making and exhibition of artworks. There are three iterations of making work (and exhibiting), each with an accompanying chapter of critical reflection.

The data from this discussion will be transcribed and digitised, and stored until 12 months after the PhD ends (October 2019). It will be safely stored on an encrypted harddrive. The discussion will be used to support the reflective writing elements of the thesis.

Permission.

I volunteer to participate in a research project conducted by Paul Dolan from Northumbria University. I understand that the project is designed to gather information about academic work of faculty on campus. I will be one of approximately 30 people being interviewed for this research.

1. My participation in this project is voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one on my campus will be told.

2. I understand that most participants will find the discussion interesting and thought-provoking. If, however, I feel uncomfortable in any way during the interview session, I have the right to decline to answer any question or to end the interview.

3. Participation involves taking part in a discussion about the *Floating Point* exhibition. The interview will last approximately 1hr. Notes may be taken during the discussion. An audio tape of the discussion will be made. If I don't want to be taped, I will not be able to participate in the study.

4. Faculty and administrators from my campus will neither be present at the interview nor have access to raw notes or transcripts. This precaution will prevent my individual comments from having any negative repercussions.

5. I understand that this research study has been reviewed and approved by the Ethics Committee for Arts, Design and Social Sciences at Northumbria University. For research problems or questions

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21/OCT/2016

My Signature Date

21/10/16

Paul Dolan Date

For further information, please contact:

Paul Dolan, Senior Lecturer of Animation, Room 013 Squires Annex, Northumbria University, NE1 8ST

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LAND ENGINES

Land Engines is a collection of work by artists who use video game design tools to create work that explores the computer generated landscape. It shows work in which the landscape is used as a setting for sublime fantasies and simulated violence through to its use as a focal point for conversation and peaceful contemplation.

The show features a range of artists including: Mark Tribe, artists group - KIT, Jen Southern, David Blandy and we delighted to have commissioned Paul Dolan to make a new piece – *Wireframe Valley* (in Gallery Two).

Re*Action Hero

On entering Gallery One you see *Re*ActionHero* by artists group KIT. *Re*Action Hero* uses landscapes from the beat'em up Tekken, these landscapes are stripped of the characters and scores and weapons to leave only the location in which the action takes place. The landscapes were then printed on to canvas that was then used to make punchbags. These punchbags are hollow, offering no resistance to a punch or a kick. The emptiness and lack of weight in these objects hints at the thought that people refer to websites and locations they inhabit in games as places, whilst in reality they have no material existence. The title Re*Action Hero refers to the improved reaction time of people who play video games. Bringing these two ideas together in *Re*Action Hero* makes poetic use of landscape, thinking about the weight and integrity of how we consider landscapes in a traditional gallery environment compared to our experience of them in a less physical and highly reactive video game environment.

Grunder Hill Road and Birdsall 5

Grunder Hill Road and Birdsall 5 are taken from Mark Tribe's Rare Earth series of work. Rare Earth explores the function of landscape as a symbolic setting for paramilitary fantasy. It consists of a series of large photographs of landscapes found in combat video games, a series of videos shot at a militia training ground in Upstate New York - Gunder Hill Road. The print, Gunder Hill is taken from a video game landscape. Tribe explained his decision to use a video game as the source for this landscape:

> "Much as certain Hollywood blockbusters have astonishing special effects, some of these games have incredible landscapes: realistic, convincing, and often remarkably beautiful. The designers of these landscapes, often art school grads employed by game publishers, seem to be influenced by the conventions of Western landscape representation, even if they aren't intentionally reproducing them."

In this exhibition you see *Gunder Hill Road* alongside the video piece *Birdsall 5*. *Birsall 5* is comprised of a single, static shot in which the only changes we witness are the subtle movements of grass and trees. It is this slight but intricate action on a high fidelity, looped video that draws our attention to the fact that we are watching video footage. In this case the footage is of paramilitary training grounds, a real setting for combat practice and acted

conflict. Displaying these two pieces together highlights contrast between the use of landscape as a setting for violent fantasy in real and in virtual environments.

Backgrounds

In *Backgrounds* a pair of figures walk and converse through a series of animated landscapes. This work reminds us of earlier '16-bit' video game graphics of the classic Super Nintendo games of the 1990's. The two characters in this landscape are David Blandy and his father, John - a landscape artist, discussing their individual art practises, wandering past snow covered temples, rainforest and ruined cities. The contemplative and thoughtful nature of this piece contrasts with our expectation for action and instead draws our attention through dialogue to the landscapes in the background.

Wireframe Valley

Wireframe Valley is a real-time landscape that slowly degrades over the 3 month period of the Land Engines exhibition, revealing the hidden mechanisms and structures used to create it. The video game engine allows for changes to occur in the landscape over longer durations than would be feasible in conventional animation. The piece replaces our expectation for immediate action with a considered composition in which the landscape is its own reward, offering new insights and surprises on return visits as the landscape gradually reduces from a traditional artists composition to a basic, conceptual wireframe structure.

About the artists

Mark Tribe - www.marktribe.net

Mark Tribe - is an artist whose work explores the intersection of media technology and politics. His photographs, installations, videos, and performances are exhibited widely, including solo projects at the Corcoran Gallery of Art in Washington, D.C., Momenta Art in New York, the San Diego Museum of Art, and Los Angeles Contemporary Exhibitions. He is the author of two books, *The Port Huron Project: Reenactments of New Left Protest Speeches* (Charta, 2010) and *New Media Art* (Taschen, 2006), and numerous articles. Tribe is Chair of the MFA Fine Arts Department at School of Visual Arts in New York City. In 1996, he founded Rhizome, an organization that supports the creation, presentation, preservation, and critique of emerging artistic practices that engage technology.

KIT - www.kitcollaboration.net

KIT is an international fluxing collaboration of artists, architects, programmers and writers. Working together since 1995, they have produced interactive robotic, sound, video and photographic installations, projects for architectural competitions and curated touring exhibitions. KIT projects have been realised in galleries, museums, festivals and off-site spaces across Europe, North America and Asia.

Jen Southern - www.theportable.tv

From learning to fly a light aircraft to making videogame clothing Jen Southern's work is experimental and plays with the idea of what it might mean to inhabit media. In collaboration with other artists, technologists or members of the public she works with hybrid places as lived environments. Recent work has been produced and exhibited

through residencies and commissions including: The Banff Centre, Canada; Mobile Media Studio, Montreal; FACT, Liverpool; The Pervasive Media Studio, Bristol.

David Blandy - davidblandy.co.uk

David Blandy's work deals with his problematic relationship with popular culture, highlighting the slippage and tension between fantasy and reality in everyday life. Either as a white man mouthing the words to the underground soul classic "Is it because I'm black" in "hollow bones" (2001), or being taught how to make art by the deceased martial arts star Bruce Lee in "emotional content" (2003), Blandy is searching for his cultural position in the world. He often uses humour to ask the difficult question of just how much the self is formed by the mass-media of records, films and television, and whether he has an identity outside that.

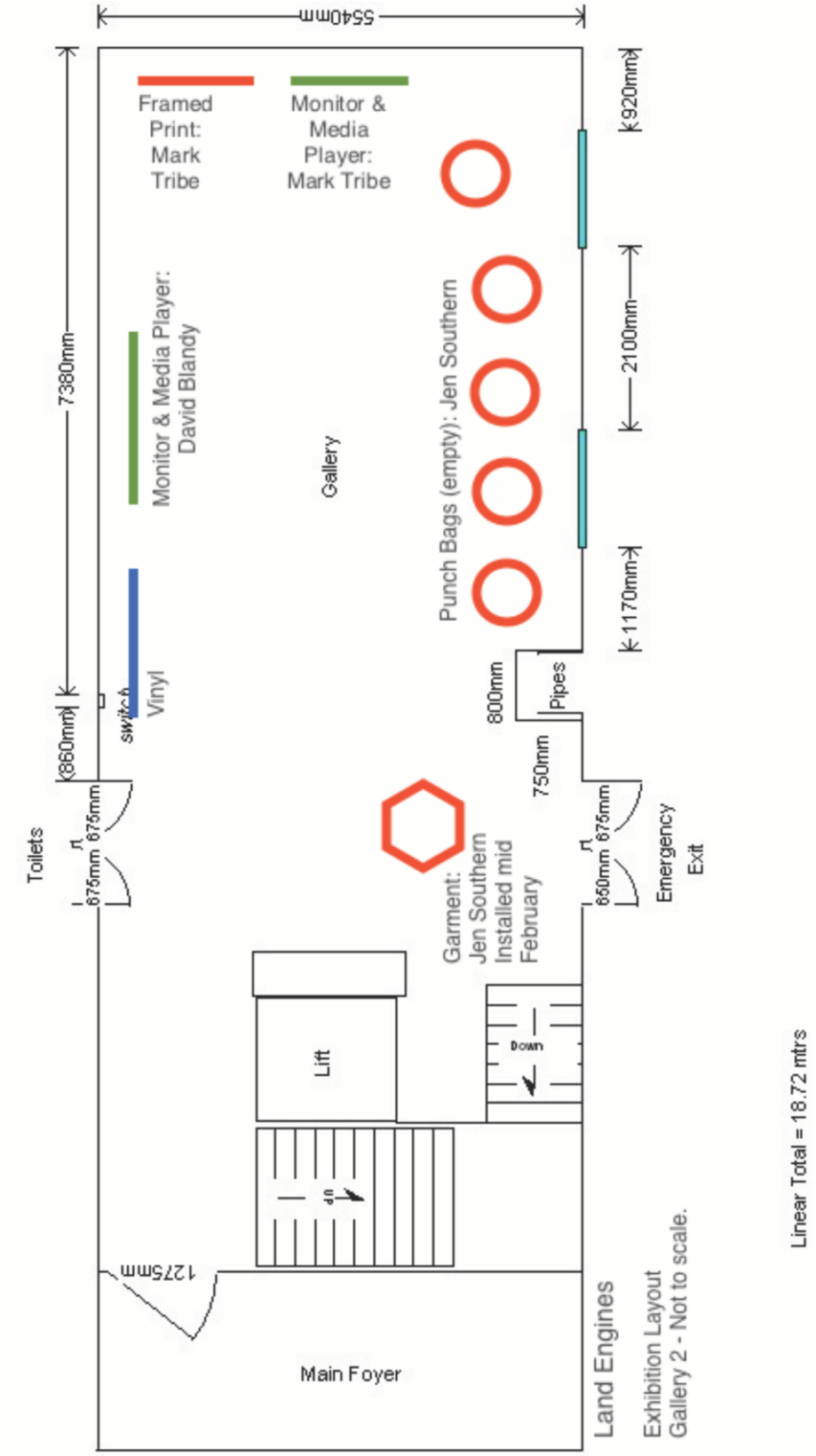
Paul Dolan - www.paulmichaeldolan.net

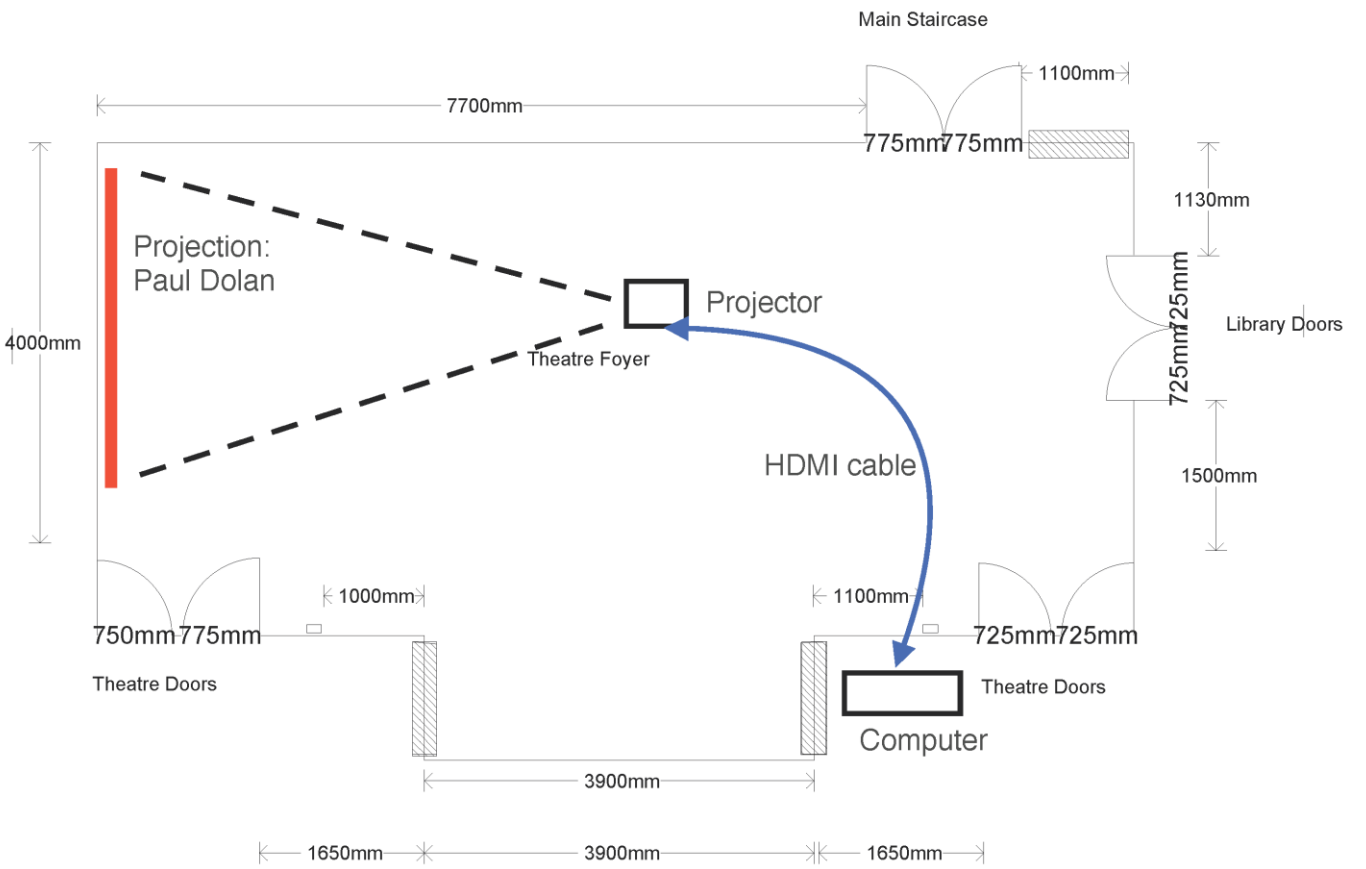
Paul Dolan is an animator and artist who is currently undertaking a PhD that explores the use of video game technologies in contemporary art. His practice involves the reverse-engineering and manipulation of videogame software and processes to provoke reflection on the problems and possibilities of the medium. He describes himself as: "a man in his thirties making things with digital technology." He graduated with a 1st degree in making animated films in 2004 and has been exploring the line between teaching and animation since then.

Land Engines is curated by Dr Dominic Smith

Dominic Smith is an artist and curator whose practice explores open methods of project development through a hands-on approach to working with art & technology. His current research focuses on the connecting nature of online platforms and our desire for a material experience with digital media. He is an independent curator developing a number national art and technology based projects, which includes working as consultant curator with Queen's Hall Arts, Hexham, supporting their creative digital media programme.

Appendix v: Land Engines Exhibition Gallery Plans



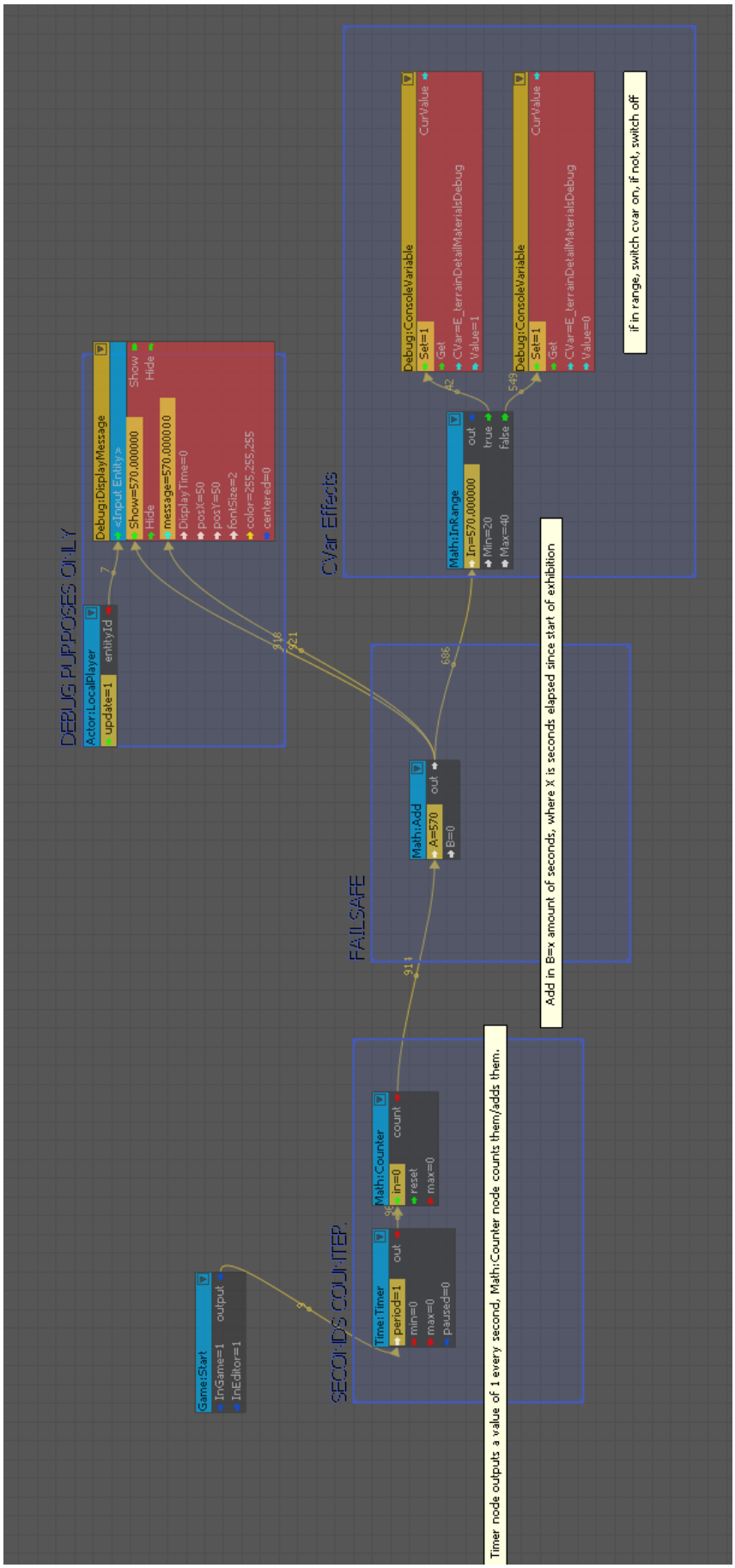


Wall Unavailable for Hanging

Linear Total = 13.33 mtrs

Land Engines
Exhibition Layout - Gallery 2

Appendix vi: Wireframe Valley (2014) Time Logic, CryEngine Visual Scripting Node Setup.



Appendix vii: Roundtable Discussion Transcription

Floating Point exhibition: Friday 24th October 2016.

In attendance: Kelly Richardson, Chris Dorsett, Dominic Smith, Narbi Price and James Darby.

CD: I have one other, sort of startup question for me is: Do you see that this is some sort of transcript that works as an appendix in the submission? And the reflection is what between your theory and your practices reflecting one another in some kind of ways, and your us as like a focus group or something. Perhaps that's too grand a term but…

for--**PD:** Yes, I guess so. I'm really not too clear about what the difference between a focus group and the discussion group is

CD: The name came into my head simply because I've seen certain kind of theses in the past, where there are little boxes with extracts from transcripts in the kind of flow of the actual thesis itself, rather than tacked on at the end. They're often in areas where there has to be a lot of reflective content, both types of research that … I'm just sort of curious for the front end, how we might be, the kind of purpose we might be serving.

PD: Yes, I think so. I think I had intended to kind of pull out a bits of what you said, and put that in the body of the thesis within the reflective chapter, just to kind of strengthen those things. I think ethically I would check it with you, before it's published and finished.

CD: That wasn't the reason I was asking, I was really sort of trying to imagine what we were doing.

PD: Yes, that's it. It will have a tangible presence in the thesis, I think.

Kelly: So, you're assuming this is going to be useful then.

[laughter]

PD: Yes, really huge assumption there.

CD: Yes, the word focus was probably questionable-

[laughter]

PD: This is the first time, some of you have seen it.

JD: I think with regards to the space, because I wouldn't go with the space, I will be in studios**.** In regards to the space, I think it's definitely one of the best shows. Just because it's something completely different to what we've had here, before. I think just because the way we set the walls as well, it works really well, because all these walls are movable. These sort of four walls here, are also movable so when we were discussing how we were going to get the light and the best sort of walls to project onto, we decided to put this wall here. As you walk into the space, you walk definitely into a subtle room, it's away from the other corridor and you

walk into a new space. And as soon you come into this space you see all three of the videos and I think that works really, really well.

NP: Probably should be said that it's lighter than it usually is. They're usually off. Could we just turn them off now, so you can see what's getting --

JD: Yes, I'm sorry.

KR: I was wondering--

DS: Okay, it's an interesting place to start, because what's sort of stuff do you normally show here?

NP: It's normally wall based, traditional wall-based kind of painting, and floor based sculpture. Has there been video before?

JD: There's been a video going on, just because we've got a projector there, with a screen, which is always used for projections and for films that's going on over there anywhere. It's been one when we've had a type of compartment with one video installation, but then there's always been other parts to go alongside, not just video and simulations.

NP: I think for a lo-fi space, it’s probably the most polished production.

KR: Yes, I think the installation and the space itself-- I'm going to project a bit of what I do here, but you are still fighting with a lot in the space, aren't you? It's just the nature of the space, it's not a white box space, to make something that is very slow moving, a very beautiful. This work is so beautiful, I could sit here for quite a long time even though that's hardly anything happening. [laughs] This is the kind of work I made, so what I try to do is create those kinds of contemplative spaces, where people can kind of forget where they are and just really immerse themselves in the work which is quite tricky here.

Trickier because of the distractions, because of the noise, I actually like that low rumble, [laughs], like the power of the truck that was outside but you get these reminders of where you were constantly. If it was a much cleaner space, it was a full bleed, and we didn't have black edge, etcetera. Then that's the only piece that we have, to fully immerse ourselves in, so I think that it is taking away from the work, but I agree that it is the best that you probably could have done for the space.

PD: Yes. It is a challenge because of that wall I think of studios and running out of movable walls.

CD: An I'd put a slightly different position on that, because although I completely sort of-- I'm with you and what you're saying, I actually felt myself slightly relieved that it wasn't too focused but there's a certain sort of thoroughness about this space, and there are things like this was like in a bar, and it feels like in a club after hours, and I quite like that. For me it improves the sort of sense in which they are simply there decaying, as it were. Just because they are projected in media, doesn't necessarily mean to say that they can't sit there like a canvas rotting.

For me that's sort of interesting, why it would be interesting for you to show it because there's a kind of stream of activity that's part of this space. There isn't too

much of the chapel, or the shrine about it. But actually having said that it's not to detract from the things you're saying because I can see the you would be struggling to have something of either of both of these worlds in what are you working on. I want to throw it back to you, having said that, because I think you're very screen based is as opposed to projection based in your head. Aren't you?

PD: Yes. I don't know, I'm not sure if I--

CD: Could you do this on a bus? Will it be all right to you? Could I be viewing it every morning on my iPad as I'm coming in the bus, will that be all right to you?

PD: Possibly, yes. I think at this stage-- [laughs]. I think at this stage, there's so many parts, like variables that could be ways of making it work, but because of the whole process of making it a thesis and making it part of research, I feel like I have to focus down a lot more…

CD: What's great that is, when it's an either or completely really, there isn't any position in between thinking that the optimum would be that kind of concentration, but it has to be in that particular idea. The thing I suggest is hundreds of variants, like of distractions and modes of concentration.

KR: Yes. That question of how you want, where you want the viewers to be, in terms of head space etcetera. How you want them to receive the work, under which conditions. Is it a free-for-all or do you want to control it a bit more… [crosstalk]

CD: I think that would be the proper optimum for what you're talking about.

NP: I think there's something to be said about the idea of pictorial scale, so it's something like the two landscape pieces. That was a landscape piece, this is more like a sprite almost, isn't it? As opposed to something like the infinity loop, something like the infinity loop by the nature of kind of being a loop suggests and the type of graphic that's used for that.. suggests that it would work in a different way, it operates in a different way than you two anyway. It would work in a different way on the screen or an iPad or whatever, because it's got that kind of close-ended thing, where I think that's slightly more temporal … time-based narrative that's going on with the changes in the two larger projections. It's a different way of looking, it's a different way of conceiving that kind of image.

DS: I guess I've got a question, a statement… the question is is the work actually finished?

PD: That's a good question actually, because in some ways, it is to me, I think in my head but at a practical level it is not because I have to keep remaking it to fit time of an exhibition or I have to keep remaking it because the tools that I used to make, I can't update it, or something breaks. So it is like spinning plates all the time, so is it-

CD: Do you remake it for a different space, or remake it for a different time?

PD: Yes, so it's like- I mean I could probably show you this later on, but the way that the work starts off now, these two bits are software basically. That's just a video loop. The software, you can double click on them like a programme and it

opens up, and there is an interface where you choose which day it is to play and it goes from there.

CD: It is quite interesting doing a TalkStudio follow up to the seminar on time and location and it grew out of conversation I'm having with Harrison in the conservation department at Northumbria. And he and I were talking in connection with my tantra project. We are considering- he keeps telling me about the test pieces that conservators make in order to sort of like if you have a Rembrandt to conserve you also don't test things out with Rembrandt.

You make versions of it but, of course, the models they make to work on, don't look like Rembrandts, they look like, what they look like all the materials presence, materialities that they actually have to work on so, they have got things that stand in for all these qualities, to make it look like a plastic cup but for them. It's got all the properties that a Rembrandt has and because they can accelerate it. They can make it so that it looks good or more or less the same age in its condition.

I am just fascinated by this because I want to- I can re-write the history of some of the objects that were in that exhibition in 1971. I can rewrite the history through this substitution. I can take one of those objects and I can say what would have happened if it hadn't been collected and ended up in the VNA? You know what would have happened if it sat in a temple in Orissa for you know two centuries instead of coming to London and sitting in the V&A?

You know, they can estimate which….

You know, following on from our conversation about locating things, it sort of suggests to me, you could actually work it in time. I mean what happens if I start saying actually all my work is 300 years old. [pauses] I feel almost in a position to say that with the conservation department.

DS: I don't know the project you are talking about, but the materials, I guess are, for want of a better term, canonised … traditional materials I guess. Whereas I guess with Paul, the software that he's using is changing all the time, it's not set, Paul probably can't remake this work in 10 years time. It's got a window…. It's got less life.

CD: Yes, I mean, I hear what you are saying but actually I would resist the difference between canonised... I mean, I probably busy being restored at the moment by loads of museum conservators, you know there's a big industry in it, and I am pretty sure the same would be happening wherever, you know, they feel it's their job to keep legacies intact but, I am talking about the reconstructive components in that process where they are not, you know, where it's not about keeping something going, maintaining, it's where you can actually make a substitute object which you can treat as though it is 300 years old, you know, whatever.

PD: I think what you are saying maps with the idea of simulation as a model. It's like in hard sciences where like physicists are trying to build simulations of things. They to do that thing where you bring in approximations of aspects of the model and [crosstalks] **[inaudible 00:14:24]**

CD: That is what I am talking about.

PD: They are not always accurate. So it's like a proxy object but apparently some physics experiments don't work if you get all of the elements exactly right so that you get better results if they just say, right? We have used these before, this calculation to represent air and even though it is not right, we get the best results. It's crazy like even like a hard science level, in simulation, this creative malleability with what constitutes reality, it's like you pick and mix with what you want to make a model out of.

In some ways, these are kinds of models, they are loads of components to them and you pull them together and then these models, the sky, the sea, each one is probably represented by a different bit of maths or code and then you just push them together and then move it.

CD: What you say sounds intriguing, the temporality, in what you are saying which I think it is interesting from this point of view… sitting in space and thinking about special effects.

DS: I guess. To go back a little bit, to what you were saying about scale as well. It's one of the reasons I was asking if the work is finished because can remember having a conversation with you encouraging you to show some of the work smaller. It's a way of saying, the ground of this piece is complete, whereas this piece is an idea I am working on and this is - so it's you get a shortcut to say how much value you want the audience to attach to the idea in the work I guess. Just this with the context of the space that we are in.

CD: Scale is the shortcut.

DS: There are possibly others but it's investigate an idea.

PD: I did take that into account. I think this was probably the one that would be small but in some ways that's got more finished than anything else because it's a fixed video loop and now I've rendered it, it's just there on a disk, and that will be like that forever. Whereas these things are likely to break. [laughs] I have thought about what the work would be like if it was like on a TV screen as opposed to a projector.

KR: I was thinking-

JD: That's what I was going to say is that, what I have noticed over the past because I have been in every day since the day after the opening is that specific students, pretty much every student that will come and slip a look at the definite look at the iceberg to see what is happening and see how it was changing and that's how I have been seeing people out thinking If you could have something which you could log into everyday to see it there, how it is progressing with, that's another way you could have a time period of say a month, which is what is going to be happening and people could log in to see that the decay throughout that time period. Because then you might have people logging in everyday or the week or-

PD: I think Marina Zurkow who did that with the Mesocosm. It's like an online web page that does that. So they are playing with the same ideas like it's a natural landscape. I think it's from Northumberland actually

CD: Sirka Lisa Kottinen?

PD: No no it’s Marina Zurkow.

DS: Queens Hall tried doing that with your other piece, wireframe Valley. But obviously they didn’t have the marketing strength behind it to do it well but they were putting images that work on the daily images progressing and

JD: that’s why I’m trying to take a photograph just to put on every day and then I mean, to have something… what sort of output would you have to have to have something playing like that to be able to get it on all different devices… it’s be massive!

[laughter]

DS: That’s a good point because you will include the context of the gallery in that constant stream or just go straight to the work.

KR: And what would be the driving impetus to do that? Is it to actually just, this vehicle through which viewers can continue to experience the work in this fractured way or do you want them to come back to the gallery which is more of a gallery concern but also maybe your concern?

PD: It's kind of conflict in mind between on one hand I quite like to get it outside for it to be an outdoor thing where it is just on a street or somehow on a screen somewhere

CD: To pick up on your point again, if it was turning up on my phone like every morning, does it matter that it is on an iPhone at that point? For me in terms of just what we think this piece is which is an art idea about it. Somehow where it is, you would see that it's kind of the whole point whereas I suspect commercial media ideas it's getting into as many places as possible and that not matter.

DS: Yes, it’s the attention that’s the valuable thing.

CD: It strikes me, the difference between those two is probably important, but I'm not quite sure how one gets at it, apart from point it out.

PD: One thing that I'm quite keen on or one part of the idea that I quite like is just how imperceptible it changes so that it takes time, and that's beyond human perception in the way it relates back to digital images and the kind of material, and how that impacts on how we receive them, and how they're stored. So I haven't really worked out if that's going to support the idea of or kill it. If it's something that you could access on your phone.

DS: What about the audience sharing images of their work via social media, I put a snap of it and put on Instagram and it had the most likes of anything I’ve shared!

CD: In the same sort of way someone else could share your things.

DS: So normally I get like two or three people liking pictures of my shoes or whatever, but I had about 50 likes. But I think it's not just the work, but it's about saying, "This is in a gallery, this is a space. It's got that mass reflection on the flow that you get from it. It's playing up to the trope of video art in the gallery space as well.

PD: I think it's something about it as well that it requires some of-- for people to understand what it is. The gallery context helps that a little bit, I'm not sure how I'll view that in the future, but at the opening, people were asking me, "What is it? What is it, a video? Is it real?"

Kelly: But it's also that space though, what happens in the experience of it? Because I can't look at something on my phone and really just shut everything else out and slow down. There so few opportunities suggest slowing right down to really getting to the proper head space to unpack it in a way that I think we want.

CD: It's such an important point. It's partly why we're all here [laughs].

PD: Yes, yes. Sitting in this for--

CD: And it is a kind of ultimate even if it's not achievable one's looking for it all kinds of ways. This isn't a tangent, it will sound like one for a bit till I get to it. When I was doing all that work to do with plaster cast collections of Edinburgh Festival 2012. There was a conference attached to it, and somebody who spoke at the conference, their name is escaping me at the moment, but she was an art historian. I think she was at York university then, but I think she's moved since, but she gave a paper about the reception of plaster cast material in the great exhibition in 1851. It was really interesting because there were complaints about the casting of pieces of temple architecture from India and parts of the world being in Hyde park basically. People writing complaining and saying, "Actually, what's the point of me having struggled to get to India to see that temple if I can now go and visit." Spatially, it's not the same as seeing a photograph or anything like that. Actually, to go to it, stand in front of it, walk through it's spaces, you've reproduced it here in Hyde Park. All the struggle is gone, any old Tom, Dick or Harry could go--

[laughter]

…to get themselves to India. What an insult to the exploring classes of Great Britain. It was really fascinating because one of the debates in this was the 19th century-- second half 19th century debates about-- in museums about whether to document thinks through photography or plaster casts, and the V&A was right in the center, it didn't know which way it wanted to go, whether photography… By 1900, it was decided not to collect casts but always photograph things. Mostly, because of print culture, not any other reason --get the image out and about. It almost sounds like the same debate isn't it, that we're having now, and the fact that a cast requires visiting. Seems to be all the difference to me.

NP: It's speed of consumption as well it made me think then of MP3s and how back in the day, finding that record by our band would be a struggle and the payoff would be so much better and now maybe there was a media. Obviously, the same thing applies with documenting it and sharing it on social media. But even when I was setting up the first day after the preview, I could see that there were 11 days of images, and the temptation to just see what it looked like in the end.

[laughter]

"No, better not, better not."

CD: Did you?

NP: I didn't, no.

CD: Good, good.

PD: On record, you didn't.

JD: I think it's nice to-- because we were going to see what it was like weren't we? To see how-- we didn't end up doing it in the end with the set up, and I'm quite glad that every day now I can see it start to slowly, slowly decay.

PD: I feel good about you so because of that. It's really important that you can--

JD: Yes, yes, definitely, yes. Like you said, Jack especially, is just absolutely loving it. He's coming in every day into the space to sit and to watch it for 10 minutes and he just loves it. It so nice to have that.

NP: I think something about time is the thing that goes through all three phases and through the practice. There's an interesting thing about the pictorial and the construction of these images. I was thinking of this on the preview night and I'm thinking very much as a painter. Painting is a record of the making of the object, each… it can only ever be this record of time spent in front of a piece of cloth. It's almost like the experience of the making is hidden, obviously for someone who is very much entrenched in the discipline that might not be the case but for somebody who is outside of that discipline, it's almost a hidden experience of the making, and the time, then is only this almost codified experiential thing.

CD: You often need to break down to get to the time, even media. Actually, I've noticed in media art-- you suddenly get a sense of it, it's studio in my terms, sort of studio presence when the thing breaks. I think that's a really interesting aspect of it all, it's because it's so covering, isn't it? Eclipsing.

NP: Also part of this type of imagery isn't necessarily of what we experience as video art or installation or whatever it's from a different set of disciplines, I think that's interesting.

JD: Are we talking about work individually as well? This is a finished piece, then this piece with-- I'm just trying to compare the two pieces and what stages you're at with each one, because obviously, the way that I see it is this is a finished piece, but then I don't know if we've discussed this or not? But then is this a finished piece as well? Or is this a different take on the sort-- For me, without having a background I don't know whether that's fit for me or not?

PD: No, that's a good question.

It's a bit like what Dom was asking before, with is stuff finished? With this one, I think this is the second time I've remade that, and the first time it had an entire background in it.

CD (to DS) You said complete didn't you, you didn't say finished. It struck me as being really different questions actually.

PD: Okay, what would you say, like complete and finished? What do you mean?

CD: Well, actually given that that's a loop, and the other ones what do you call it? Decay? Yes, a slow, slow, decay. Strikes me that being finished. That's a different connotation there.

PD: I assumed you knew, and some half like time.

DS: I think I said finished actually.

CD: Maybe you did. Maybe it's just me.

DS: I can't wait to say in this as well, there's a point that I want to make right away, but it hasn't been raised and that it's on what time, but you simulated the time as well because you've got complete control of how long these things take, and you've only chosen to make them reveal themselves in real-time, if you could do that in a couple of clicks it could be half time or you could accelerate this sort of aspect to take half an hour. You've chosen to make it real-time, or what you're telling us is real-time, as far as I'm aware, we just have to kind of believe you.

Or are we are all just imagining that, and you've never said that.

PD: I've never said that, I think I have to or maybe I have because real-time is become that kind of catch-all term to describe what the media is in relation to videos, its real-time because it is happening kind of as a live thing, I guess. But actually, I'd probably stop using the term real-time, because they're not. And actually if you look at the iceberg the sea code is kind of happening like in real-time. But the animation of the iceberg itself is key frames but just stretched out with really really long periods of time.

KR: Which is constructed, it's not representative of a particular time frame anyway.

PD: So then, the way that's done is, I work on my quite small level just I can play it back and see how it changes and I just multiplied the time by a very large amount of numbers that stretches outwards so it's just the way the interface works, so in some ways you're actually looking at two different ways of constructing time in the same piece. I find that quite interesting that kind of goes back to the idea of models but it's the kind of components but each one's got completely different temporal format to it, so it's misleading to refer to as real-time.

DS: Ok, I won't.

[Laughter]

KR: We are just saying live.

CD: It's a good question though, it's got so much going for it.

DS: There's more than one time frame in each piece, so as a painter would kind of build layers of material and form, you're using time as one of those components.

CD: It's not cumulative in that way you were describing… as this compressed thing that just then explodes out, you just multiply it to make it fully temporal.

PD: Yes, it's kind of like a telescopic, it's the way you say it, it's like when you extend the telescope out and it stretches out to fit to different time frame, I suppose to, if I make sense.

CD: Yes, it's that like the kind of growing block idea we were talking about. There it is, it's expanding. But actually the expansion doesn't happen in time either.

PD: It's hard because the construction and the reception of two different things we need in the way that we're receiving it, is always bound by real-time. So it's the constructive elements that are different but yes, I don't think it's like the growing block, because that suggests it’s like a stockpile.

CD: That has to be cumulative.

PD: Yes, it's not like that, no.

CD: The layers on a painting are like that.

PD: Yes. The time on this one is slightly different in that the civic… the crowd is kind of simulated, with software and it's a different process to conventional animation where you just kind of set positions and record it and then move them again and then record it, so you just define the parameters where they're going to move and then have to set all the parameters to be kind of hit a button, it stimulates it for you and it works out the timing of it all, the walking through the air.

CD: Through the air.

PD: So yes, that kind of, works in a different way as well.

JD: So you what, you pinpoint where you want the actors to set off from, and map them out so each one’s always different, and then press go?

PD: Yes, you have no individual control, it’s just as a cohort or a crowd, it's just kind of parametric. You just define how close you want them to get to each other and what direction, what surface you want them to stand on, and how long you want them to do it for. Then it just populates all of the time populate for you.

DS: What would have happened if you have enabled collision detection?

PD: Yes, I tried it, all of this stuff is so hacky, the tiniest value change on one thing makes it all fall apart.

DS: That's a really good point, so if you’re kind of hacking your way through, these works, how expressive is it? Because you get this argument amongst some media artists that you have to be a complete master of the machine and the code, before you’re an artist, using that material. I kind of don't go along with that actually. But do you feel like your knowledge of the software and tools, are able to express yourself as efficiently as you want?

PD: Yes, I can agree, I don’t think that’s super important and that comes from music really, just doing what you need to do, like DIY punk, or at least the punk of my childhood days. It’s an underground DIY way of doing it, otherwise I wouldn’t be able to do any of this stuff, it’d be paralyzing.

NP: And that’s also why you chose this space because of the DIY aesthetic.

KR: Can we asked about the actual content of the imagery, why present an iceberg? Why a tree- I can come up with my own answers, but I'm curious about why you've chosen to explore your ideas using this image construction.

PD: Yes, would you use the word natural, is that part of the question?

KR: It is going to be part of my question. Why use signifiers of it, representations of it?

PD: A few reasons. I think one comes directly from the theoretical part of the thesis and the Baudrillardian ideas about simulation theory and the natural world starting to disappear, or plastered over by images and signs and there's that kind of detachment from the natural world that happens. The most simple answer really is that I'm trying to find a visual language to come to terms with that. Through making the work, to get a sense of whether that's real or not, if it's a true statement, and I don't think it is, but I got there through making and modelling these things.

KR**:** That you don't think it is, so you disagree with it?

PD: Yes, I think so. I do.

KR: I'm just trying to tease that out, so I can get a sense of…. you might be very fuzzy with that in your thinking at the moment.

PD: I think it's shown that it's kind of postmodern historical way of thinking about those things and then the main part where it falls down for my thesis is that, if you're thinking about these things through them like the eyes of Baudrillard, or simulation theorists, there quite apocalyptic and there's no way out of it and it's all over and this detachment has happened, and then you can't talk about things as real objects anymore, so that everything is just become like a floating signifier. That there's like an irreversible detachment from the object and its meaning.

CD: Does it matter that that feels quite old-fashioned?

PD: Not really, I think it's still there but I think that the point at which it falls apart for me and what makes it more of a contemporary issue is that and I think these are real things and I think there is a tangible kind of material to them.

CD: I keep finding myself meetings and seminars where everyone's trying to say, well, surely there is no one left in the world thinks that experience is mediated in any sense, because everything's gone hard again, in a theoretical domain.

PD: You mean with new materialities?

CD: Object orientated ontology and all these areas are definitely about banishing the notion of mediation, it's part of everything now. Well that's the thrust. It's not kind of really possible, everything is overlaid by signs and whether you decide to call those meditations or not is a debate in semiotics, is not new, let's put it like this. It's kind of Sassure vs Pierce.

PD: I'm going to sit on the fence on it.

[Laughter]

CD: No, but I mean it's your right as a researcher to select your field and say, of course your examiner's going to say, "Does it work?" One of the questions might be and what about these other people doing this.

DS: There's an interesting point in your thesis, the bit I've read of it so far, where you say that this is to be useful for artists as well. And if you said object-oriented ontology to most artists they'd just kind of look at you like you were mad.

CD**:** Not at Northumbria.

KR: It is actually really big now

PD: No, but sorry- practicing artists.

DS: Otherwise …. not in any kind of an academic environment.

CD: Well, they are practicing artists.

Well I'm just sort of thinking of the people I hear saying it. The members of staff as well as students.

DS: And I mean it's a Phd it's got to hold its own and be robust, with it's critical framework. Yet if I went into my studio and knocked on every studio door and asked people to tell me what that meant, I could bet on it, they wouldn't be able to tell me. So it's really interesting that.

CD: How about reviews? Or things like that, it comes up a lot.

DS: Okay. I'll take that back. **[inaudible 00:40:42]** But the point I'm trying to make actually is that it's really useful to go back to those positions and explore them through your work, to get to that point in your thesis where you're revealing something new. Which is where I was going with that statement really. So, it's okay to explore old approaches before you get to the new ones as well.

CD: Well yes of course but also it might be that actually your practice can only trigger though this particular kinds of areas of thinking or ways of talking about things anyway. I don't think it's your right to claim it, whether it's in fashion or not. That's why we're artists rather than something else.

PD: There's something inescapable about all of the simulation postmodern theory about images and how they're constructed, and the replacement of the natural world. I don't think there's anyway to look at this work, and not have some kind of attachment to that at all. I think from a practical perspective it is easier to grab some of that theory that's to do with new materialities just so that you can use it as a framework to look at what it is, really, like in some practical sense.

CD: Because I would say that in a practice based or a practice led investigation, one of the things that that can do is just to say, well although this theory might be thought to be wrong by half the theoretical academic community in the world at the moment. More than that but actually, but this work proves that it has some role because it's manifest in some kind of way in this work and this work is still working and that's what you can do, you can use the practice to sort of torpedo the fluidity of thinking obviously goes where it wants to go.

NP: I'm going to be a little more pragmatic. Why does that one look so different? Why do we have this two in natural forms that are both time-based and then we've got this closed loop?

PD: I wanted to just to experiment and do something different.

NP: Or something that looked or in the context of this exhibition something that really did stand out as very different pallet of imagery.

PD: It came off from trying to think about how to move out of natural imagery and tackle the social element of the theory a bit more. So, I started to think about how to explore some idea of society and how that was represented within the simulation theory. So, I wanted to move with crowds and bodies of people because all of the other works have got nobody in, like the one from last year.

JD: Is that one a simulation though or is that more of the?

PD: It kind of is, it's not playing back in real-time**…**Or whatever you want to call that. But the way that it's constructed, it's a parametric thing. But the end form of it is a video, you just export it and play back on a loop.

JD: So every day that will always be the same?

PD: That's right.

JD: Whereas everyday those other two will always change?

PD: Yes.

CD: You said they're different, you meant?

NP: I meant purely visually.

CD: Visually.

PD: Am quite interested in exploring crowds a bit more it's just it's a bit of a technical hurdle. I think there's a few other things I wanted to do with crowds so I think that's going to come back.

CD: What does the tree look different from the others? I think they look different.

PD: To me this was more moving towards being okay with it being like an experiment, like a model like a scientific thing, so it’s like deleting everything out of the scene, so there’s no…

JD: I see this one more as a sculpture and this one more as a painting. I think it's because of the background changes on that doesn't it?

Whereas there's no background on that, that's almost like a piece on a cliff. Does the grass change?

PD: Yes, the grass is moving but you have to get quite close to see it.

NP: It reminded me of a piece I saw in New York about 16 years ago where a tree reacts haptically with the viewer. So the seasons change the closer you get to it and if you go right up close to the screen, the tree dies, and you can jump up and down the leaves shake and that kind of thing**.**

CD: It says quite a lot about Bill Viola really.

[laughter]

NP: But that was an incredibly controlled environment, because of the technology, it was one in one out, there was this long corridor. He used that very simple pallet of almost architectural simulation, tiles kind of like Sim City.

PD: Yes, I thought you said that on the opening night, they're like tiles.

DS: Yes, they've like god games where you can place like a tile at a time with trees or villages or people. It's almost like you're saying you have control over something when you do that, you kind of using that, I've used the word trope already today but I'm going to use it again, when you're using that video game trope that feels like it's taken from a video game landscape and I don't know if that's just an inevitable consequence of the tools you're using or if it's deliberate. Which is it?

PD: I made this look like that because that's what it is. It's like created with the *Speedtree* software that video game artists use to put trees in the games where you can open a tree and you can just change parameters to change how tall it is or how many branches it's got so that's why I guess it looks like that. I was thinking about it terms of like a petri dish, where you'd stuff single thing and trying to get rid of the excess images that might change that thing… to make it more focused.

DS: It makes me think a bit about the kind of work Cory Archangel was doing with the photoshop gradients where it's just referring directly to the software itself and then the creation of the work is that moment where in future work along those lines I'll be tempted to consider how much I include like traces of the software itself in the final work.

PD: What you mean?

DS: Just kind of the- in the way that often most interesting drawings or paintings or the unfinished ones where you can see the working out as well, or there are aspects of … the artist leaves traces… a history in the creation of the work visible to the audience.

CD: Interesting. Because this makes me think about what we were saying about paintings being covered over depends on how much you know about technology, isn't it? Because I wouldn't have known any of what you just said. I just took it as a sort of complete surface.

DS: So the question is does Paul make it more visible so that you can't hide even if you're not used to using software it's still visible from inside it so you're aware of it?

PD: I think this comes back to the conversation that we were having in the Phd panel which was about formalism…I'm a bit uncomfortable in saying the work is formalism, because my understanding of that is that I don't know, in a media sense… There was a suggestion it was formal because…

NP: We're talking about a pictorial formal?

PD: I think so.

KR: In terms of the aesthetic composition of the thing, is that what you're talking about?

Male Speaker 3: I think it was to do with the constructed elements of some of the work appear, like the wireframe aspect of the iceberg for example, it was my understanding that it was like I don't know if am using that as part of the language like the form like the material…

CD: It wasn't coming from a fine art angle, it's the media people that was saying it.I was sitting on the edge so, I didn't join in on that one.

[laughter]

Did I say anything at that time?

PD: I don't think so.

CD: No, because I really think I wasn't quite sure what they were talking about. Because my assumption would be exactly the same as probably everyone else in that formalism associated with certain kinds of modernism and --

PD: It's quite conservative with like a --

CD: Well, yes. I mean it used to be quite a good thing to be in and then suddenly it was a very bad thing to be in you know.

KR: Ah, the art world.

CD: Yes. The older you get, the more used you get to that happening.

PD: I suppose it's a good question about that. Yes. In some ways I wonder how much of that comes from just me like struggling to make the work and how much of it comes just through being an amateur.

CD: Yes, but that's from your point of view. I think one of the interesting thing about what you're saying is not being the receiver of the work with the … tools, that's important or not?

PD: Yes.

NP: I think context is the main thing that we're talking about. For me, the three pieces were in very different context. You've got this, the iceberg that is in the trope of video art or the cinematic or painterly of 2D, a flat image that shows a three-dimensional illusion. They are all that I suppose. Then we've got this one which is an icon. It's closed ended, it's this thing on it's own that could, that floats it's space. We've got this one which is almost… It's a 3D object, but it feels a very different than that 3D object. It's like three different languages. You've got this snippet of something there that, whilst arguably a representation original and then the rest of it functions very, very differently. With the screen, the iceberg one, there are all of those pictorial formalist propositional questions to be asked and to be thought of, just because we would have drawn on a pencil sculpture or whatever. Where with these two, that's striped away, we've just got this thing.

I think in terms of how the images are consumed, that immediately takes in different realms, so what even though we've got the exposed wireframe over that,

which is almost like I'd shown your work in the under drawing thing happening and that slow reveal of the technology, we almost, or I almost ignore that in a way, because I'm looking at this, I'm still looking at this representation of something. Whereas, with the square edges of the tile base thing, the technology becomes immediately more visible with that. This one makes me think of, I don't know really. It's something, it's in a different palette of representation altogether. I don't think it particularly benefits from being a projection either but I think these two with the sense of light inherited and do, yes. Almost makes me think of like the, when you first saw *Terminator 2*, the ILM kind of shininess. There was no point to that by the way.

PD: It's interesting you raise the idea of projection as part of the work, because it's the thought that projections dying as well as --

KR: What?!

DS: I know sorry Kelly**,** I was deliberately not looking at you when I said that. Because screens are becoming higher resolution and cheap to produce. We're not too far off in a situation where you go to a cinema and you're no longer watching a projected image but it's a giant screen. It's about, how important is the fact that this is projected to the work.

NP: Yes. I think for me, I think it's about scale and I'm just associating projection with the scale.

DS: Yes.

NP: I think the tree works quite nicely with being about real size and so maybe slightly smaller than real size. The iceberg I think the cinematic is inescapable because of the format.

DS: Yes. I guess I'm in a way also referring to the materiality of projection as well. I'm going to trip over on this one but I'll try and get there anyway is the, we're talking about simulation theories and the idea that it’s gone hard again. I can't believe I just said that in a room full of people.

[Laughter]

DS: But projection in itself is a material form in itself. You know that famous work *Line Describing a Cone* (1973, Anthony McCall) which just explores that perfectly, that idea perfectly, and at which point you say you’re playing with time, when you project an image then you can play with the space in the gallery. I think about the context of the gallery in a better way then you can when you say when I need… screens don't come in such variable sizes you're restricted to whatever's most produced and freely available as well as most projected you can take the context of the gallery really into account and also --

KR: Also what happens when the viewer themselves interrupt that space.

DS: Yes. Absolutely. Yes.

CD: Would you have consider having on a screen or something?

PD: Yes. I did think about putting some of the work on screen. I had another couple of pics of work though that I just didn't get to a point that I was -- happy to

present but I in my mind if they were going to work as to TV screens on the wall. I think in some ways that would have worked quite well, the black space behind the mobius strip is just too light, I think on the wall, where you get like a better colour definition. There's something about it where you because the people are quite small, the scale of the people possibly would work on the screen.

KR: With projection and talking about the construction of this is, the choices that you've made and for I understand why you've made them. But I also picking up on what Dom had said earlier how this the aesthetic in a way or some of the choices that you've made here really remind me of video games or just being a block that you can just stick into a viewer game. I think it's the choice of the square first of all that's doing that.

Also I'm wondering why the tree is glowing particularly as it's being clipped by the top of the projections screen and I'm not, I'd like to know why the tree is glowing first of all. My this again me projecting, I always want to hide the edge of -- It seems like this thing is floating there and it might be… I would like to not even see the edge of the projection and just have this the thing itself. It seems like the edge, is the edge in ??? and this one as well because that's really easily fixed in terms of creating a optical mask - masking tape or duct tape. That's what the optical mask.

JD: how do you do that then?

KR: If I hold my finger up here --

JD: I see.

KR: I can create a gradient where you can absolutely will delete that edge. The further away you get the harder that mask becomes, so sometimes you'll see in galleries some armature over here that takes the mask away so you can get quite a hard edge but sometimes in this case that most definitely would be close to the edge …would make that much more seamless and it sits as an object on the wall.

JD: That's a really yes, nice little tip there.

KR: I would lower that also because you've got that kind of space it seems like if you don't want that clip at the top which I'm going to assume wasn't a deliberate choice. --

PD: It wasn't deliberate.

KR: Driving force right. You could actually lower that and that would give you more room over there.

PD: Okay. Yes, good tips Kelly thank you.

KR: Sorry to get all technical.

PD: No, it's good. Yes, that's pretty useful.

PD: It does affect how it's read as well.

PD: Yes. I think like a lot of it does come down to projectors…

CD: Yes, well it does if you are exhibiting them.

PD: Yes. I mean so much comes down to like just the quality and the light, how much contrast you can get.

KR: Yes, absolutely.

PD: Does it look like it did on my screen was making --

PD: Yes.

CD: It sort of returns us to that point… that the sort of space in which it's seen in the degree of concentration that's needed overall asked in some kind of a way.

PD: Yes.

CD: How you meet that, that's what we've been just been hearing about… a higher degree of resolution of meeting that than you're actually using. You didn't answer the question about the glowing tree. I'm intrigued, I'm intrigued by that.

NP: I've seen other artist's glowing trees.

[laughter]

KR: I see, I'm not pointing any fingers.

PD: It disappears, so really it's like – it's just part of – it's about two days where it glows like this. But if you watch it back over the space it's about five minutes then it's just one part of it disappearing. It kind of burns – it kind of like a cigarette burning a piece of paper. It kind of burns away the material itself, so that's more of an object. The object themselves are starting to fall apart (pointing towards Floating Point).

This is happening more of a material level. The works and it's like a hack of the material itself, so I can work with the code for material and animate starting to crumble. And it looks quite different in a day or two –more fragmented and glitchy almost. By about day six or seven or it just looks like burning embers like – but still on the material itself, so that looks like a tree burning that disappears completely at the end.

KR: Nice.

DS: I realize it's near the end, I'm going to ask a quick question. How important fidelity in your work, getting it high resolution? How important is high fidelity to the work. Because there's a difference in fidelity between this piece and this piece, where the grass refers to almost pixel art, it's very flat, in a packaged way, it's not got a very strong shader on it. You haven't gone for realism with the shaders, I don't think.

KR **:** A friend.

DS: Yes, I'm trying to think.

PD: I don't know really. I think in some ways probably what I'm assuming is that I need to have some degree of photorealism to some of it in order to – for some of that thought process to kick in - to start comparing it with the real world. And in some ways I think if it's too far removed from that and possibly you don't get called into making that distinction and try to think about how it relates to the real world.

I quite like it more when the work is, the way you look at it you're not really quite sure how it's being constructed because it looks quite close to real but not quite. And so I think this is probably more of an experiment with just working directly with things that look fake really and try to work out what difference it makes.

PD: Yes. are there deliberate disruptions to the work – again, with that one and the exposed wireframes?

PD: Yes, yes, that's right.

CD: Does it mean that they can be treated as separate artworks? It's a stupid question, because they *are* separate artworks, but they're not just separate in how they look, they're also separate in a way that you conceived of them. That's why they will be different in terms of various kinds of qualities you use and the way that they're brought to some kind of conclusion.

PD: I guess I was just experimenting with different ways and this is my way of – like putting all of those experiments together. Which is why it might seem quite mixed…

CD: The way that looks and then the way you described it, it suggested all kinds of content that come in the back of my mind. Is that all right? With all that burning bush stuff that's going on?

PD: All right. Okay. Yes, I haven't thought that, but keep talking.

CD: I don't know. I don't know because I don't know whether – I mean, I think it's all right for it to hover undeclared in the background because that also how ambiguity works isn't it and why it's important. But at the same time, it's the kind of thing that people pick up on and because it's such a loaded cultural idea that I just wondered what you thought about it, whether it's for something that's important to you.

PD: In some ways that like what I'm doing is have to rain a lot of thoughts in to keep it on track. And that the fact that it's being done as research, as a thesis. Like I have to just close avenues of thought and just focus on a small part.

CD: You know how, in art school crits, it's really annoying because people do this all the time, it's 'oh it's about burning bushes' and you can't stop it rolling down this track because you can't say 'it completely isn't', because you can see yourself that you're making these illusions. But that's partly what's good about art school crits, is that you learn to live with all the stuff that comes out.

PD: Yes. I mean, bringing it back to… and we should finish them in a couple minutes if that's right. One of the other things about – I'm returning to the idea of like hard science simulations. Is a book that came out last year that was talking about how the success of simulations, is not so much like how it's done mathematically, but just how it's communicated to the audience.

CD: Believed?

PD: Yes. But like the mediation of it and how it's communicated. This book was talking about hard science simulations as rhetorical devices. I found that quite

interesting. I guess like in some way maybe it's heading towards that, a model that is rhetorical.

CD: It makes me think that things like leading that temporal development of an artwork whether we're talking about some technology or a pencil drawing or whatever it needs to be is that – quite a lot of the time but you don't see that because we're just reading the tree. And it's a learned dimension of – to be temporally like that, whether it's technology or whether it's just a line drawing to actually stop looking at the tree and think, "Oh, this line came first, the line came next" you know and sort of thing. It's an educated response of some kind or somehow, perhaps, I don't know.

KR: Just related to what you're saying. Again, we can't – I think we can't look at it as an iceberg and not think of huge, one of them arguably the greatest issue facing humanity is climate change and here you are literally you're presenting this thing which is the simulation of the environment that you're creating, breaking down while the physical environment is breaking down. And so you're going to get those questions. I remember asking that, it is in there isn't it?

PD: Yes, I mean, it does relate back to ideas of the natural world decaying, and I think that's fine for that to be there. That's good. I don't mind that.

KR: And I'll have to curate that into something.

PD: Yeah. Are we alright to stop there?

DS: No, because I want to ask one more question, sorry. It might be really useful to you two guys is to – how has putting this show on impacted what you're going to do in the future?

DS: Your question again, sorry.

JD: Yes, definitely. Well, I mean, I think I'd definitely think of doing more of this stuff, that it's something that I want to do, but then it's finding the artist that would want to do something like this here I guess. You're more than welcome to do another show here if you want Paul.

NP: Find an artist who's got three projectors.

DS: Yes, yes. But from what I gather you've mainly shown traditional, wall-based stuff?

JD: Yes, yes.

NP: This is like a step out for you?

JD: Yes, definitely it is. It's really nice to do something different.

DS: Do you see it connecting to that traditional of or does it feel like it's a real outlier compared to what you'd normally do?

JD: Oh no, no, no. The way I still see it as it being just completely taking over wall with a piece of artwork. So it's the same sort of thing with-

CD: Yes, I mean there just are interesting differences within that**.** Yes, and then I agree.

JD: The space is – I mean, I think that piece over there is absolutely beautiful. I just love sitting and watching it. I think it's amazing. And I think the way that the space feels and people coming in and say how much calmer it is than normal.

CD: But you consider it just having that?

JD: Yes.

CD: There's another dimension to it, that it's not an exhibition. It's like a placement of something.

JD: I think if we just have that – this space wouldn't work – whatever really. I think what goes to that question also is I don't know – I mean, you probably had seminars and things like that, you know group meetings, this is quite interesting though, four or five people sitting around with a tape machine having discussions. Do you do that? It's quite different from the kind of seminar-- meeting type discussion. More like a round table talk.

JD: Yes. And this has worked really well, having this going on within the gallery space.

PD: All right. I'm going to switch it off.

[01:10:31] [END OF AUDIO]

Appendix viii: NEoN Festival PR

RECORDS AND WIREFRAMES

Paul Dolan (UK) & Paul Walde (Canada)

Thursday 9th of November at 17:00 until Sunday 19th of November at 18:00

CENTRESPACE
Dundee Contemporary Arts
152 Nethergate
DD1 4DY

Records and Wireframes presents moving image works by artists Paul Dolan (UK) and Paul Walde (Canada) alongside skeletal remains of the extinct Tasmanian Tiger, on loan from the collection of the University of Dundee's D'Arcy Thompson Zoology Museum. Curated for NEoN by artist Kelly Richardson to accompany her exhibition at DCA, 'The Weather Makers', 'Records and Wireframes' explores themes around climate change and screen culture with allusions to the past, present and future.

In the expansive video installation Requiem for a Glacier (2013), Paul Walde memorialises British Columbia's Jumbo Glacier, or "Qat'muk", now under immediate threat from global warming and resort development. The work shows a four-movement oratorio performed by an orchestra and chorus atop the area's Farnham Glacier. Over thirty-seven minutes, Requiem for a Glacier features panoramic glacier views alongside the oratorio that was composed by converting data such as temperature records for the area, into musical notation.

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Requiem for a Glacier (2013), Paul Walde

The theme of disappearing landscapes, and data as a form of media archaeological artifact, continues in Paul Dolan's real-time video work, Wireframe Valley (2017), which presents the gradual disappearance of a digitally constructed landscape, revealing its virtual origins. The defining features of the landscape degrade over the exact duration of the exhibition. In the context of global warming, where the physical planet is increasingly incapable of sustaining life as we know it, our refuge amongst digital environments may not placate us for long.

Wireframe Valley (2017), Paul Dolan

Should we fail to alter our course, predictions for the fallout from large-scale, unchecked industry are nothing short of terrifying. Some scientists believe that a 6th mass extinction event is already underway through the "biological annihilation" of wildlife in recent decades. Recent studies suggest that the Tasmanian Tiger's extinction in the 1930s was itself caused by drought.[1] Due to human overpopulation and overconsumption, roughly 50% of the earth's wildlife population has been lost during our lifetime. A recently published study in the peer-reviewed journal Proceedings of the National Academy of Sciences forgoes the usual sober tone and refers to the gravity of the loss as a "frightening assault on the foundations of human civilisation". [2]

Carrying on from themes explored in Kelly Richardson's exhibition The Weather Makers at DCA, Records and Wireframes shows the work of artists who, through their art, are creating digital records expressing how we understand our world today. These art works, like the fragmented thylacine skull, may become artifacts that future archaeologists consider in their

search to appreciate how, in 2017, inhabitants of Earth understood the global environmental crisis facing them.

About the Artists

Paul Walde is an intermedia artist, composer, and curator. His work has been exhibited across the United States and Canada, including View From Up Here: The Arctic at the Center of the World at the Anchorage Museum, Anchorage, USA (2016), All Together Now at the University of Toronto Art Centre in Toronto, Canada (2014); Beyond/In Western New York (2007), a biennial organised by the Albright Knox Gallery in Buffalo, USA;. His work is held in several Canadian and American collections including the Museum London, Canada and the Anchorage Museum, Anchorage, USA. Walde currently lives and works in Victoria, British Columbia, where he is Associate Professor of Visual Arts and Department Chair at the University of Victoria.

Paul Dolan is an artist, animator and musician, interested in the materiality of media and how it relates to ideas surrounding 'nature' and 'environment'. He is a current PhD candidate at Northumbria University where he is exploring changing notions of materiality within computer simulation-related contemporary art. Wireframe Valley (originally from 2015, reproduced in 2017) was commissioned by Queens Hall (Hexham, England) and included in the exhibition Land Engines alongside established artists using video game design tools to create works that explore computer generated landscapes, including David Blandy (UK), Jen Southern (UK) and Mark Tribe (USA). He currently lives and works in North East England, where he is Senior Lecturer of Animation at Northumbria University.

Supported by the High Commission of Canada to the United Kingdom

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[1] https://www.theguardian.com/science/2017/sep/28/tasmanian-tigers-on-australian-mainland-killed-off-by-drought

[2] Gerardo Ceballos, Paul R. Ehrlich, and Rodolfo Dirzo (2017) 'Biological annihilation via the ongoing sixth mass extinction signalled by vertebrate population losses and declines' Proceedings of the National Academy of Sciences of the United States of America. See http://www.pnas.org/content/114/30/E6089 Accessed: 25/09/17.

Opening Preview Thursday 9 November 5pm – part of our Gallery Tours and Exhibition Opening Night programme

TICKETS

Free. Open daily 10am to 6pm (8pm on Thu)