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# Scripted performances:

## designing performative architectures through digital and absurd machines

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# Abstract

'Scripting' in architecture is usually associated with computer-based design programming. However, this narrow usage belies a rich vein of concepts intrinsic to architecture and authorship. This thesis frames scripting as a critical mode of computation, performance, and design process. It does this through seven projects that explore relationships between technology, society, and the philosophical absurd. Works include films, performances, programmes and installations produced independently and collaboratively with experts from scientific and artistic fields.

This thesis asks: how might an expanded definition of 'scripting' act as a critical methodology for performative architectural design?; how can this methodology mediate between, and comment on, technology and society?; and what is the relationship between scripting, authorship and agency? Computational scripting has been explored in depth by a number of practitioners and theorists; performative scripting has been examined within the context of theatre and artistic practice; this study adopts an expansive definition of scripting that embraces each of these approaches whilst simultaneously proposing scripting as a critical design methodology. Furthermore, the thesis introduces the philosophical 'absurd' as a framework for critiquing emergent technologies and their impact on society.

In chapter 1 two projects (*Ant Ballet*, *Godot Machine*) are discussed as modes of diagramming absurd theatrical scripts. The 'framing' of these projects provides direction for further work within the thesis. Chapter 2 introduces two dance pieces (*Nybble*, *Scriptych*) which represent scripted performances and a novel computer-scripted feedback mechanism. Both are diagrammatic modes of presenting contemporary computing mechanisms. Chapter 3 then discusses two experimental computationally-scripted absurd films exploring the practices and impact of contemporary technology companies (*86400*, *24fps Psycho*). Chapter 4 introduces a film (*Network/Intersect*) created through a novel design process imposing strict rules on the creation of work. It concludes by naming this practice ‘reflexive scripted design', proposing it as the thesis' original contribution to knowledge.

# Declaration

I, Oliver Matthew Palmer, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed

31st October 2017

# Abstract

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# Introduction

‘Script’ is a commonly used term within contemporary architectural design. Historically, it contains numerous meanings and implications central to architectural practice and methods, but today it is most commonly associated with a particular subset of computational design. This narrow definition belies the wealth of ideas that ‘script’ encompasses. This thesis presents my use of scripts as a mode of critical design research in examining a range of issues related to contemporary technology. Embracing the philosophy of the absurd, it examines a range of my design projects, which each use different scripted methodologies, resulting in the creation of films, installations, computational code and performances.

The thesis consists of four chapters, an introduction, and a conclusion. Each chapter presents a project, or pair of projects, which exemplify a different aspect of my practice, and mode of scripting. These range from behavioural scripts, to computational scripts, performance scripts, and finally, script as a mode of instruction in a design process. The thesis contains two direct contributions to knowledge. The first is a novel mode of physically navigating a three-dimensional vector database via a human-machine interface, which is described in chapter 2. The second is a novel design methodology, entitled ‘reflexive scripted design’, which was used to produce a film in chapter 4. The overall aim of this thesis is to reframe the term script within architectural discourse; to open the term up to debate, and embrace the numerous complimentary and contradictory ideas it contains. Reflexive scripted design is the most material manifestation of this aim.

This introduction will outline the theoretical and methodological basis for the thesis. The first part provides an overview of the contextual framework for the research. It begins by examining the development of the term ‘script’ in computational, architectural, psychological and literary disciplines, aiming to reveal the varied, yet interrelated, semantic and functional uses of the term within these different fields. The chapter then goes on to outline three definitions of script, which will form the core methodology for production of works described in this thesis – computational script, performance script, and reflexive scripted design – with a brief explanation of where each type can be found. This section will conclude with an analysis of another related field of research that is integral to the thesis: technology and the philosophical absurd. The next section details the design methodology underpinning the work, beginning with the description of two key ideas – the ‘absurdb machine’, and the ‘diagram’ – before moving on to a description of the modes of practice, and personal assessment criteria for design work. The introduction concludes with chapter summaries and a brief description of the works discussed.

## Contexts

### Computer scripts

The term ‘scripting’ in computation derives from its directive function. As a 1962 Fortran[1] computer programming manual explains: ‘A programme for a computer is like a set of instructions for a clerk who is running a desk calculator. We can tell the calculator clerk *what* to do with some numbers without saying what the particular numbers are.’[2] As this quotation implies, programming in computing involves the production of routine, procedural instructions based on binary logic. The actions of the computer are dependent on the legibility of specific symbols, usually inconsistent or incompatible with human language conventions. As a mode of programming, scripting is predicated on this idiosyncratic binary process, yet its function and *modus operandi* is distinct from programming in terms of its legibility and its dependency on a pre-existing language. As Ousterhout argued in 1998:

Scripting languages are designed for different tasks than are system programming languages, and this leads to fundamental differences in the languages. System programming languages were designed for building data structures and algorithms from scratch, starting from the most primitive computer elements such as words of memory. In contrast, scripting languages are designed for gluing: They assume the existence of a set of powerful components and are intended primarily for connecting components. System programming languages are strongly typed to help manage complexity, while scripting languages are typeless to simplify connections among components and provide rapid application development. Scripting languages and system programming languages are complementary, and most major computing platforms since the 1960s have included both kinds of languages.[3]

Where programming languages employ a low level of abstraction from the computer’s instruction set, scripting languages are much more abstracted.[4] This means that they are typically written in language that is easier for a non-programmer to understand; for example, there is no need for them to have to manually address memory operations. Scripting languages are useful for a variety of repetitive functions, such as renaming files, and often make use of conditional devices such as *if* and *for* statements, clear binary logic, and rules. Ousterhout calls scripting languages ‘glue languages or system integration languages.’[5] Put simply, most tasks that a computer script performs could be performed by a human, given enough time (an idea explored with the project *Nybble*, described in chapter 2).

Written at the height of the dot-com bubble, Ousterhout’s predictions that the increased prevalence of ‘gluing tasks’ would make scripting ‘an increasingly important programming paradigm in the next century’ have been largely proven correct.[6] Several of the main languages used in contemporary web programming, such as Python (the language the original Google crawler was written in), Perl, Ruby and JavaScript are scripting languages, and use libraries of pre-existing code to speed up programmers’ ability to implement functions and build higher-level programming.[7] Google’s TensorFlow – an open source machine-learning toolkit – is controlled via Python.[8] As Autodesk (commercial CAD software company) product manager McCullough said: ‘No need to learn how to link headers or throw exceptions. This kind of code is by you, for you – and it is fun.’[9]

The distinction made by Ousterhout positions scripting as a mediating layer between human language and pure computer-programming language; it implies that scripting is therefore removed from the original programming language, but still reliant upon it. Despite the fact that the term ‘scripting’ has been in common usage since the late-1970s, some contemporary critics – predominantly ‘purist’ programmers – dispute the validity of the distinction due to the dependency of scripting on the original programming language: programming is the essential language-form, which aims to optimise the function of a computer via the minimum amount of instructions that are necessary; whereas scripting is a derivative activity, which adapts the existing language framework to enable easier user-intervention, yet in doing so corrupts the purity of the language.[10]

On the one hand, the definition of ‘script’ implied here – as a subordinate and derivative – deviates substantially from the etymological associations of the word ‘script’ with its Latin root *scribere*: ‘to scratch, grave, engrave with a sharp point; hence […] to *write*, *draw*, or otherwise *make* lines, letters, figures, etc.’[11] Here the term implies intentionality and has subsequently become connected with the concept of one’s own *script*, or handwriting, which bears an intimate connection to the person who wrote it, which clearly deviates from the idea of computational scripting as inauthentic.[12] This would imply that programming is in fact closer to the common interpretation of the word scripting. Yet it could also be argued that computational scripting is closer to the etymological root of the word than ‘programming’, by virtue of its inauthenticity. To write, or script, is not to *create* the language, necessarily, but rather to *assemble*, *arrange*, *copy*, and *repeat* its elements in order to communicate an idea to the reader. The ‘scribe’, for example is ‘one whose business is writing’, and historically has been charged with ‘interpreting’ or ‘transcribing’ existing words, speech and language.[13] In Jewish history scribes were professional interpreters of the law, and in Biblical history, documenters (and upholders) of ceremonial tradition. Yet whilst associated with education and prestige, the role of the scribe also inferred a certain lack of decision-making power, as exemplified in the Bible verse Matthew 7:29: ‘For he taught them having authority, and not as the scribes.’[14] In computation, ‘scripting’ manipulates and transcribes a pre-existing programming language to communicate instructions to the computer and ultimately, by virtue of the ‘copy-and-paste’ approach used in scripting languages, to the user. As such, like the cultural use of the term scripting, it emphasises the act of copying and arranging more than the act of creation.

This notion of computational scripting therefore brings up a multitude of questions regarding the issue of agency and authenticity: it is a set of instructions that the computer must follow sequentially and *unquestioningly* based on a binary logic;[15] it can draw upon *pre-existing* bodies of work, external sets of instructions, data sources or even programming languages; it has *dependencies* and requires the *frame* of its parent language to compile; and it can be used at multiple levels of *abstraction* (a script may call on another script, which may call on another, and so on). The question of authorship in computational scripting that these characteristics raise has become particularly contested in the domain of architecture, since the emergence of script-based design strategies in recent years (discussed below), where a conversation around the creative agency and responsibility of the architect has been called up for debate. Yet as in computation, the term ‘script’ in architecture embodies semantic ambiguities, due to its changing use and association throughout history.

### ‘Scripting’ in the architectural context

The earliest usage of the term ‘script’, according to Oxford English Dictionary (OED) was c.1374, in Geoffrey Chaucer’s epic poem *Troilus and Criseyde*.[16] The term originates from the Old French *escrit*,[17] which is derived from the Latin base of *scriptum*: ‘something drawn, a space enclosed by lines’, a derivation of *scribere* (‘to scratch, engrave, draw’, whereby ‘scratching refers to engraving onto wax tablets’).[18] Such definitions imply that *scripting* might be used interchangeably with the word *drawing.* The motion of *scratching* onto a wax surface, for example, implies a sense of movement, gesture and authorial intent: the movement of an individual person’s hand in a deliberate manner, in the knowledge that those movements will be recorded. Similarly, ‘a space enclosed by lines’ inherently conjures the practice of pictorial representation. In this sense, the relevance of the term for architecture is obvious. However, another linked definition of the term has more ambiguous, but no less interesting resonances with architectural production: ‘to write, to draw, or otherwise make lines, letters, figures, etc.’[19] This definition of ‘scripting’, which equates drawing with the practice of ‘making lines, letters, figures, etc.’ arguably makes ‘scripting’ a useful word for describing the composite act of architectural design, which makes use of images, words and figures in equal measure.

Whilst drawing is the mode of representation and communication most readily associated with architecture, in recent years architectural historians have highlighted the importance of language – the written and spoken *script* – as a central part of design. Architectural historian Adrian Forty’s book *Words and Buildings: A Vocabulary of Modern Architecture*, examines the role that language has played in the development of modern architectural ideas.[20] In the chapter ‘Language and Drawing’, Forty questions the idea that the drawing is the most efficient and significant mode of communication for architects by outlining the co-dependency of drawing and language throughout the design process:

…the client *tells* the architect what is wanted; the architect does not only draw the building, he or she *describes* it, variously, to the client, to other architects, to regulatory authorities, to the contractor, to the tradesmen, to the press; and even the encounter with a work of architecture, its occupation, it itself rarely a wholly non-verbal affair (“No, that’s the fire exit – the main entrance is over here…”).[21]

Forty goes on to argue that these processes are necessarily of equal significance as the written word is able to convey certain aspects of information or meaning that the drawing cannot, that are crucial to the design process, such as the communication of vague ideas like ‘nuances, moods, atmosphere’, the expression of *difference*, and the conveyance of meaning.[22] In a similar vein, Mario Carpo’s books *Architecture in the Age of Printing* and *The Alphabet and the Algorithm*, trace the multifaceted means by which architecture is produced, from the writing and plans of Italian Renaissance architect Leon Battista Alberti, through the ages of mechanical printing, to the algorithms within contemporary parametric architectural design.[23] The focus of much of Carpo’s work relates to the technological shifts in architectural design.

Forty and Carpo are agreed on one premise: for most of history, architectural drawings, as we know them today, were not privileged as the primary design tool or communication device. Forty states: ‘In previous periods of history, antiquity and the Middle Ages, drawings played little or no part in the production of buildings.’[24] Carpo agrees: ‘Before the invention of print, manual copies of drawings were famously untrustworthy, and as a result, images were seldom used, or altogether avoided.’[25] As a result, most architectural descriptions ‘from antiquity to the Middle Ages to the Renaissance’ were ‘verbal, not visual.’[26] Even Alberti’s celebrated treatise, was intended to be transcribed ‘without any images or illustrations.’[27] Carpo argues that one reason for the emphasis on language over drawing was the unreliability of image reproduction prior to the widespread availability of printing technology:

Copying [images] by hand, regardless of the motivations of the artist and his desire to remain more or less faithful to the model, is always to some extent a creative act. With few exceptions, a manual copy is executed outside the control of the author of the original design, sometimes at a great geographical or chronological distance, and with aims that may be different from those that were initially anticipated.[28]

Thus, Carpo raises the question of authorship in relation to the act of copying (although here with images rather than text). If images could not be stored for long periods, or copied accurately, how might they be encoded so that a copy had maximum accuracy? The answer, according to Carpo, is procedural instruction. Ptolemy, for example, used written instructions for the creation of *Geography*, or *Cosmology*.[29] Carpo describes Vitruvius’ instructions in *De Architectura* as a ‘procedural algorithm’,[30] a set of instructions, which could be followed in exact order to recreate illustrations.[31] Alberti (the central actor in of much of Carpo’s research) took the procedural instruction further, creating a system which enabled the digitisation of a three-dimensional structure. Within *De statua*, Alberti proposed using a special radial measurement device ‘somehow inconveniently nailed to the head of the body to be scanned’,[32] capable of taking distance measurements (presumably in two directions, with a rotational angle). The measurements would be recorded in some sort of table, which would then be used to enable the original form to be stored and reproduced in perpetuity, with no loss of quality.[33] The system adds a third dimension to the system already described in Alberti’s famous survey of Rome, *Descriptio Urbis Romæ*, which contained a similar polar coordinate system with a table of numerical data to enable a reader to construct their own map of the city. This is not far from the idea of computational scripting discussed earlier, with the map’s ‘scribe’ following the instructions in the ‘script’ laid out by Alberti.[34]

The connection between this particular mode of procedural instruction, and computerised architectural scripting, was demonstrated in a more complex manner in the work of Nicholas Negroponte at MIT in the 1960s.[35] Negroponte’s 1966 undergraduate thesis entitled *The computer simulation of perception during motion in the urban environment* described a procedural programme enabling a computer to simulate moving objects, rendered in perspective.[36] The programme operated procedurally via dual sets of constraints: one ‘external’ set loaded onto the computer as an ‘explicit or implicit library of information’ (for example, a library may contain building codes, or construction standards), and one ‘internal’ set of constraints:[37]

The drawing routine possesses the flexibility to enable the designer to call for ‘rules’ of procedure. For example: “lines must be straight; lines are parallel or perpendicular to the ‘drawing surface’; all lines meet at 90º; all rotations of the image are 90º.” Such constraints allow the designer freedom to sketch ‘loosely’, while maintaining an accurate drawing.

If the designer self-imposes, for example, the constraint that that “all lines meet at 90º”, and proceeds to draw a line that meets at 80º, the computer will force the line to ‘wander’ into the correct position.[38]

This use of libraries and higher-level language to define a set of parameters within which the programme can operate is reminiscent of Ousterhout’s later description of scripting languages (which would come 32 years later).[39] Explicit reference to scripting within a computer system, however, emerged in Craig Reynolds’ 1978 Master’s thesis (self-described as a ‘computer system user’s manual posing as a Master’s thesis’[40]) on *Computer Animation in the World of Actors and Scripts*.[41] Supervised by Negroponte (who was, by this time, the founder of the Architecture Machines Group), the thesis is rich in theatrical analogy, employing the terms ‘actor’, ‘script’, and more.[42] Reynolds, who would go on to win an Oscar for animation work, identified that, whilst animation requires skill, it also involves much tedium.[43] The solution he proposes is computer automation of the animation process. But rather than merely in-filling between keyframes, Reynolds’ programme creates entire scenes based on the input of a script. A level of control is ceded to the computer – but the payoff is that the creation of scripts is easy and unintrusive: ‘you could do it at the beach for example.’[44]

Reynolds’ thesis proposes the script as a set of parameters within which a programme can operate. It sets the boundaries and goals of the programme’s operations – the script-writer merely tells the computer what they want it to do, and lets the programme work out the best way to solve it. The parameters are adjustable, but the computer ultimately makes decisions about the best way to implement the programme and create the animation. For Reynolds, the script analogy carries into much of his writing. Like a real-world theatrical performance, the performance (and the various actors and crew who will carry out the performance) are separate from the writer, director, or choreographer, to the extent that: ‘[…] on the night of the performance the choreographer (for example) could just as well be in another city.’[45] The script is separate from the computer carrying out its instructions, much in the way that scribes who translate Alberti’s maps today are removed geographically and temporally from the script-writer. Given such vague instructions, the computer can ostensibly make decisions that affect the designed outcome. Of course, this raises questions about the role of authorship ascribed to the script-writer, the programme, its programmer, and the computer.

Similar questions are raised by Forty in his examination of the 1960s architectural collective Archizoom, who proposed a scheme with only a verbal description. Testing a notion that ‘architecture might be projected not in drawings at all, but entirely in words’, the group laid out a description of a design that was deliberately vague:[46]

The fact is, everything will be simple, with no mysteries and nothing soul-disturbing, you know. Wonderful! Really very beautiful – very beautiful, and very large. Quite extraordinary! It will be cool there too, with an immense silence. […] You see, there’ll be a lot of marvellous things, and yet it will look almost empty, it will be so big and so beautiful.[47]

The scheme, notes Forty, contains ‘contains no particulars - no mention of what the space was for, whether ‘house’, ‘office’, ‘library’ or ‘bar’, and nothing about it physical delineation.’[48] The description of the house, then, serves as a mode of instruction, albeit vague, for an architect to interpret. It gives similar levels of leniency to the architect as a playwright gives to a director producing a play:

What we use, then, in creating our environment is the least physical thing in the world, namely, words. Of course, that doesn’t at all mean that in postponing the physical realization of this environment, we have avoided picturing it. On the contrary, we have refused to complete a single image, our own, preferring instead that as many should be created as there are people listening to this tale, who will imagine this environment for themselves, quite beyond our control.[49]

This idea is similar to that of the Oulipo: where Raymond Queneau’s *Cent mille milliards de poèmes* (which will be discussed later in this chapter) provides the framework for a number of poems too great for any one person to read, this Archizoom scheme provides an infinity of possibilities, with the design morphing each time it is interpreted by a designer. This is distinct, however, from Reynolds’ software, which allowed for certain parameters (e.g. timescale, particular movements of objects) to be controlled by the designer; the Archizoom scheme fails to mention a project site, scale, budget, or any other material constraints. The Archizoom scheme is provocative, but vague; the instructional script provided to a designer provides few limits.

### Computerised architectural scripts

Whilst Archizoom follow vague constraints, Nicholas Negroponte’s first major published work, *The Architecture Machine*, contains an explicit aim to change the means by which architects produce work.[50] Its ‘Preface to a Preface’ explains the ‘three possible ways in which machines can assist the design process:’ the first is by increasing efficiency for existing practices via automation; the second is by changing existing methods to fit machine-specifications, whereby ‘the design process, considered as evolutionary, can be presented to a machine, also considered as evolutionary, and a mutual training, resilience and growth can be developed’;[51] the third mode of assistance, which is the focus of Negroponte’s work, is by uniting:

[…] two dissimilar species (man and machine), two dissimilar processes (design and computation), and two intelligent systems (the architect and the architecture machine). By virtue of ascribing intelligence to an artefact or the artificial, the partnership is not one of master and slave but rather of two associates that have a potential and a desire for self-improvement.[52]

This ‘Architect-Machine Symbiosis’ (itself the title of chapter 001), whereby the computer is imbued with a level of ‘intelligence’, and the architect works *with* rather than *on* the machine to solve problems, is Negroponte’s ultimate goal. In *The Architecture Machine* he describes variously using this sort of interdependent design process to model myriad systems, such as traffic prediction, forensic event analysis, 3D animation, and more.[53] Much of Negroponte’s description mirrors Reynolds’ notions of scripting as natural-language processing, which generates results that the designer then decides either to keep, or to modify via a further scripting procedure. Several of these ideas have been integrated into contemporary architectural design practice in recent years, including Building Information Modelling (BIM) software, which enables the modelling and management of multiple systems within the design and construction of buildings, giving architects real-time or near-real-time feedback on the systems they are designing.[54]

Parametric design processes such as BIM are now pervasive in architectural practice and education. Computer programmes like Grasshopper, itself a built-in extension of McNeel’s Rhinoceros 3D (commonly known as Rhino) design programme, provide an interface that enables the computer scripting of components’ forms and relationships.[55] Using this interface, the designer programmes ‘parameters’ within which the computer is to solve a particular geometric problem. [56] In the case of Grasshopper, the interface for such programming acts as a layer on top of a standard Computer Aided Design (CAD) interface, comprising a series of nodal points, connected to each other via ‘wires’, each consisting of controls for objects and their respective connections within the 3D model.[57] The most basic form of such a parametric model might consist of two points in space connected via a line, with each point defined by their position on the X, Y and Z axes. By adjusting the position of sliders for each of these six parameters, the length, position and angle of the line can be manipulated. A more advanced model could then position further sets of points or lines in relation to the first pair, so that changing the parameters of the first line would cause changes to a series of subsequent lines. Complex geometric relationships can be defined with relative ease through such scripting; a few lines of code may create an assemblage with thousands of inter-related parts.

Grasshopper fits Ousterhout’s description of a scripting language: it can make use of myriad plug-ins or libraries to extend its functionality (it is fundamentally reliant on the RhinoScript programming language for the Rhinoceros). Such libraries vary in scope: some enable programming of particular forms or solve particular problems (for example, a module that enables parametric design of standard elements) whilst others add the ability to connect microprocessors such as Arduino boards, giving Grasshopper a physical input or output. A recent library created by Khaled ElAshry and Ruairi Glynn at the Bartlett School of Architecture’s Interactive Architecture Lab facilitates the control of industrial robots;[58] Andrew Heumann’s ‘MetaHopper’ extension enables the parametric design of Grasshopper nodes themselves, effectively controlling one instance of Grasshopper via another instance of Grasshopper.[59]

The use of parametric design is becoming increasingly pervasive among architecture practices. Malcolm McCullough claims that there have been certain contextual factors which have increased the uptake in computer scripting as part of the design process, including the development of the programmes which enabled scripting to take place, fuelled by advances in mathematics or software, and the promotion of computers within design by educators such as John Maeda.[60] The practical appeal of parametric design is twofold: on the one hand, it increases productivity by embedding a form of intelligence into the architectural drawing process, facilitating faster compilation of plans through, for example, the application of standardised components and processes – as predicted by Negroponte. On the other hand, computer scripting also extends the form-generating capabilities of existing and new software, enabling the construction of buildings with unprecedented stylistic and formal properties, with architects such as Greg Lynn, Achim Menges and Patrick Schumacher, as early experimenters of the latter in the 1990s.[61]

This form-driven use of parametric design has gave rise to a new genre of practice in the 2000s known as ‘Parametricism’, a term coined by Patrik Schumacher in 2008.[62] For Schumacher, scripting presented the opportunity to revolutionise architectural practice via a holistic design process whereby architectural forms are produced by the codified manipulation of parameters, rather than the manual conception of every detail; the computer script, rather than the architect’s hand, determines the formal outcome at every scale.[63] But Schumacher’s approach extends beyond parametric design as a mere design tool; initially positioning Parametricism as a successor to, and replacement for, all contemporary architectural styles, his later arguments pose the notions of Parametricism as highly politicised form of free-market order which would have wide-ranging impacts on notions of public space, private property, and social housing.[64] In his 2009 manifesto, entitled ‘A New Global Style’, the architect argues that this scripted approach ‘succeeds Modernism as the next long wave of systematic innovation’, replacing Corbusier’s ‘rigid geometric primitives such as squares, triangles and circles’ with forms are ‘parametrically malleable, differentiate gradually (at varying rates), inflect and correlate systematically’.[65] While Schumacher’s approach is undeniably progressive in technological terms, his conception of the design potential of scripting is limited to its role as a determinant of spatial-aesthetic characteristics.

Schumacher’s comparison of Parametricism with Modernism exposes the architect’s formalist concerns. Modernism is only rejected on the basis of the Corbusian veneration of the orthogonal, which is positioned as the antithesis of Parametricism’s pursuit of complex forms and patterns. As Schumacher argues, beyond this formal distinction, the goals of the two architectural movements are the same:

Le Corbusier’s limitation is not his insistence upon order but rather his limited conception of order in terms of classical geometry. […] [He] realised that although “nature presents itself to us as a chaos ... the spirit which animates Nature is a spirit of order”. However, while his understanding of nature’s order was limited by the science of his day, we now have the tools to reveal the complex order of those apparently chaotic patterns by simulating their “material computation”.[66]

While, for Schumacher, the forms of Modernism may be ‘primitive’ on account of a lack of scientific knowledge of natural systems at the moment of conception, the movement shared Parametricism’s quest for ‘order’ via the implementation of universal design principles. Indeed, the notion of a totalising design methodology forms a core tenet of Parametricism, which aims to operate at all scales ‘from architecture to interior design to large urban design. Indeed, the larger the project, the more pronounced is Parametricism’s superior capacity to articulate programmatic complexity.’[67] The key differential between Modernism and Parametricism, according to Schumacher, is thus not architectural determinism, or what Peg Rawes has described as ‘modernist myths of autonomy and innovation’, but rather, their respective definitions of ‘nature’.[68] For Schumacher, the appeal of nature as the source of inspiration does not lie in its geometric simplicity (as for Corbusier), but rather in its complexity and intelligence.

Schumacher’s analogy between natural systems and artificial (computational) systems is, however, fundamentally reductive due to its emphasis on the formal (rather than relational) character of natural systems. As Rawes has noted in her critique of Parametricism, Schumacher’s conception of nature in purely *formalist* terms (organics shapes and abstracted analogies of biological systems) obfuscates the complex and contingent relationships (or ‘ecologies’) between architecture, humans and the environment, at a time when thoughtful, responsible and sustainable design is critical. The emphasis on the formal rather than the relational aspects of nature, Rawes claims, draw ‘metaphorical alignments between digital code and biological DNA as evidence that architects have now been released from the limitations of human authorship in design processes.’[69] Rawes argues that the removal of authorial agency (and by default, environmental and social responsibility) from the architect is reinforced by the professional and training environments within which Parametricism is taught, namely ‘through intensive workshops which focus on repetition and emulation’ and by working in ‘hermetic teams or “labs”’ where employees rarely receive individual recognition or appropriate remuneration.[70] Thus, Schumacher’s claims that the use of script within Parametricism promotes a *synergy* between architectural/urban forms and the ‘natural’ (human) processes they accommodate is drastically undermined by the fact that it disregards the fundamental relational components of that system, be they social, political or environmental.

Schumacher’s limited definition, and use, of the concept of *scripting* in architectural design privileges abstracted computational complexity over real, socio-spatial complexity in the urban realm. This smooth, idealised version of complexity mimics, and complies with, neoliberal ideology, whereby the rhetoric of ‘self-organisation’ within the market, and the conflation of economic processes with natural systems, is key.[71] This relationship between Parametricism and neoliberalism is not accidental, but rather, fundamental to its success. As Schumacher himself noted in 2016:

Parametricism 2.0 makes urbanism and urban order compatible with the neo-liberal re-emergence of market processes after the demise of Modernism – the golden era of urbanism. […] The global convergence and maturation of Parametricist design research implies that this style of urbanism is ready to go mainstream and impact the global built environment by re-establishing strong urban identities on the basis of its adaptive and evolutionary heuristics.[72]

While this thesis does not dispute the advantages of *parametric* techniques in contemporary design, whereby scripting is used as a tool in a wider design process, it *does* contend that the lack of authorial agency and emphasis on the autonomy of scripting as presented in *Parametricism*, and its attendant ideological argument, is highly problematic for three reasons: firstly, it reduces the scope of creativity in architectural practice to the purely formal, positioning the human, political and social aspects of design as elements that ‘that divert and dissolve the innovative thrust of architectural discourse’, rather than being central to it;[73] secondly, it eradicates the critical involvement of the designer in the most important stages of the design process, as well as other crucial agents such as the user; thirdly, and perhaps most critically for this thesis, it limits the definition of ‘parameters’ in scripting to purely abstract, form-generating constraints, that are complicit within a neoliberal world-view of self-interest and self-determination, rather than socially-engaged, real-world constraints, that force the designer to challenge and even resist the dominant socioeconomic paradigm. In other words, Parametricist design represents a very limited notion of what scripting as a generative framework in architecture *could be*.[74]

### Psychological scripts

The relationship between agency, subjectivity, sociality and scripting has been explored more expansively in the field of psychology. Initial research in this area was triggered by the widespread interest in artificial intelligence in the 1970s, spearheaded by figures such as Marvin Minsky at MIT. In 1974, Minsky proposed a theory about the operation of knowledge structures, introducing the notion of ‘frames’ as ordering mechanisms for the mind.[75] He summarised the idea as:

[…] a partial theory of thinking, combining a number of classical and modern concepts from psychology, linguistics, and AI. Whenever one encounters a new situation (or makes a substantial change in one’s viewpoint) he selects from memory a structure called a frame; a remembered framework to be adapted to fit reality by changing details as necessary.[76]

In the paper, Minsky cites Roger Schank and Robert Abelson as both having similar, but distinct ideas about this model of thought, at the time described as ‘conceptual cases’ by Schank, and ‘scripts’ by Abelson’s.[77] Schank and Abelson worked on this area independently and collaboratively, publishing a book in 1977 entitled *Scripts, Plans, Goals, and Understanding: An inquiry into human knowledge structures*,[78] based on what they claimed were questions shared by psychologists and artificial intelligence researchers. Schank and Abelson explain that whilst psychologists were asking: ‘What the is nature of all knowledge and how is this knowledge used?’,[79] artificial intelligence researchers were asking similar questions, but with the motive of programming computers to ‘understand and interact with the outside world’.[80] Using this line of enquiry, the book takes sets up a framework for the application of script theory to computer programming. At around the same time (or shortly thereafter), the psychologist Silvan Tomkins published his own version of script theory, which was rooted in psychology. Both books adopt a similar underlying premise and, remarkably, a similar title. Here I will briefly examine both.

### Silvan Tomkins’ script theory

Tomkins’ research was based on the investigation of psychological *affect* – the study of emotions, and reactions to emotions. His use of script theory was part of a larger set of interrelated theories developed throughout his lifetime, referred to by Rae Carlson as a ‘grand theory of personality’.[81] Tomkins’ script theory starts with a premise which:

[…] assumes that the basic unit of analysis for understanding persons, as distinguished from human beings, is the scene and relationships between scenes, as ordered by sets of rules I have defined as scripts.

Some scripts are innate, but most are innate and learned. The learned scripts originate in innate scripts but characteristically radically transform the simpler, innate script.[82]

The first witnessed innate script is the ‘birth distress cry’, stimulated, at the time, by a ‘slap on the behind’, and accompanied by a baby’s ‘flailing arms and limbs’.[83] The second innate script is the ‘excitement-driven visual tracking of the utterly novel face of the mother.’[84] Babies then begin to correlate their behaviour (the actions and the responses they create) with the stimulus they are given in the world, which Tomkins calls a *scene*, developing sets of rules known as *scripts* to react to situations. An example of this is the baby experiencing hunger, and learning the appropriate response to this feeling in order to be given food.

Throughout peoples’ lives, the theory continues, they develop more rules to follow in reaction to the scenes they find themselves in. An interesting detail in Tomkins’ description of scripts is their potential vagueness:

Scripts may vary radically in their completeness of specification of rules or in their particularity or abstractness of rules, as well as in an indefinitely large number of other possible distinctive features of rules for dealing with scenes. All scripts are incomplete in varying degrees and depend on auxiliary information to particularise the script. What is distinctive about innate scripts is not the incompleteness and abstractness of their rules, but rather the imposed identity and similarity of their strict correlation between stimulus and response.[85]

The indistinct, non-binary nature of script rules is then useful in categorising scenes into groups called *sets* – for example, sets of *exciting scenes*, *surprise scenes*, *distressing scenes*, *enraging scenes*, *disgusting scenes*, and so on.[86] An individual’s reaction to certain environmental stimuli may lead to the categorisation of a scene, and the triggering of a certain script in response (as is the case with such as the *guilt*, or *shame-inducing* scenes).[87] Scripts are activated both in response to an immediate scene (experiencing and reacting to an immediate stimulus), and dealing with *sets* of scenes. Co-assembled scenes, which can include real-world experience, as well as projections of future scenes, are ‘amplified by fresh affect’.[88] This means that, by experiencing a scene (real or imagined), the script for experiencing similar scenes may be altered. This is a mechanism Tomkins calls *magnification*.[89]

The effects of magnification and amplification come into play very early in human development. For example, babies learn to react to their experience of hunger on their first day. As well as learning a script which scripts are successful for gaining food, babies can also mis-learn behaviour that is detrimental to nutrition through the vagueness of magnification whereby the outcome, and its affect (i.e. the internal emotional reaction to a stimulus), is ascribed to one’s own script – often incorrectly. Tomkins’ use of scripts expands the theatrical metaphor to deal with life as a whole:

In my script theory, the scene, a happening with a perceived beginning and end, is the basic unit of analysis. The whole connected set of scenes lived in sequence is called the plot of a life. The script, in contrast, does not deal with all the scenes or the plot of a life, but rather with the individual’s rules for predicting, interpreting, responding to, and controlling a magnified set of scenes.[90]

This theory then enables the development of scripts that are useful (for example, a script allows us to negate the real danger of crossing the road on a daily basis), as well as causing larger-scale, longer-term, and often cyclical effects on behaviour – such as scripts resulting in addictions. Tomkins describes *affect scripts* which regulate ‘control, management, and salience of affect’, creating sets of rules that shape individual emotional reactions to certain stimuli. [91] Tomkins’ formulation of scripts encompasses multiple short, and long-term effects on individual psychology, offering a mode of describing seemingly irrational rules that determine individual behaviours and ideologies.[92] His work on ideology, which builds on his script theory, follows a similar logic to the relationship between script and affect; the magnification of affect in response to other human beings over time leads to ideological polarisation, between the ‘ideological humanist’ (‘positively disposed towards human beings in his displayed affect, in his perceptions and in his cognitions’) and the ‘ideological normative’ (‘negatively disposed towards human beings in his displayed affect, in his perceptions and in his cognitions’).[93]

Such ideas are relevant within the context of this thesis because they pose questions about human agency and innate internal scripts. Simultaneously, Tomkins’ scripts offer a mode of consciously analysing (and changing) human behaviour, through the realisation that the seemingly abstract, irrational and unforeseen forces within the human psyche are often caused by amplification mechanisms, which reinforce certain scripts, changing individuals’ behaviours and emotional responses.[94] The concept of the irrational as a controlling force has parallels in the work of the Theatre of the Absurd (which features later in this chapter).

Besides psychology, Tomkins also had an interest in artificial intelligence. Inspired by Norbert Weiner’s early work in cybernetics,[95] Tomkins’ attempts to design a ‘humanoautomaton’ led to writing of a 1963 book entitled *Computer Simulation of Personality.*[96] This, and research into ideology, were common grounds with Robert Abelson, who in the mid-1970s began working with artificial intelligence researcher Roger Schank on what they would come to call Script Theory; a different, but related, approach to Tomkins.[97]

### Schank and Abelson’s script theory

In contrast to Tomkins approach, Schank and Abelson’s script theory is concerned with modelling knowledge structures in relation to artificial intelligence.[98] The pair met in 1971 (three years before Minsky published his article citing them both) at a workshop on psychology, artificial intelligence, and linguistics.[99] This cross-disciplinary approach continued into their collaboration on *Scripts, Plans, Goals, and Understanding*, in which Schank and Abelson focus on text-based events, and describe the basis for computer programmes and modes of interpreting, understanding and predicting behaviour.[100] They state that certain psychologists, in asking the question about the nature of knowledge and the way it is used, ‘have found it useful to view people as “information processors” actively trying to extract sense from the continual flow of information in the complicated world around them.’[101] The book relates to ‘psychological and physical events occupying the mental life of ordinary individuals, which can be understood and expressed in ordinary language.’[102] Thus, their work can be applied to computer systems. Most of their examples take the form of short paragraphs which an ‘ordinary’ person could understand and make inferences from, but a computer would not.[103]

Like Tomkins, Schank and Abelson see the world as a series of discrete events called scenes. Scenes are data structures which allow for generalised inferences to be reached about likely event ordering within predictable environments. As Abelson explains: ‘The understander is hypothesized to possess conceptual representations of stereotyped event sequences, and these scripts are activated when the understander can expect events in the sequence to occur in the text.’[104] The primary example of a scene, referred to multiple times across Schank and Abelson’s joint and individual work on the subject, is the restaurant scene. A restaurant is a highly codified space in which people have clear roles (such as waiters and patrons), and events occur in a predictable order (such as ordering, serving, eating, paying the bill). The situation requires two kinds of knowledge to navigate: general knowledge, enabling a person to ‘understand and interpret another person’s actions simply because the other person is a human being with certain standard needs who lives in a world which has certain standard methods of getting those needs fulfilled’, and specific detailed knowledge, which enables the individual to ‘do less processing and wondering about frequently experienced events.’[105] This kind of knowledge ensures that, for example, we know to order food rather than shoes in a restaurant, or to hand an usher our ticket when asked for it in a cinema.[106] Thus, with fragmentary information, we can describe and imply a high level of detail:

John went to the restaurant. He asked the waitress for coq au vin. He paid the check and left.[107]

In reading the above scene, the reader is able to deduce exactly what has happened, filling in much of the information based on our own collated experiences in restaurants.

There are numerous other ‘frequently occurring scripts’ like this (the authors cite being on the street, a bus, at a birthday party, playing specific sports and going to a park, among others).[108] Schank and Abelson apply codification to scripts, examining dynamics of a scene, and creating what they call a ‘giant causal chain’.[109] The causal chain within the ordering scene of the restaurant script has 14 different actions:

***S = waiter F = food C = cook MTRANS = mental transfer, or telling PTRANS = physical transfer, or the moving of an object or person ATRANS = abstract transfer, or the giving of an object from someone to someone else MBUILD = thinking (roughly speaking)***

As exemplified in Table 1-1, this script contains Schank and Abelson’s’ codified actions (***MTRANS*** / ***PTRANS*** / ***ATRANS*** / ***MBUILD***), written in language developed by Schank called ‘Conceptual Dependency’*.*[110] One interesting feature of this language is ***MBUILD***: described as ‘roughly equivalent to thinking’, or as simply ‘now think’, this implies a level of decision-making on behalf of the participant, rather than a total automaticity.[111] Abelson explains that whilst ordering food can become habituated, the ***MBUILD*** unit found in most scripts implies the individual has a level of agency.

Scripts themselves can have variants, which are called *tracks*. Whilst the script contains common themes (e.g. a waiter or server in a restaurant), each track contains ‘characteristic paths, scene selections, and props not shared by other tracks’.[112] For example, there may be several tracks for the restaurant script: ‘a fast-food track, a standard-restaurant track, a fancy-restaurant track’, and so on.[113] This enables a certain level of efficiency in the storage of scripts. Abelson also describes meta-scripts, which abstract scenes at a higher level than a standard script, efficiently grouping similar activities. A visit to the doctor and the dentist are similar, yet distinct scripts; in one, a nurse may take blood pressure, and the other X-rays, but both generally involve a waiting room.[114] But the efficiency of the script model of knowledge can also be detrimental, leading to false recollection of memories. Gordon Bower, John Black and Terrence Turner found that in factual recall of written stories, participants in experiments are subject to elaborating explicitly stated actions with the stereotypical components of scripts;[115] participants also tended to recall scrambled events in the ‘canonical’ (or script-normative) order. Furthermore, cognitive psychologists Elvira García-Bajos and Malen Migueles found that these false memories of events, ‘generated by activating our prior knowledge’ and subsequently elaborated with standard script-elements, have a high recall-confidence in the opinions of the subjects:[116] false memories generated in this manner have a high persistency (remaining consistent for at least a week) and are ‘resistant even to explicit instructions warning against such errors.’[117] This aspect of Schank and Abelson’s script theory is perhaps one of its most interesting features.

Scripts, in the Schank and Abelsonian sense, are fascinating knowledge structures, providing individuals with codified routines for carrying out standard social interactions. Embedded within these are moments of physical, mental or abstract (possessive) transfers, and explicit moments for decision-making.[118] However, the efficiency of these knowledge structures is also a potential weakness when it comes to recall of incomplete information that may be confabulated via standardised scripts.[119] This is perhaps similar to Marvin Minsky’s concept of *frames* in artificial intelligence;[120] the frame is a more generalised, stereotyped situation that an individual can find themselves in.[121] The subject of frame in artificial intelligence, however, is beyond the scope of this thesis.

### Scripting in creative practice

The term *script* presents multiple potentials for agency: from the faithful scribe or computer copying without question, to the architect working within scripted *parameters*, to the human operating within their own scripted psychological environments, for whom scripting is both an efficient model of knowledge, but can also lead to strange affect (in the case of Tomkins, who observes a lack of rationality within human decision-making) and potential memory manipulation (as exemplified by Bower et al, and García-Bajos and Migueles).[122] These examples imply a *limitation* of agency via the medium of scripting. Yet in the theatrical and literary context – a context perhaps most obviously associated with *scripting*, the term implies absolute freedom and creativity. This section explores the critical possibilities for the term scripting opened up within the creative literary field, through exploration of the Theatre of the Absurd, the Oulipo and Italo Calvino.

These playwrights / movements are linked by their exploration of the ‘absurd’ as a creative framework for societal critique, which highlights and indeed perpetuates a general feeling of lack of agency among the characters in the work as a way to critique it. Here the script operates as a constraint that generates creativity, whilst the ‘absurd’ acts as a strategy to unravel the use of psychological scripts (the things we say and do without thinking, our automatic existence) in our everyday lives. Thus there is an entanglement between the form of the work, and the content. The strategies used by these absurdist writers have been inspirational in my own practice as a critique of contemporary technology. Thus their role within this thesis is to offer an alternative model of scripting (entitled reflexive scripted design, as described later in the next section on ‘definitions’), which embraces the creative potential of script, whilst also remaining critical of it.

### Theatre of the Absurd

The Theatre of the Absurd was a literary and theatrical genre, first identified by theatre critic Martin Esslin in 1960, and described in detail in a book of the same name in 1968.[123] Esslin identified stylistic and thematic convergence in the plays of writers such as Samuel Beckett, Eugene Ionesco, Jean Genet, and Harold Pinter in the late-1950s and early-1960s, although the Theatre of the Absurd was never a formal ‘school’, or rooted in any one place,[124] and was even rejected by many writers it claimed to encompass.[125] Esslin traces the origins of the Theatre of the Absurd plays back to antiquity (through Shakespeare’s tragicomedies, Alfred Jarry, Franz Kafka, Søren Kierkegaard and more), yet claims that the density of works produced in the 1950s onwards and their similarities of subject matter and form – such as Eugene Ionesco’s *The Bald Soprano* and Samuel Beckett’s *Waiting for Godot* – heralded a new theatrical movement.[126]

The term ‘absurd’ has multiple meanings, all of which contain similar notions, but carry different implications. For the purposes of clarity in this thesis, I distinguish between the two types whenever the term is written, calling them absurda and absurdb (and occasionally absurda+b).[127] Where the term is quoted from another source, its type will be inferred through the surrounding text.

Absurda is the more commonly-used adjective form of the word, as defined by the OED as: ‘Out of harmony with reason or propriety; incongruous, unreasonable, illogical. In modern use esp. plainly opposed to reason, and hence, ridiculous, silly.’[128] This can refer to both people and things; it is the illogical, ridiculous absurd. In general terms, this is the type of absurdity that can be immediately recognised in this section of Samuel Beckett’s play *Waiting for Godot*:

VLADIMIR: I don’t understand. ESTRAGON: Use your intelligence, can’t you? [VLADIMIR uses his intelligence] VLADIMIR: I remain in the dark.[129]

The exchange is absurda due to its nonsensical stage direction (directing an actor to ‘use his intelligence’). *Waiting for Godot* is full of the ridiculous absurda – ludicrous logic, non-sequiturs, slapstick gags, and vaudeville stage directions. This form of absurdity is easily identifiable, with lighter philosophical implications than absurdb.

‘Cut off from his religious, metaphysical and transcendental roost, man is lost; all of his actions become senseless, absurd, useless.’[130] Esslin (and the OED) cite this definition of absurd as having originated with Albert Camus, Algerian-born French novelist, philosopher and playwright who in 1957 won the Nobel Prize for literature for ‘his important literary production which with clear-sighted earnestness illuminated the problems of the human conscience in our times.’[131] Camus’ definition of the absurd was introduced and discussed in the four essays published collectively as *The Myth of Sisyphus*. The noun ‘absurd’ (referred to here as absurdb), often capitalised and prefixed with *the*, refers to ‘the chaotic and purposeless nature of the universe, and the futility of human attempts to make sense of it.’[132]

The book, Camus states, is a reaction to ‘an absurd sensitivity that can be found widespread in the age.’[133] At the time of publishing (1942), Camus was living in a Paris under German occupation during WWII. An avowed member of the French Resistance, it is not hard to see how his personal experience at the time might have influenced his thinking in relation to the futility of human existence. The book is written from a highly subjective point of view; in essence, Camus’ absurdb is about the individual realising of the disharmonic and illogical nature of the world, and the individual human’s frailty and insignificance within it.

Camus’ descriptions of the absurdb are innately theatrical and performative, and offer a rich language of spatial visualisations. A section entitled ‘Absurd Walls’ describes the metaphorical barrier between the realisation of the absurdb and peoples’ everyday actions; the ‘stage-scenery [of the world] masked by habit’ suffers a ‘collapse’.[134] In the first essay of the book, [135] Camus also writes that ‘At any street corner the feeling of absurdity can strike any man in the face.’[136] This absurdity can have a ‘ridiculous beginning’ – for example, when watching a man, whom he cannot hear, talking in a telephone booth, Camus argues that he is struck by the ‘incomprehensible dumb-show: you wonder why he is alive.’[137] The man serves to remind us that, in the same circumstance, we might well look the same, and, when seen from this abstracted point of view, our existence (and the Schank-and-Abelsonian scripts that people follow in the course of routine) merely mask the innate absurdb nature of the universe. When a catalyst rouses us from routine, our ‘consciousness’ is roused, from which:[138]

[…] strangeness creeps in: perceiving the world is ‘dense’, sensing to what degree a stone is foreign and irreducible to us, with what intensity nature or landscape can negate us. At the heart of all beauty lies something inhuman, and these hills, the softness of the sky, the outline of these trees at this very minute lose the illusory meaning with which we had clothed them, henceforth more remote than a lost paradise. […] For a second we cease to understand it [the world] because for centuries we have understood in it solely the images and designs we had attributes to it beforehand, and henceforth we lack the power to make use of that artifice.[139]

Devoid of the meanings and interpretations we layer upon it and perceive it through, ‘the world evades us because it becomes itself again’, leaving us with the feeling that the ‘denseness and strangeness of the world is absurd.’[140] This is Camus Ian absurdity – a sense of deep disconnect from an irrational, uncaring and dispassionate world. Plays belonging to the Theatre of the Absurd canon channel this sense of the absurdb. Many of the playwrights cited by Esslin experienced political horror or oppression directly: as previously mentioned, Albert Camus published *The Myth of Sisyphus* during the Nazi Occupation of Paris;[141] Samuel Beckett was a member of the French Resistance;[142] Eugene Ionesco witnessed the rise of the fascist Iron Guard in Romania;[143] Jean Genet spent much time in prisons throughout Europe for acts of petty theft and prostitution.[144] Ionesco’s *Rhinoceros*, a play in which an entire town of people inexplicably and irreversibly turn into rhinoceroses, is clearly a direct reaction to the irrational rise of fascism he witnessed. In this sense, the plays of the absurdb are used as a mode of critiquing the societies and situations the playwrights had experienced.

Metaphysical, and comical absurdity is used in the projects presented in this thesis as an active methodology to critique contemporary technologies which have an impact on society. Like the Theatre of the Absurd, this is manifested in two ways. The absurdb, as described by Camus, is a realisation on behalf of an individual. This means that the individual has to come to a realisation themselves, thus constructing the absurdb realisation in their own mind. However, this realisation is often triggered through use of the comic absurda. Ionesco said of humour:

As far as I am concerned, […] I have never been able to understand the difference that is made between the comic and the tragic. As the comic is the intuition of the absurd, it seems to me more conducive to despair than the tragic. The comic offers no way out. I say “conducive to despair”, but in reality it is beyond despair or hope. […] Humour makes us conscious, with a free lucidity, of the tragic or desultory condition of man….It is not only the critical spirit itself….but….humour is the only possibility we possess of detaching ourselves – yet only after we have surmounted, assimilated, taken cognizance of it – from out tragicomic to our human condition, the malaise of being. To become conscious of what is horrifying, and to become master of that which is horrifying….Logic reveals itself in the illogicality of the absurd of which we have become aware. Laughter alone does not respect any taboos, laughter alone inhibits the creation of anti-taboo taboos; the comic alone is capable of giving us strength to bear the tragedy of existence. The true nature of things, truth itself, can be revealed only to us by fantasy, which is more realistic than all the realisms.[145]

The comic, in this case, is the catalyst to the audiences’ individual construction of the absurdb in their own mind. This is a similar argument to that used by cybernetician Gordon Pask in the paper ‘A Comment, a Case History, and a Plan’.[146] Pask argues that the mental processes involved in creating and performing a work of art are not distinct from those involved in appreciating a work of art.[147]

The Theatre of the Absurd is directly linked to the idea of scripting in two ways: firstly, it is a body of work rooted in theatre and theatrical scripts; and secondly, many of the characters in the plays act in ways that appear as if they do not have agency over their environment or free will, thus, their behaviours could be said to be scripted. This is seen, for example, in Ionesco’s *Rhinoceros*, Beckett’s *Waiting for Godot*, or the eponymous character in Camus’ interpretation of *The Myth of Sisyphus*. [148] Camus argues that Sisyphus, the Greek mythological figure doomed to an eternity of pushing a rock up a hill only to witness it rolling back down again, is actually a happy figure. The realisation of the futility and mundanity of his fate is a metaphor for our own meaningless existence, and thus, freed from the burden of artifice involved in denying this, ‘one must imagine Sisyphus happy.’[149]

### Oulipo

Where the Theatre of the Absurd use literary scripts to cause audiences to consider and construct concepts of the absurdb, writers within the literary movement the Oulipo use scripted principles in the form of self-imposed instructional constraints to generate new forms of literature. The Oulipo was a literary movement that followed both chronologically and geographically from the Theatre of the Absurd. Their name is an abbreviation of **Ouvroir de littérature potentielle** (‘Workshop of Potential Literature’), and their work involved the creation of highly constraining rules for the writing of new work. Founded by writer Raymond Queneau, artist Marcel Duchamp, mathematician François Le Lionnais and the self-styled ‘pataphysicist’[150] Jacques Bens in Paris in November 1960,[151] the group aimed to ‘apply mathematical structures to writing’,[152] using mathematical constraints to ‘determine how arbitrary limitations work as aesthetic principles, how, for example, constraints generate innovations’,[153] and thus create ‘new forms and structures that may be used by writers in any way they see fit.’[154]

An early example of Oulipian writing is Raymond Queneau’s poem *Cent mille milliards de poèmes* (‘A Hundred Thousand Billion Poems’).[155] The poem consists of ten pages, each cut into ten strips. Each strip has a line of a sonnet printed onto it, with the same rhyming structure throughout the ten pages. The strips can be combined, from the top of the page to the bottom, in any order, and still create a poem that formally makes sense. Thus, there are 1010, or 10,000,000,000 potential poems that can be made; the reading of all combinations is clearly more than several lifetimes’ work. Therefore, Elkin and Esposito argue, ‘Oulipian literature performs a balancing act between produced and potential work, between what appears on the page and what is suggested beyond it.’[156]

Implicit within each Oulipian work then, are the writing itself, and all other possible permutations of the same piece that could be created using the same ruleset. The form of the work is as important, if not more so, than the writing it contains. The Oulipo’s layering of mathematical rules was of great appeal to Italian writer Italo Calvino,[157] who encountered the group upon moving to Paris in the early 1960s.[158] Their influence on Calvino was profound.[159] In 1967, Calvino authored an essay called ‘Cybernetics and Ghosts’, in which he extolled the virtues of the Oulipo in relation to numerous other literary movements, and also explored the potential for computer-driven literature.[160] This essay reveals not only revealed Calvino’s admiration for the Oulipo, but also his sympathy for the modes of enquiry favoured by both of the forms of script theory we have already examined. Like Tomkins, Calvino was inspired by early cyberneticians such as Norbert Weiner, and the excitement of new opportunities offered by ‘electronic brains’.[161] He declared: ‘the world in its various aspects is increasingly looked upon as *discrete* rather than *continuous*’, and that ‘faced with the vertigo of what is countless, unclassifiable, in a state of flux, I feel reassured by what is finite, “discrete,” and reduced to a system.’[162] This attitude is reflected in the collections of short stories he wrote in the years preceding ‘Cybernetics and Ghosts’; many of the stories in his *Cosmicomics* series apply ideas and rules from a specific scientific ‘fact’ to create a short work of fiction.[163] It appears to the reader that Calvino was creating discrete rulesets for each story: a principle to work through, explore, and humanise, often in an absurda manner.[164] Many of the *Cosmicomics* begin with a short statement taken from a scientific article, which acts as context for the story. ‘The Light-Years’, for example, start with the premise that the universe is continually expanding, and that at some point in time, two galaxies will never be visible to one another again.[165] The story that follows is absurda, recounting the experiences of a being who sees a handwritten sign on a distant planet and decides to engage in a conversation across the galaxy (with each message taking over 400 million years to send and receive). Simultaneously, it is a story about the physics of such a conversation, the expansion of the universe, human insecurity, and the impossibility of communication (a theme popular with absurdists). Cosmicomics show that Calvino had a long-standing love of rule-based writing; by the time he wrote ‘Cybernetics and Ghosts’, he had already translated Queneau’s work into Italian.[166] He was formally invited into the group in 1973 – the same year he published ‘The Burning of the Abominable House’ – having already written several more stories that seemed to have an Oulipian influence.[167]

‘The Burning of the Abominable House’ is remarkable due to its use of a computer programme to create the story; Calvino worked with computer programmer, and fellow Oulipian, Paul Braffort, to achieve this computer-scripted workflow.[168] The premise is relatively simple: an insurance investigator is looking into a house-fire, in which four bodies were found. Alongside the inhabitants (all of whom had insurance policies with the same company), the charred remains of a notebook’s front cover survived, with ‘Accounts of horrible acts perpetrated in this house’ written on its front. On its back is a list of 12 headings (such as *to bind and gag*, *to blackmail*, *to seduce*). The order in which the crimes were committed is not known, and the combinations of possible events make traditional linear combinatorics (such as seen in Queneau’s *One Hundred Thousand Billion Poems*) impossible, since several of the characters’ actions infer the death of their intended victim – after which, the victim cannot do anything.[169] Thus, in the story, the insurance agent has written a computer programme that will help them find the only logical sequences of events, given a primitive set of information about the characters’ relationships before the fire took place. Calvino and Braffort created a series of programmes to solve the mystery, creating a narrative that ‘remain[s] “logically” and “psychologically” acceptable’.[170] Calvino argues that:

[…] the aid of a computer, far from replacing the creative act of the artists, permits the latter rather to liberate himself from the slavery of a combinatory search, allowing him also the best chance of concentrating on this “clinamen” which, alone, can make of text a true work of art.[171]

In the tradition of the Oulipo, this work’s translation is presented in *The New Media Reader*[172] (and in its original form, in the Oulipo’s *Atlas de littérature potentielle* compendium)[173] without the final solution – in other words, the potential forms the story may take are more important than the final outcome of the work.[174]

Paul Fournel provides a taxonomy of the roles played by computers in the Oulipian work carried out at the Centre Pompidou, including by Calvino and Queneau.[175] He distinguishes between the role of ‘aided reading’ and ‘aided creation’. Aided reading brings a computer into the interpretation of existing literary material, such as in enabling an audience to generate one of the many available sonnets from *One Hundred Thousand Billion Poems* on cue, whereas aided creation invites a computational element into the creation of work (as with Calvino’s *Burning of the Abominable House*). Fournel distinguishes between three different modes of engagement with the computer in this manner. The first, as seen with Calvino, is ‘Author – Computer – Work’; in this particular case, the computer is used to generate scenarios, which are selected by the author. In the second type, ‘Author – Computer – Work – Computer – Computer – Reader’ the reader interacts with a computer to, for example, solve mysteries (in a manner now familiar to anyone who has played a text-based computer mystery game).[176] The third type is ‘more technically complex’;[177] the ‘Author – Computer – Reader – Computer – Work’ format is used to create myriad short stories according to the readers’ wishes.[178]

## Definitions of scripting in this thesis

This chapter has explored several different definitions of scripting. The purpose of this thesis is to examine and interrogate script as a methodology within the framework of performative architectural design. It would be a momentous, tedious – and somewhat Oulipian – task to exhaust all possible permutations and interpretations of the word, and present a working methodology and design project for each. Therefore, the following three definitions of scripting will be used from this point on for the purpose of project development and analysis.

### Computational script

A computer blindly follows instructions given by a programme or programmer. This method is used in most design projects this thesis will examine; computer scripting of this sort is a methodological practicality to almost anyone working with computer-aided design today. This does not mean that the use of computer script is a purely functional tool; the shape of a project is often determined in part by the language, libraries and dependencies used within it. The scripts can include references to external and internal libraries, languages, logic operators, parameters, and variables. They can process many formats of information.[179] Scripts can be written and executed asynchronously, and multiple scripts can operate on the same computer at once.

In code form, the computer script acts as a mode of diagram; a procedural set of instructions that manipulate the symbols the programme works with. For the most part, parameters are defined in advance, and the programme will only make changes to and within these pre-defined variables. The computer script is then a one-dimensional plan.

The development of computer scripts in this thesis follows a largely code-based approach (see chapters 1, 2 and 3), although projects in chapters 2 and 3 (*Scriptych* and *24fps Psycho*) also employ Max, a visual programming language that operates in a ‘diagrammatic’ manner. Where possible, source code, screenshots and schematics are included in the appendix of this thesis. The person writing the code is its author. The computer, whilst executing the code, is in a sense ‘performing’ the script; the output will be examined and scrutinised, live, or later. The author thus becomes audience, and, like a theatrical audience, becomes a part of the performance.[180] In the instance of live computer scripting, a secondary audience are also watching the performance. However, unlike human performers, this does not become feedback. In chapters 2 and 3, I will discuss the role of machine learning in computer scripting.

### Performance script

Written or drawn directions are performed for an audience or camera. An example is the film or theatre script, shooting schedule or diagrams, or scripts used to record dance (e.g. Labanotation). In this instance, the script is a form of plan – a diagram of intent. Scripts for performance (as opposed to computer scripts) offer a degree of flexibility in their execution. Thus, classic plays are interpreted and reinterpreted each year, with directors, designers and actors modifying the performances the audience sees. In the context of this thesis, a performance script of some kind is involved with every chapter, with the exception of the *Godot Machine* (chapter 1) and *86400* (chapter 3).

### Reflexive scripted design

In a manner similar to Oulipian writing, constraints on a design process can be used to generate forms of projects that may not otherwise be reached. Whilst all live design projects must enforce some form of constraint (for example, spatial, technological, or budgetary constraints), this technique involves taking the idea of constraint to an extreme, so that the constraints become an active part of the design process. This is a novel methodology that was generated throughout the research process; questions around the role of parameter constraint are tackled in most chapters, but Chapter 4, which describes the production of the film *Network / Intersect*, is the first dedicated use of this approach. The latter began with the goal of making a film whose form would reflect its content, which imposed a series of mathematical constraints on its making. The resulting project is, in the style of the Oulipo, as much about the potential other films that could have been created as the one that was. This process is named reflexive scripted design.

## Technology and the absurda+b

In every movement, every communication, every purchase, the subject leaves traces to be reappropriated, mapped out, configured into patterns from which future behaviour can be predicted and acted upon. The ideal of this totality – comprised of corporate, financial, military and governmental agents – is of an unreflective subject, passively and unknowingly productive of the information through which its futures will be shaped.[181]

### Big data and the control society

The work discussed in this thesis is largely a critical reaction to, and commentary on, various control systems and computational technologies. The initial basis for my research was within Deleuze’s ‘Postscript on the Control Society’.[182] Written in 1990, and building on the work of Foucault (in particular his notion of biopolitics), as well as Deleuze and Guattari’s extensive body of work, this short essay poses the hypothesis that power within society is undergoing a transformation away from *discipline societies* – highly regimented, formal expressions of dominance (of the kind found in institutions such as schools, the military and factories) – and towards *control societies*, which remove the former’s formal delineations, to the extent that: [183]

one is never finished with anything – the corporation, the educational system, the armed services being metastable states coexisting in one and the same modulation, like a universal system of deformation.[184]

Deleuze argues that the machines a society use are in fact a reflection of the society itself, ‘because they express those social forms capable of generating them and using them.’[185] Whilst *discipline societies* constructed clockwork mechanisms, levers, and pulleys, *control societies* make use of a new type of machine: computers.[186] He goes on to describe a city imagined by Félix Guattari, in which inhabitants each carry electronic access cards. The cards allow access to different parts of the city, so that, to leave an apartment, or exit a street or neighbourhood, the card must be presented. Such a system would necessarily allow for the rejection of access at certain times. ‘what counts is not the barrier but the computer that tracks each person’s position – licit or illicit – and effects a universal modulation.’[187]

Tung-Hui Hu, in the book *A Prehistory of the Cloud*, states that this specific prediction now seems mundane;[188] e-card access now a standard feature of university, hospital, and corporate campuses, not to mention metropolitan transport systems. However, the core concepts of the *control society* today persist in far more pervasive modes; often these contain their own internal logics and contradictions, and subtly change individuals’ potential range of behaviours, to the extent that we might identify a certain type of script, as in *ruleset*, emerge. Hu argues that this regulation of behaviour can often occur from within the individual as a mode of self-regulation. He uses the example of credit cards to explain this principle. Credit allowances are dependent on past behaviour; in order to make a $100,000 purchase, a user would benefit from buying a ‘series of $1000 meals over a period of time’[189] in order to fit the profile of a high spender. Fraud detection works in the same manner; purchases outside of a user’s ‘normal’ behaviour patterns trigger a rejection of a transaction.[190] Hu continues:

Somewhere, a computer is calculating the impact of each spending decision and adjusting to it in real time, and, in turn, the cardholders adjust, too. ‘You’ are a set of spending patterns, and that projected profile both enables the bank to extend credit to you as well as puts the onus on you to take responsibility for those spending patterns. [...] The core idea behind a control society, then, is thus a continuous set of cybernetic systems, financial incentives, and monitoring technologies moulded to each individual subject, that follow him or her even when ‘outside’ an institution as such; and, precisely because there are fewer explicit institutions, spaces, or rules to restrict the subject’s behaviours, these systems are often experienced as freeing.[191]

This assertion is particularly true of so-called ‘big data’[192] that is generated around individuals as a result of modern interactions with (or use of) technology.[193] Companies such as Google and Facebook, credit agencies such as Experian, and multiple other data analysis companies now collect and analyse vast troves of data through myriad means;[194] use of apps and services on a smartphone, a credit card, a transport system, or a website, each person creates data trails which can be analysed to make inferences and predictions about them. As Hamed Haddadi et al. of the University of Cambridge’s Human-Data Interaction working group note, the processes and decisions behind these inferences are often hidden from the public, as the aggregation and use of such data is ‘at the heart of most Internet business models, particularly those based on advertising and market intelligence.’[195] This problem plays out in two ways: users are often unaware both of the data being collected about them, and the inferences drawn from those data.[196] As Claudia Aradau points out: ‘The reader never knows the mechanisms through which the results are produced – but needs to rely and trust those who know – while not being able to participate in the production of knowledge.’[197]

One example of an absurdb limitation on individuals’ ability to participate in the production of this knowledge can be found in standard End User License Agreements (EULAs) or Terms of Service (ToS). An EULA/ToS in a technological context is an agreement by an end-user to abide by rules set by the service provider. In order to use iTunes, the software that allows an iPhone to synchronise with an Apple Computer, for example, a user must agree, among other things, that the software will not be used for ‘the development, design, manufacture, or production of nuclear missile, or chemical or biological weapons.’[198] A 2012 article on consumer website *Which?* noted that the iTunes EULA at the time was longer than Shakespeare’s *Macbeth*.[199] It is clearly the case that most users of these services do not read the myriad agreements they sign up to; reading and assessing terms of service for every app, service, or product that they use would yield little benefit. Rather, the ‘freeing’ experience described by Hu draws users to services without analysing the potential cost. One of the reasons that this analysis doesn’t generally take place is that often using a service offers a binary ‘Agree/Disagree’ option (the consequence of disagreeing generally being that you cannot use the service). This is exemplified by the controversial ‘taxi’[200] service Uber: to use the Uber app on an iPhone – the central premise of which is that a taxi can be ordered from your precise location – the user can choose to share their location ‘never’ or ‘always’. The former would render much of Uber’s functionality useless; the latter would grant Uber the knowledge of the users’ phone location, and by inference the location of the user, at all times that it is on.[201]

### Absurda+b control

There are two ways in which this relationship could be described as absurda+b. The first is in the lack of agency that individuals have in their relationship to technology. Technological products and services are often presented with a *fait accompli*, something inevitable and unchangeable. The carrot is just too juicy. Deleuze uses the following metaphor: ‘Man is no longer man enclosed, but man in debt.’[202] In this case, the unending debt owed by is paid off through the sharing of personal information, for unseen use. The inherent lack of agency – over both desire and the terms of use – is reminiscent of the characters in Ionesco’s play *Rhinoceros*, where one by one inhabitants of a village inexplicably turn into rhinoceroses; control over one’s individual actions are ceded to a mysterious ‘other’ power, subject to irrational desires. In this case, technology comes from ‘elsewhere’: conceived of in California, manufactured in South Asia, delivered to your door.[203]

The second mode of absurdity is in the behaviours that networked computational technology creates within the individuals who use it. Foucault described governmentality as the ‘conduct of conduct’.[204] In an edited volume on Foucault’s concept of governmentality, Colin Gordon explains:

Government as an activity could concern the relation between self and self, private interpersonal relations within social institutions and communities and, finally, relations concerned with the exercise of political sovereignty.[205]

Within networked computation, Hu argues that users are often the subject to self-policing, although the intentions behind these actions are often for rational reasons. Users of the ‘cloud’, he argues, are invested with myths ‘about security and participation’.[206] Behaviours tend towards normalising behaviour, often through the perceived positive or negative impact something may have on the security of the system itself; marking messages as spam, or tagging photos on Facebook, ‘construct a set of cultural norms that we internalise as “responsible” online behaviour’.[207] Use of networked technology affects its users behaviour in the present through the creation of internalised rules akin to scripted behaviour (itself an absurda behaviour). But this behavioural change is a reflection of the ‘invisible rules and systems of regulation’ observed in ‘Postscript on the Societies of Control’.[208]

Networked technologies simultaneously lead to the modification of its users’ behaviour in the present, and the future. In the present, users often project the impact of their actions as previously discussed. In the future, the range of possibilities available to an individual is largely determined by inferences made through data. In some cases this appears trivial; Facebook, being an advertising-based platform dependent on keeping its users happy, will serve adverts and stories that its algorithms determine the user is likely to ‘like’. Haddadi et al. note, with a slight absurda comicality, that:

the inferences drawn from our personal data are also sometimes wrong – certainly if the adverts shown in the authors’ Facebook news feeds are anything to go by, mostly wrong. This can be due to poor quality input data, sometimes itself the output of an inference process, or simply the statistical nature of the inference process analysing the data. However the algorithms cannot know this, and we, the users, frequently do not know when invalid inferences have been drawn.[209]

However, Facebook’s shift from mere social media platform, connecting people, to being a primary source of news and opinion for many people, has led to a phenomenon known as the ‘filter bubble’. Users, by ‘liking’, ‘sharing’, and ‘commenting’ on news that reinforces their world-view, are more likely to consequently be fed stories that are harmonious with this view. Consequently, people are seen to be more likely to polarise their political opinions. However, there is great potential for absurda algorithmic mis-inference, with absurdb results. Where these comical mis-inferences have impact on peoples’ lives – a mortgage application being tied to one’s travel records, thus inferring if they have a regular job (or even show a tendency to be late for work) could have more concrete, but untraceable, absurdb impacts.[210]

Finally, there is an absurda element to the use of big data for what may be its most famous usage: prediction of terror incidents. In the wake of the Snowden leaks, which revealed the existence of huge ‘drag-net’ data collection programmes in the USA, the UK, and others, largely under the premise of improving state security through the prevention of terrorism, Aradau probes the metaphors which are used to describe the security services’ activities:[211] searching for ‘the needle in a haystack’ and gazing into a ‘crystal ball’.[212] Both methods are flawed, for different reasons, she concludes. The ‘logic of resemblance’ in searching for ‘clues’ (such as the ‘needle in the haystack’) relies on ‘four methods of knowledge production: convenience (convenientia), emulation (aemulatio), analogy and sympathy.’[213] However:

In a world where the ‘next terrorist attack’ is unexpected and unpredictable, where the future event is always already different from past events, there are no predictable expectations in reality against which the anomaly can stand out. Rather, the intelligence agencies argue that the hay field – all the data – is needed first in order to derive both expectations about normality and the anomalous elements. Big data is the new whole. The normal and the anomalous, the haystack and the clue, are supposed to emerge from big data. The epistemic logic is not that of locating and assembling insignificant details that stand out against the background of social order, but reading the data in order to produce the normal and the anomalous. For security professionals, the hunt for terrorists cannot be based on past knowledge as terrorists change their methods all the time.[214]

Using the technique of analogy, for example, leads to a situation where ‘[a]ny action, any characteristic, can become the sign of terrorist activity – from buying a one-way plane ticket to reading online material.’[215] The scale of inferences is potentially absurd:

Big data reasoning combines a veneer of rationality – algorithmic logic and probabilistic calculations – with the irrationality of telling the future from data ‘signatures’. Everything has a ‘data signature’ and everything can be derived from data in a never-ending loop of adding variables and correspondences. Big data is rendered as an inescapable system not only from which there is no place to hide, but where it is impossible to think the error of knowledge.[216]

Aradau concludes that both analogies for this use of data do not work; the needle in the haystack relies on past events matching future ones, whilst the crystal ball displays an irrational faith in the needle in the haystack approach that is akin to divination. She concludes by comparing contemporary big data approaches to preventing terrorism to astrology, via a quote by Theodor Adorno, extolling the absurda nature of this mode of big data prediction:

‘There is nothing irrational about astrology’, concluded Adorno, ‘except its decisive contention that these two spheres of rational knowledge are interconnected, whereas not the slightest evidence of such an interconnection can be offered.’[217]

## Absurda+b machines and diagrams

The relationship between technology and the absurdb informs the methodological framework for the works discussed in this thesis, via mechanism I refer to as the ‘absurdb machine’: an assemblage of components which hint at the absurdb nature of a larger technological system that increasingly compromises human agency and determines the mode of existence.

### Absurdb machines

The term ‘machine’ is used intentionally for its ambiguity; a device that could be interpreted as a physical mechanical object, or a bigger generative system. The definition of the term has acquired ambiguities of meaning over time concerning its scale and objecthood. Examination of the etymology reveals that the eleven senses of the word deriving from its original Middle French root were each implemented at roughly the time of the technological or scientific discovery or development, which lead to the word’s broadened definition.[218] The oldest quoted example of the word in the OED is from 1545, and refers to a machine as ‘a material or immaterial structure, esp. the fabric of the world or universe.’[219] Over time, the word has come to refer to smaller entities seen to have this same essential quality of unity, through a material or immaterial structure: from the Descartean notion of body as machine (first quoted by Shakespeare in 1604); to the idea of an apparatus which completes a specific task; to the straightforward mechanism (such as a car); to the male penis.[220]

The scalar variability of the term ‘machine’ has been explored by philosopher Manuel de Landa within the framework of what Deleuze and Guattari have called the ‘machinic phylum’, in both his essay of the same name, and the 1991 book *War in the Age of Intelligent Machines*.[221] In his discussion of Deleuze and Guattari’s notion, De Landa describes ‘phylum’ – a term taken from zoology – as a taxonomy above ‘class’, but below ‘kingdom’, implying that the conception of a machine is closer to that of a system, or operational group, than a fixed object; it refers to the consolidation of what would otherwise be ‘merely coexisting, heterogeneous elements’[222] into ‘a novel entity.’[223] As De Landa points out, this can operate across scales:

In one sense, the term [machinic phylum] refers to any population (of atoms, molecules, cells, insects) whose global dynamics are governed by singularities (bifurcations and attractors); in another sense, it refers to the integration of a collection of elements into an assemblage that is more than the sum of its parts, that is, one that displays global properties not possessed by its individual components.[224]

Thus, De Landa claims, the same methodology could be applied to ‘all the different structures that inhabit our universe’:[225] military institutions and war machines,[226] books (‘A book itself is a little machine’),[227] rivers (which act as a pebble ‘sorting machine’),[228] geological stratification,[229] bureaucracies,[230] faciality,[231] wolves,[232] and anuses[233] all are machines as they are systems that amount to more than the aggregate of their components.

In this sense, the Theatre of the Absurd could be described as an absurdb machine comprising an assemblage of plays, which are in turn absurdb machines. One of the intended effects of absurdist theatre is to trigger the realisation of the absurdb in the mind of the observer. As Camus describes it, this realisation is machinic in its manifestation, the emergent product of a catalyst, such as seeing a man in a telephone booth. The purpose of the projects presented in this thesis is similar; each project is an assemblage of components which hint at the absurdb nature of a larger, usually external, machine such as the technology industry or a Russian propaganda agency. Like the above definitions of machines, there are no fixed formal parameters that define the projects I describe here; they all deal with related subject areas, and work through a series of similar processes to achieve their goals, although the output of each project varies tremendously.

### Diagrams

Within this methodology, I use the concept of the ‘diagram’ to articulate the relationships and mechanisms that constitute each absurdb machine. Once again, this term has abstruse connotations. The most common definition pictorial in nature: a spatialised graphic representation of relationships between components, generally consisting of a ‘configuration of lines, whether they are drawn or written.’[234] In this sense the term is readily associated as part of the design process. However, as Mark Garcia has noted, while the term is ‘as old as architecture itself’,[235] the study of architectural diagrams within the practice of architecture is relatively new;[236] his book *The Diagrams of Architecture* claims to be the first anthology to present the histories, texts and theories of the architectural diagram in its current guise.[237] His work builds on, and is supplemented by, that of Peter Eisenman, who has carried out extensive work in this field.

This thesis aims to bridge between this more traditional conception of the diagram, and Deleuze and Guattari’s articulation of the diagram as an ‘abstract machine … a map of relations between forces’.[238] Here the distinction is perhaps between the notion of the diagram as a noun, and a verb; an outcome and a process.[239] For Deleuze – who has written extensively on the subject – a diagram, at its most fundamental, is a mode of ‘conveying information about something incorporeal.’[240] This can be broken down into three essential typologies: the plan (e.g. the ‘building that is not yet built’), the map (e.g. ‘terrains not yet travelled’), and the graph (i.e. ‘relations between variable qualities’).[241] Within this thesis, each of these typologies is used within different contexts to illustrate different concerns: where plans are employed, for example, they are generally diagrams of something that will exist in the future, such as, in chapter 4, in which shooting diagrams are prepared for a film, or in the conclusion to chapter 3, where a description of an incomplete project plan is described. They are created with the full knowledge that they are subject to change. This is true of any form of premeditated script (e.g. film or theatrical script); they are subject to interpretation when actually implemented. In this thesis, I use the term diagram as both a noun and a verb, as a technique of explicating concepts as much as thinking. Diagrams as described by Deleuze and Guattari are assemblages; the projects *Nybble* (chapter 2) and *24fps Psycho* (chapter 3) both present different forms of diagrams.

## Design methodology

This thesis presents seven projects which have been designed with various modes of scripting and performance in mind, each using the methodological framework of the ‘absurdb machine’. This section explores the criteria upon which projects are assessed and introduces some practitioners from several disciplines who have set precedents for this kind of work. It concludes with an explanation of the biographical context in which the work described in this thesis was created.

### Precedents and assessment criteria

The nature of the judgement I pass on my own work is highly subjective; the criteria are not purely based on aesthetics, or audience reception. Here I attempt to illustrate the questions that I ask myself when developing and assessing a project using the work of several other practitioners whose work I admire.

### Communication

*Does this project communicate its core ideas effectively?*

A good project communicates both the theoretical basis of a project, and the experiential knowledge gained through the *immersion in*, and *application of* this conceptual framework. This means that there must be a breadth and depth of research into the subject area. This research should encompass both paper-based forms, and immersive techniques; for example, if working on a project relating to machine learning, one must learn the fundamental principles and mechanics of the field (i.e. conduct a formal or informal literature review of key principles and practitioners), as well as gain experience putting these principles to use (through, say, learning how to train a machine to recognise handwriting samples using the MNIST dataset via online tutorials).[242] The combination of these practices enables the project to communicate a theoretically grounded, yet subjective viewpoint on a subject.

The subjectivity of the knowledge contained within my projects is fundamental to their execution; as an independent practitioner, my role is to communicate what I know through the projects themselves. In his article ‘Science as Technology’, Srdjan Lelas discusses the interplay between the traditional terms *theoria* (‘knowing that’) and *techne* (‘know-how’).[243] Aiming to work exclusively in *theoria* or *techne* is impossible, and rejects the lineage of scientific progress. To do so creates a ‘spectator theory of knowledge’, Lelas argues, in which the observer is:[244]

[…] allowed to enlarge or augment the capacities and accuracy of her senses, using instruments like a microscope or telescope, so long as their use does not cover rather than reveal the essences of things. All external actions are considered as tricks to aid vision, and are dispensable, traceless and purely instrumental, as is vision itself.[245]

Scientific theory, being experimentally testable, renders it a technological discipline.[246] Therefore, Lelas adds:

[…] to produce an artefact, scientific or other, is to be engaged in complex dynamics, both ontological and epistemological in which at least two component processes, that if bringing forth and that of bringing into, are intertwined.[247]

The creation of projects within this thesis follows similar logic; artefacts produced, in the form of projects, are the result of the dynamics of the theoretical and practical research and application of knowledge. An example of a practitioner who carries out thorough research into his subject matter, and manages to communicate both the theoretical and experiential knowledge to a high standard, is Heath Bunting. Another is found in the work of Stanley Kubrick (whose work is discussed in chapter 1).

### Heath Bunting

Heath Bunting is a British artist who works on the subject of identity and sovereignty, and his research is both theoretically based and immersive. His *Status Project* traces the legal signifiers that surround the construction of a legal person according to UK law.[248] Distinguishing between *human beings*, *natural persons* (‘an objectified human being’;[249] the set of legal constructs which make a human a *person*), and *artificial persons* (‘generally objectified collectives of natural person(s)’, i.e. corporations), Bunting examines the elements of law that have enabled corporations to gain legal *personhood*.[250] The work takes the form of large maps formed from relational databases of possessions and statuses. *A1034: A Human Being Normal* is a portrait of Bunting, revealing how his status at the time of execution is formed.[251] The map is a flow-chart: flowing to the right, with constituent elements being introduced on the left, nodal point ‘09438: a human being normal’ is a status that is achieved by combination of ‘03208: a human being able to provide age’, ‘03410: a human being able to provide name (forename / nickname)’, ‘09435: a human being able to provide nationality’, and crucially ‘01187: a human being alive’. ‘01187: a human being alive’ is itself a product of ‘05021: a human being in possession of basic needs’ and not ‘07521: a human being dead’.

The object rationality that is displayed in the categorisation is inherently humorous, and draws upon the vocabulary of British legal processes; Bunting explained at a conference in Nottingham that the reason he began making such maps was due to an incident in which he fell onto a terrorist watch-list, and was detained by intelligence services.[252] He used his recent artistic commission from the Tate to create a map of his status at the time, in an attempt to diagram the absurda nature of a system whereby every action he could take would only put him under more suspicion. As Sadie Plant wrote of the piece:

The terrorist is one of several identities explored by Bunting in *The Status Project*, a body of work which draws our attention to the astounding degree to which the citizens of the UK have their lives overseen and their identities constructed by the state bodies and corporations with which they interact. No opportunity is missed for movements to be tracked: purchases are recorded, information is gathered, footage is shot, images are stored.[253]

The Status Project follows on from Bunting’s *Border Xing* project, which sought to examine the practicalities of crossing borders within the EU, supposedly a zone with free movement of people.[254] The artist travelled around Europe for a year, documenting the ability to pass from one country to another without detection. The work was presented as a guidebook, as well as a website (which was, for the projects’ launch, password-protected; the protection has since been removed).

Bunting’s work has relevance for my practice for several reasons. He is an artist who works in a similar subject matter and medium, using databases to highlight the absurda+b construction of identity and status in modern states. His work relies on a high level of immersion in his subject, physically crossing borders and testing the legal limits of his identity practice. His presentation of work is both comical and detailed (in *A Terrorist*, for example, the *A-Z Map* logo and indexing system is employed, giving the impression that navigating one’s identity as a suspected terrorist is whimsically easy).[255]

### Form

*Is the form of this project honest?*

*Does it express the processes and techniques used to create it?*

*Does it formalise its intent in the expression of its form?*

In the execution of a project, the expression of form is fundamental to the way in which it is understood. As already witnessed with the work of Italo Calvino and the Oulipo, the revealing of the ‘mould’ that created the project (in the case of the Oulipo, the revealing of the rulesets of project themselves) is as much a part of the work as the formal contents. An example of a contemporary practitioner for whom this is also the case is Tom Sachs.

### Tom Sachs

New York-based artist Tom Sachs is a sculptor who creates artworks via a process he describes as ‘bricolage’. His sculptures and films are embedded in the grammar of American pop culture, graphic and industrial design, and film. The 2016 film *A Space Program* documents Studio Sachs’ 2012 imagining and enacting of a NASA Apollo space programme journey to Mars.[256] The project followed an extensive period of research into technologies and techniques used by NASA for the training of astronauts in the 1960s. The studio then painstakingly recreated, from a limited palette of materials and processes, a range of vehicles, costumes, sets, and live special effects that would enable members of the studio to perform a hypothetical mission, travelling to Mars and collecting a ‘soil sample’. The entire re-enactment would take place, however, in the Park Avenue Armory, a large warehouse-performance space two blocks from Central Park in Manhattan.[257] The accompanying film (directed by long-time collaborator Van Neistat) shows both the mission as a large-scale performative spectacle, whereby an audience in the same building watch from stadium seating as the ‘mission’ takes place, willing it on, and the preparations and studio ethos which led to the mission’s conception and execution in the first place.

Sachs’ studio is well-established in New York; he has rented the same space since 1989.[258] The studio enforces a strict code upon its workers and visitors, which have been formalised and codified in the film *Ten Bullets*.[259] Each of the ‘bullets’ is a short, succinct and humorous guide to the specific use of materials, colours, measurements, storage of tools and behaviours permitted for use inside the studio. Another video, *COLOR*,[260] acts as a 26-minute treatise on the limited colour palette the studio permits: Rich in pop culture references, the film opens to the regal, sinister Wendy Carlos-composed theme music from Stanley Kubrick’s *A Clockwork Orange*.[261] Soon, a firm, precise British voice announces: ‘Developed over decades, our colour code consists of a finite and precise palette. […] The colour code is non-negotiable; we do not stray from the colour code.’[262] The video, both comical and informative, consists almost entirely of special effects made in-studio (and in-camera); it tells the audience exactly which colours they can use, down to the suppliers that make them. We learn, for example, that: The five chosen colours are not only named, they are given characters, a wealth of pop-culture references[263] that root them in time, justifying their presence in the limited palette. Yellow is ‘either McDonalds yellow or Kodak yellow’,[264] whilst for red: ‘we paint with McDonalds Red. McDonalds Red is Benjamin Moore Impervex Latex High Gloss Metal and Wood Enamel, Brilliant Red 309 20, or Krylon Industrial 2108 Banner Safety Red.’[265] Unsurprisingly, Sachs studio rule also insists that construction of projects takes place in a specific order: wood, for example, must be painted *before* it is cut or sanded, rather than after. This means that the wood takes on a particular appearance which is in line with Sachs’ practice of *bricolage*; the surface becomes scratched and shipped, and the appearance of objects gains a certain naivety. Bricolage, explained Sachs in a discussion in Chicago,[266] is the means by which the studio produces its work; having initially trained as a sculptor, and thinking that craftsmanship implied the removal of signifiers of the handmade, Sachs later realised that the process of production should in fact be a more prominent part of the work itself. In order to leave a human impression on objects, plywood is always to be painted before it is cut. This means that the imperfections, a quality of human craftsmanship, are left on the objects; chips and scrapes, the trace of their construction.[267] The models and artefacts created by the studio all show these qualities, a deliberate naivety, use of form, material, colour and sign of process that unites the objects into a distinct family. It is precisely these imperfections which lend such charm to the audacious space programme artworks; there is a clear level of humour in the use of an umbrella as a satellite dish.

Sachs’ studio ethos offers two principles that are of use to this thesis: the honesty of forms that reveal the processes that created them, and the humour inherent within the undertaking of an absurda task. The work shows that, in taking on a patently ridiculous activity, but approaching it with utmost sincerity and a depth of both theoretical and technical immersion, an artwork that is genuinely moving can be created.

### The absurda+b

*Does the project make use of humour (is it absurda)?*

*Does the project hint at the absurdb?*

Much of the content of this thesis deals with absurdb topics and themes. As already explored, the philosophical absurdb is a construction in the mind of the audience; as a practitioner dealing with this subject, a means to catalyse the absurdb realisation is via humour (as was the case with playwrights of the Theatre of the Absurd). A successful project combines several types of humour; it can use an absurda premise (as with the *Ant Ballet*, chapter 1). It can require absurda behaviour from a performer (as with *Nybble* and *Scriptych*, chapter 2, and *Network / Intersect*, chapter 4). Or it can use analogy to evoke an emotional state that engages in the absurdb (as with *24fps Psycho*, chapter 3). Senses of humour are highly subjective. Design is a discursive discipline, and my projects are shaped by the many conversations that happen whilst the project is being developed. As a rule of thumb, if a project can be described in a way that reveals both its humour and its sincerity, this element is a success.

Two practitioners who use the absurda+b as a medium successfully are artist and architect Francis Alÿs, and screenwriter and director Charlie Kaufman.

### Francis Alÿs

Francis Alÿs is a Belgian-born, Mexico-based artist who initially trained (and practiced) in architecture. His work frequently makes use of the absurd; *When Faith Moves Mountains* and *El Ensayo* are both examples of this.[268] *When Faith Moves Mountains* is an absurda+b work: a team of 500 volunteers gather together with shovels, and spend hours working together to collectively displace a Peruvian sand dune, 500 metres in length, by just 10cm.[269] The work is absurda in its sheer comical nature; the act itself has no functional purpose but to make a metaphorical statement (as one volunteer states ‘it’s the mirror of a society, the mirror of a moment in society’).[270] Yet in utilizing labour as a mediator, Alÿs creates an incongruous situation, in which the tension between art and socio-political reality is maintained: a huge workforce is mobilized to literally sculpt the landscape, the effect of which is barely noticeable; the useless, ephemeral act of art-making simultaneously shapes a momentary communal subjectivity, effectively ‘de-romanticiz[ing]’ and politicising Land Art.[271] Fluctuating between emancipation and restraint, individual and collective identity, grand gesture and menial task, art and life, the piece operates within a series of dialogues. Furthermore, the crucial presence of physical labour as the arbitrator illustrates the extent to which the global economy creates a demand for meaningless objects and tedious manual-labour, subverting as if to parody the capitalist mantra in a single statement: ‘maximum input, minimum output’.[272]

This event was the result of intensive research into the historical context of Peru, the significance of the site, and the consultation and collaboration with curator Cuauhtémoc Medina and film maker Raphael Ortega. Created for the Lima Biennale, itself a form of solidarity against Alberto Fujimori’s regime, Alÿs’s work emphasizes the state of Peruvian inhabitants as a forced community, shunted from centre to periphery via economic necessity, to form temporary shanty-towns that have become permanent dwellings.[273] The repetitive and inconclusive nature of the action highlights the continual failed attempts at constructing a national identity throughout a history divided by civil war and plagued by the horrors of a brutal regime.[274] Thus the work is critical and poignant through the use of an absurda+b mechanism.

In the work *El Ensayo*, a red Volkswagen Beetle – a common car in Mexico – repeatedly attempts to drive up a hillside in Tijuana, Mexico.[275] Accompanying the video is a cacophonic big band momentarily playing jazz. Every time the car nears the top of the hill, the music stops, and the car rolls backwards to the bottom of the hill again. It is unclear whether the music is driving the car, or the car driving the music, but each time the car gets tantalisingly close to the top of the hill, it just cannot make it all the way up. The video is nearly half an hour in length. As the scene continues, it becomes funnier and funnier. Eventually, the car reverses to where it began, out of the frame to the left of the camera. This work plays with the classical absurdist notion of the *Myth of Sisyphus*, discussed by Camus in the book that introduced the philosophical absurdb in 1942.[276]

Both works use metaphor and performance to express a sense of absurdb futility. As curator Russell Ferguson notes in an essay on Alÿs, the artist takes a joy in the incompleteness of his own work; he has ‘adopted a way of working that tends to reject conclusions in favour of repetition and recalibration. He has, that is, put the idea of rehearsal at the heart of his practice.’[277] Ferguson (who has previously curated Alÿs’ work) notes, almost with frustration, that there is a lack of closure to the artists’ works; they are in a continuous state of rehearsal and potential alteration:

For Alÿs, then, the final work is always in some sense projected into the future, a future that is always advancing just ahead of the work. In the interim it can constantly be revisited, and its presence can be constantly shape-shifting, not just in the form of documentation through photographs or video, but also through written descriptions or oral accounts passed from person to person.[278]

Alÿs’ presentation of work is, like Sachs’, highly accessible, despite the potentially morbid subject of existential angst it is dealing with. The documentary video about *When Faith Moves Mountains* shows Alÿs; engagement with a local college to recruit volunteers to the project.[279] Samuel Beckett famously rarely discussed the meaning of his work in public; in Alÿs’ documentary, it is only the voices of the volunteering participants who express any potential symbolic meaning the piece has. The humour and warmth of Alÿs’ work is a big influence on my own.

### Charlie Kaufman

On a similar theme of unfinished work, Charlie Kaufman’s film *Synecdoche, New York* presents the story of a theatrical director producing an eternally unfinished work that continually grows in scale and ambition.[280] The film is a musing on the nature of creativity, the desire for perfection and the potential of creeping scope for creative work. It combines many elements of the absurda+b. In the film, director Caden Cotard wins a MacArthur Genius Grant for his theatrical production of *Death of a Salesman*. This enables him to begin production of a large-scale, ambitious play within a large warehouse in Schenectady, New York. At the same time, his marriage to a portrait painter falls apart, and his wife moves to Berlin with their young daughter. However, Cotard focuses on his work; within the warehouse, he builds a scale model of the city outside, and hires a large team of actors to populate it and perform as normal people, each with their own lives, relationships, and daily tragic instructions to react to. Within the city-set, there is a scale model of the warehouse itself, and soon this becomes populated with a smaller model of the original set. A whole team of actors who resemble the originals is hired to work inside the second warehouse. Cotard’s life becomes entangled with the actors, and more replica sets and actors begin shadowing each other. As his work increases in its physical scale and ambition, his wife’s paintings become smaller and smaller, to the extent that when she has a retrospective in New York, the audience must wear magnifying glasses to see the microscopic works.

The film is layered with absurda+b elements: the portrayal of time is skewed, so that what appears to be a few weeks in the film is actually a series of discrete moments months apart; there are repeated moments of mis-hearing, and use of non-sequiturs. The title of the film itself is a play on words: it is set in *Schenectady, New York*, but called *Synecdoche, New York* (the figure of speech whereby a small part represents a whole): the film itself becomes a synecdoche *of* New York; and the lead character, who throughout the film gains quasi-comical physical impairments, is named after a delusion in which a person believes they are already dead.[281]

Kaufman has written other films that also deal with absurdb themes (*Being John Malkovich*, *Adaptation* and *Anomalisa*, for example), but *Synecdoche, New York* is the most explicitly relevant to this thesis.[282] The films’ form is thoroughly reflective of its content: densely layered, a grand statement on the notion of creating, and ultimately with a feeling that it has a lack of resolution (like the play it is about). Kaufman has stated that he is aware of absurdist plays, but his method of creating films that truly hint at absurda+b themes in a modern context, that are both hilarious and existentially absurdb, is a key influence in the creation of my work.[283]

## Practice

### Film, architecture and code

Whilst scripting, the absurda+b, and criticism of issues surrounding technology are the main subjects of my research, the primary means of carrying out active research is through the design of films and filmic experiences. This thesis was written in the context of an architectural school, through an architectural design PhD programme, yet its primary artistic output is filmic and performative. Of the seven projects discussed in this thesis, six use film as a primary output.[284] They also variously include the construction of machines and artefacts, the use of code, performance and choreography.

Throughout these projects, film is not simply an *extra* mode of documentation to the creation of an artefact or performance; rather, it is something that influences both the content and form of projects. The influence of filmic content can be found in projects such as *Ant Ballet*, where numerous references to the films of Stanley Kubrick were woven into the project; or *24fps Psycho*, whose entirety is in reference to an artistic work and the film *Psycho*;[285] or *Network / Intersect*, whose narrative style owes much to the films of Charlie Kaufman and Michel Gondry.[286] The form of films also influences all of the projects, *Ant Ballet* and *Network / Intersect* are both narrative films designed in their entirety; *86400*, *24fps Psycho* and *Network / Intersect* experiment with the form of film itself; and *Nybble* and *Scriptych* are both performances captured by film, but whose design was influenced by this from the projects’ inception. Where possible, the thesis explicates the conscious decisions made within each project around the influences, restrictions, and freedoms granted through working with film.

### Timescale and artistic residency

The work presented in the chapters of this PhD was completed between September 2012 and July 2015. Prior to joining the PhD programme, I completed Master’s in Architectural Design at the Bartlett under Stephen Gage and Ruairi Glynn, graduating with the projects *Ant Ballet* and the *Godot Machine*. These projects are discussed in chapter 1 in the context of their status after completion of the Masters course. The framing of these projects is important, as it lays the basis for the work that follows in this thesis. The work discussed in chapter 1 (the reappraisal and reframing of the work) was completed after the work was submitted for Masters examination. Technical and methodological details about these projects are included in the appendix of this thesis in order to inform the reader about the context of the project. Work that was previously submitted for examination is clearly indicated.

Much of the work included in this thesis was developed, executed and exhibited during my 8-month residency at the Pavillon Neuflize OBC, ‘research lab’ of the Palais de Tokyo.[287] I was incredibly fortunate to have been offered this opportunity, as it provided time, space, facilities, funding, briefs, and exhibitions for my work. These provisions were particularly important as my practice moved from the production of objects and installations, where it is relatively easy to intuitively determine if a project is finished or not, towards a practice encompassing potentially open-ended hybrid films, performances, installations and computer code. In particular, I find the presence of a deadline, and a site to produce for, creatively liberating constraints, in a similar manner to the mode of scripted design process I describe in chapter 4.

Much of this work appears to have developed rapidly during the eight months. In reality, each project is the product of a lengthy process of research and development that began several years before I started at the Palais de Tokyo. The projects each went through several stages of iteration and ideation before I arrived in Paris.

### Teaching

Central to the development of the theoretical basis has been teaching practice. Design is by nature a social activity, which is enriched by a multitude of perspectives and ideas. Through teaching in the Graduate Architectural Design programme at the Bartlett, running workshops, and participating in critique panels, I have been fortunate enough to be able to share and develop ideas with students and staff alike.[288] Many of the concepts discussed in this thesis were the product of this exchange.

As well as teaching, I have also attended several workshops during the course of this work. The most influential of these were held by Punchdrunk, the UK-based theatre company (the contents of which are discussed in chapter 4) and Heath Bunting, whose methodology is briefly explained above.

### Learning

This thesis presents a combination of theoretical and practical knowledge about computer programming. Much of this knowledge has been learnt through pure immersion in the subject; much of my education in programming and programming logic has been of an autodidactic nature, aided by online resources: tutorials, code repositories, and forums.

Where possible, I have included source code from my projects in the appendix. Whilst I realise that the reader is unlikely to be able to run their own version of my project from these sources (due to the nature of hardware, software and library dependencies) I hope that the provision of code and schematics aids their comprehension of the project.

## Thesis presentation

### Structure

This thesis has four chapters, each of which presents two projects (with the exception of chapter 4, which presents only one). The chapters each present a different notion of script, and design methodology that engages with that method. Chapter 1 deals with scripted behaviour, and uses computational scripting in its execution; chapter 2 deals with scripted performances, with projects that focus on philosophical arguments surrounding computational scripting; chapter 3 deals with computational scripting, both in terms of form and content; and chapter 4 presents reflexive scripted design, a novel design methodology developed throughout the PhD. At the end of each chapter I present a sub-conclusion, in which I assess each projects’ success according to the criteria laid out earlier: form, communication, and the absurd.

### Chapter 1: Diagramming the absurd

Projects: *Ant Ballet* (2009-14) and the *Godot Machine* (2009-14)

The contexts in which artworks are exhibited frame the way in which they will be interpreted by an audience. This chapter presents two projects (*Ant Ballet* and the *Godot Machine*) initiated during Master’s degree study, and subsequently exhibited in and modified for different contexts, including those associated with ‘sic-art’. *Ant Ballet* represents a new approach to scripting animal behaviour; The *Godot Machine* represents the application of a robust diagramming design methodology to an absurda+b project.

The chapter re-frames the projects from their previous sci-art position to state their original intention as modes of diagramming the absurdb and as explorations of notions of script, arguing that they should be seen as analogous, rather than literal, works. The re-framing of these projects enabled a critical reappraisal of their content and the development of the methodology used for later projects in this thesis, as well as some criteria for project assessment.

Note that this thesis is not presenting *Ant Ballet* or the *Godot Machine* as PhD thesis projects (they were initiated as master’s projects); rather, it discusses the *framing* of the projects in relation to the wider body of work presented in this thesis.

### Chapter 2: Performing data structures

Projects: *Nybble* (2013) and *Scriptych* (2016)

Computation is central to the contemporary built environment, yet the underlying principles of computing are not widely known by the general public (as highlighted by recent debates in the media about advances in artificial intelligence research). This chapter presents a pair of design projects which use dancers to show computational processes in the form of diagrammatic performances. *Nybble* is a performance which acts as a diagram of John Searle’s *Chinese Room* argument against hard artificial intelligence; *Scriptych* consists of dancers interacting with a three-dimensional database of words. Scripting is used as a mode of instruction for performers in both performances, with direct computer-scripted feedback provided via a novel interface in *Scriptych*. This advances the notion of script as mode of performance-instruction in the context of this thesis, as well as demonstrating computer scripting as a mode of interaction. It finds that the notion of performance-script can be used to drive performances at various stages the design process, representing different levels of agency for performers.

### Chapter 3: Noise and difference

Projects: *86400* (2016) and *24fps Psycho* (2016)

The recent emergence of ‘platform services’ such as Uber, which makes use of large online databases, web protocols and location-based services (usually accessed via smartphone) has changed ways in which people can navigate and negotiate in cities. Moreover, Uber in particular reframes their workers’ conception of spare time, and empty space in a dwelling as spaces for potential profit. Using the approach, tools and platforms of this industry – interaction with databases, APIs, and the internet via the Python scripting language – two computationally-scripted films (*86400* and *24fps Psycho*) analogously explore the lived realities of users of these new services. The projects create new artworks that find new relationships between the contents of existing archival film and images. *86400* represents an absurda+b critique of specific technology companies’ tendency to convert all spare time into potential profit; *24fps Psycho* represents an experimental, potentially expandable generative film which provides a potential framework for future artworks. The chapter concludes that, whilst *24fps Psycho* was a failed project, computer-scripted design can and should have a critical engagement with the social realities it helps create.

### Chapter 4: Reflexive Scripted Design

Project: *Network / Intersect* (2016)

In the first three chapters, scripting is presented as a computational process, and as a mode of instructing performers. The fourth and final chapter proposes an original process called reflexive scripted design, inspired by methodologies from the Oulipo and immersive theatre company Punchdrunk, and using the film *Network / Intersect* as a prototypical example. The film was created via the creation of a script-ruleset, which enabled its form to wholly reflect its content; this ‘script’ was followed throughout the entire production process from initial concept to editing. Reflexive scripted design represents an original contribution to knowledge – a methodology that can be applied to other performative architectural designs, and as such will be developed further beyond the context of this thesis.

### Style

This thesis is written in two distinct ‘voices’. The first, as exemplified by this chapter, presents the theoretical and methodological framework for the thesis itself. Whilst no voice can be truly neutral,[289] it aims for an objectivity that is not found in later chapters. The second voice presents a first-person recounting of the process that drove design projects. It is entirely and unabashedly subjective, as it presents rationale and processes that I carried out, decisions I made, and opinions that I hold that caused these decisions.

The process of completing a PhD by Design is complex; there are multiple modes of enquiry that a designer may take. Some lead with theory which is illustrated with projects; some lead with projects that are backed by theory; I have aimed for a series of design projects that presents a robust set of thoughts on a specific subject area. My use of differing voices is a deliberate step that reflects the duality of mind-sets that have led to this stage in the research process.

I have deliberately shied away from conversations regarding the aesthetics of the work within this thesis. This is a conscious decision; as I hope the work shows, the element that binds the individual pieces together the most, besides their subject matter, is the underlying design *process* that each one has used. The intention of this thesis is to render these processes visible, and provide rationale that enables the critical interrogation of my work. In the course of completing each project, I have made conscious decisions about visual, audial and textural aesthetics; these undeniably affect an audiences’ engagement with the work. Aesthetic decision-making is a large part of the designer’s job.

However, I wish for this study into scripting architectural performances to differentiate itself from recent parametric and Parametricist treaties, as I have made clear in this introduction. Much of the Parametricist design scripting today is arguably still driven by aesthetic, rather than ideological, principles.[290] It is my desire to differentiate my work from Parametricist work in the application of methodological, rather than aesthetic principles. I hope that, for the most part, the aesthetic choices of the projects speak for themselves.

[1] Fortran is a computer programming language that has been in continuous use since the 1950s.

[2] Harry L. Colman and Clarence Smallwood, *Computer Language: An Autoinstructional Introduction to Fortran* (New York, San Francisco, Toronto, London: McGraw-Hill Book Company, Inc., 1962), 1. The manual also states: ‘The programmer must *clearly* specify, via precise instructions, exactly *what* he wants the computer to do and the order in which it is to be done.’ Ibid., 5.

[3] John K Ousterhout, ‘Scripting: Higher Level Programming for the 21st Century’, *Computer* 31, no. 3 (1998): 23.

[4] ‘Programming languages’ are also known as ‘assembly languages.’

[5] Ousterhout, ‘Scripting: Higher Level Programming for the 21st Century’, 33.

[6] Ibid., 30.

[7] Google’s original crawler was written in Python. Sergey Brin and Lawrence Page, ‘The Anatomy of a Large-Scale Hypertextual Web Search Engine’, *Computer Networks and ISDN Systems*, Proceedings of the Seventh International World Wide Web Conference, 30, no. 1–7 (April 1998): 113, <https://doi.org/10.1016/S0169-7552(98)00110-X>; Larry Page, ‘Stanford BackRub Web Project’, 10 December 1997, <https://web.archive.org/web/19971210065425/backrub.stanford.edu/backrub.html>.

Ruby was the original programming language for Twitter. Vijay Dev et al., ‘Getting Started with Rails — Ruby on Rails Guides’, accessed 31 March 2017, <http://guides.rubyonrails.org/getting\_started.html>.

JavaScript is a popular scripting framework for a wide range of web-based applications, from Google Analytics’ measuring engagement on individual web pages, to loading external typefaces, animating content, and more. The website on the DVD accompanying this thesis, for example, uses JavaScript.

[8] Martín Abadi et al., *TensorFlow: Large-Scale Machine Learning on Heterogeneous Systems*, 2015, <http://tensorflow.org/>.

[9] Malcolm McCullough, ‘Scripting (2006)’, in *The Digital Turn in Architecture 1992-2012*, ed. Mario Carpo, AD Reader (Chichester: Wiley, 2013), 182.

[10] ‘Script, n.1’, *OED Online* (Oxford University Press, September 2016), <http://www.oed.com/view/Entry/173567> Draft additions December 2004, citation 1. Some computer programmers feel that ‘programming’ and ‘coding’ are terms enough to describe scripting, although this is usually a thinly-veiled derision for what they perceive as low-grade computer programmers. See the Wikipedia Talk page on Scripting Language for a sample of the conversations around this topic: ‘Talk:Scripting Language’, *Wikipedia*, 16 March 2017, <https://en.wikipedia.org/w/index.php?title=Talk:Scripting\_language>. However, there is an abundance of books on computer scripting; as a brief sample of recent literature, see: R. P. Loui, ‘In Praise of Scripting: Real Programming Pragmatism’, *Computer* 41, no. 7 (July 2008): 22–26, <https://doi.org/10.1109/MC.2008.228>; Hans Petter Langtangen, *Python Scripting for Computational Science* (Springer Science & Business Media, 2013); Arnold Robbins and Nelson H. F. Beebe, *Classic Shell Scripting: Hidden Commands That Unlock the Power of Unix* (O’Reilly Media, Inc., 2005); Jeffrey Sambells and Aaron Gustafson, *AdvancED DOM Scripting: Dynamic Web Design Techniques* (Apress, 2007); Mark Watson, *Scripting Intelligence: Web 3.0 Information Gathering and Processing* (Apress, 2009)., and many more.

[11] Charlton T. Lewis and Charles Short, ‘Scrībo’, *A Latin Dictionary* (Oxford: Clarendon Press, 1879). Original emphasis.

[12] The action of writing through *scrībo* also carries ‘[…] the accessory idea of intellectual action,’ further emphasising this implied intentionality. Ibid.

[13] ‘Scribe, n.1’, *OED Online* (Oxford University Press, September 2016), <http://www.oed.com/view/Entry/173504>.

[14] ‘Matthew 7:29’, in *The Bible*, King James Version, n.d.

[15] The use of the term ‘binary logic’ does not imply that scripts cannot be sophisticated; much advanced image or linguistic analysis makes use of scripting languages such as Python. See chapter 2 for use of Python scripts, using the Gensim library, for word-vector analysis.

[16] ‘Script, n.1’ Definition 1; Geoffrey Chaucer, *Troilus and Criseyde*, Project Gutenberg Ebooks (1374; repr., Urbana, Illinois: Project Gutenberg, 2010), ll. 1369, 1865, <http://www.gutenberg.org/cache/epub/257/pg257.txt>. Chaucer later uses the terms ‘scripture’, ‘circumscript’, and ‘circumscryve’. This indicates that the term script may have been used in various permutations before this date.

[17] This is an alternate spelling for the now-obsolete term *scrite* – meaning ‘a written document’. Eric Partridge, *Origins: A Short Etymological Dictionary of Modern English.*, Array (London: Routledge & K. Paul, 1966), 597.

[18] Lewis and Short, ‘Scrībo’.

[19] Ibid.

[20] Adrian Forty, *Words and Buildings: A Vocabulary of Modern Architecture* (New York: Thames & Hudson, 2000), 29–41.

[21] Ibid., 33. Original emphasis.

[22] Ibid., 37–39.

[23] The changes in architectural design thorough printing are particularly scrutinised in Mario Carpo, *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory*, trans. Sarah Benson (Cambridge, MA: MIT Press, 2001). The key source for this section is Mario Carpo, *The Alphabet and the Algorithm*, Writing Architecture (Cambridge, Mass: MIT Press, 2011).

[24] Forty, *Words and Buildings*, 29.

[25] Carpo, *The Alphabet and the Algorithm*, 13.

[26] Ibid., 14.

[27] Mario Carpo, ‘Parametric Notations: The Birth of the Non-Standard’, *Architectural Design* 86, no. 2 (2016): 28.

[28] Carpo, *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory*, 11.

[29] Carpo, *The Alphabet and the Algorithm*, 55.

[30] Carpo, ‘Parametric Notations’, 29.

[31] Carpo, *The Alphabet and the Algorithm*, 54–58.

[32] Ibid., 55.

[33] In a remarkable proposal several centuries before contemporary globalisation, Alberti also proposed that this technique would allow production of statues to be distributed, so that components could be produced in different cities simultaneously. Ibid.

[34] Carpo makes this point explicitly in several sources: Carpo, *The Alphabet and the Algorithm*; Carpo, ‘Parametric Notations’.

[35] An appraisal of the wider implications of the MIT Media Lab’s model of operation and its impact on higher education can be found via Manuel Shvartzberg, ‘Play Turtle, Do It Yourself: Flocks, Swarms, Schools, and the Architectural-Political Imaginary’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London and New York: Bloomsbury Academic, 2015), 94–122.

[36] Nicholas Peter Negroponte, ‘The Computer Simulation of Perception during Motion in the Urban Environment.’ (Massachusetts Institute of Technology, 1966), <https://dspace.mit.edu/handle/1721.1/13288>. Negroponte’s thesis was written at a time when the particular type of computer could be referred to simply as ‘A computer (7094 model)’. Ibid., 68.

[37] Negroponte, ‘The Computer Simulation of Perception during Motion in the Urban Environment.’, 127.

[38] Ibid., 128–29.

[39] See, for example, the description of the Object-Oriented (OO) languages and their potential for external libraries. Ousterhout, ‘Scripting: Higher Level Programming for the 21st Century’, 29. Note that in this instance Ousterhout’s predictions about OO languages were wrong; many of the popular scripting languages today enable OO programming.

[40] Craig William Reynolds, ‘Computer Animation in the World of Actors and Scripts’ (Massachusetts Institute of Technology. Dept. of Architecture., 1978), 8, <http://hdl.handle.net/1721.1/16203>.

[41] Reynolds, ‘Computer Animation in the World of Actors and Scripts’.

[42] ‘The terms ‘script’ and ‘actor’ come from the real-world concepts of theatrical or television script and the human actors who play it.’ Ibid., 29–30.

[43] Reynolds would later win Scientific and Engineering Academy Award for CGI work in Hollywood films; . Internet Movie Database, ‘Craig Reynolds: Awards’, IMDb, accessed 1 April 2017, <http://www.imdb.com/name/nm0721662/awards>.

[44] Reynolds, ‘Computer Animation in the World of Actors and Scripts’, 18.

[45] Ibid., 29.

[46] Forty, *Words and Buildings*, 34.

[47] Emilio Ambasz, *Italy: The New Domestic Landscape: Achievements and Problems of Italian Design* (Greenwich, CT: New York Graphic Society, 1972), 234.

[48] Forty, *Words and Buildings*, 35.

[49] Ambasz, *Italy: The New Domestic Landscape: Achievements and Problems of Italian Design*, 234.

[50] Nicholas Negroponte, *The Architecture Machine: Toward a More Human Environment* (Massachusetts Institute of Technology: MIT Press, 1970).

[51] Ibid., sec. ‘A Preface to a Preface’.

[52] Ibid., vi ‘Preface to a Preface’.

[53] Ibid., 48. Negroponte’s description of the Computer Automated Routing and Scheduling system reads much like the theoretical base for a system such as Uber today; see chapter 3 of this thesis for more on this subject.

[54] Although the concept of contextually-aware computer models within design which would allow for computer-human co-authorship has existed for some time (see S. Ruffle, ‘Architectural Design Exposed: From Computer-Aided Drawing to Computer-Aided Design’, *Environment and Planning B: Planning and Design* 13, no. 4 (1986): 385–389.), the term Building Information Model was first used in G. A. Van Nederveen and F. P. Tolman, ‘Modelling Multiple Views on Buildings’, *Automation in Construction* 1, no. 3 (1992): 215–224. The correlation between contemporary Building Information Modelling (BIM) and Negroponte’s work is examined in Phillip G. Bernstein, ‘Parameter Value’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London and New York: Bloomsbury Academic, 2015), 200–212. For more on the history of design scripting, see Mario Carpo, ed., *The Digital Turn in Architecture 1992-2012*, AD Reader (Chichester: Wiley, 2013).

[55] *Rhinoceros*, version 5.4 WIP, Mac OS X (Seattle, WA: Robert McNeel & Associates, 2017).

[56] Note here that ‘parametric design’ is distinct from ‘Parametricism’, a term coined and promoted by Patrik Schumacher representing a particular form of parametric design closely ideologically linked with neoliberal politics and economics. Matthew Poole and Manuel Shvartzberg, eds., *The Politics of Parametricism: Digital Technologies in Architecture* (London and New York: Bloomsbury Academic, 2015), 4–5. These ideas will be discussed in more detail in the next section of this thesis.

[57] A critique of developments in CAD, and in particular parametric programming, can be found in Shvartzberg, ‘Play Turtle, Do It Yourself: Flocks, Swarms, Schools, and the Architectural-Political Imaginary’, 118.

[58] Khaled ElAshry and Ruairi Glynn, ‘An Approach to Automated Construction Using Adaptive Programing’, in *Robotic Fabrication in Architecture, Art and Design 2014*, ed. Wes McGee and Monica Ponce de Leon (Springer International Publishing, 2014), 51–66, <https://doi.org/10.1007/978-3-319-04663-1\_4>.

[59] Andrew Heumann, *MetaHopper*, Grasshopper, 2017, <http://www.food4rhino.com/app/metahopper>.

[60] McCullough specifically mentions George Stiny’s *shape grammars*, followed by the development of TopDown software written by Robin Ligett and William Mitchell. McCullough, ‘Scripting (2006)’, 184–85.; Ibid., 186–87.

[61] Greg Lynn’s essay *Folding in Architecture* grounds his use of ‘folding’, a process of form-generation in reference to Gilles Deleuze, Mark Wigley and Robert Venturi. Though the essay itself makes curiously little reference to digital technologies, it is widely regarded as a precursor to many contemporary parametric principles. See Greg Lynn, ‘Folding in Architecture (1993)’, in *The Digital Turn in Architecture 1992-2012*, ed. Mario Carpo, AD Reader (Chichester: Wiley, 2013), 28–47. For a lineage of practitioners adopting parametric software, see Carpo, *The Digital Turn in Architecture 1992-2012*; Carpo, ‘Parametric Notations’.

[62] Matthew Poole and Manuel Shvartzberg, ‘Introduction’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London ; New York: Bloomsbury Academic, 2015), 1.

For the sake of clarity in this thesis, Parametricism will be capitalised, whereas parametric design

[63] Patrik Schumacher, ‘Parametricism: A New Global Style for Architecture and Urban Design’, in *The Digital Turn in Architecture 1992-2012*, ed. Mario Carpo, AD Reader. (Chichester: Wiley, 2013), 244.

[64] Schumacher’s free market principles are exemplified in his presentation at the 2017 World Architecture Festival in Berlin, where he advocated measures such as the placing of all public spaces into commercial ownership and removal of all forms of social housing. Patrik Schumacher, ‘Housing as Architecture’ (World Architecture Festival, Berlin, 17 November 2016), <https://www.dezeen.com/2016/11/17/video-live-stream-patrik-schumacher-keynote-seminar-world-architecture-festival-2016/>. This is an extension of the principles he advocated in articles such as Patrik Schumacher, ‘Hegemonic Parametricism Delivers a Market-Based Urban Order’, *Architectural Design* 86, no. 2 (2016): 114–123.

[65] Schumacher, ‘Parametricism: A New Global Style for Architecture and Urban Design’, 244.

[66] Ibid., 248.

[67] Ibid., 241.

[68] Peg Rawes, ‘Spinoza’s Geometric and Ecological Ratios’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London and New York: Bloomsbury Academic, 2015), 215.

[69] Ibid., 217.

[70] Ibid., 216.

[71] Douglas Spencer, *The Architecture of Neoliberalism: How Contemporary Architecture Became an Instrument of Control and Compliance* (Bloomsbury Publishing, 2016), 18.

[72] Schumacher, ‘Hegemonic Parametricism Delivers a Market-Based Urban Order’, 115. For further criticism of Schumacher’s work and politics, see *The Architecture of Neoliberalism*; Rawes, ‘Spinoza’s Geometric and Ecological Ratios’; Peggy Deamer, ‘Parametric Schizophrenia’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London and New York: Bloomsbury Academic, 2015), 178–88; Reinhold Martin, ‘On Numbers, More or Less’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London and New York: Bloomsbury Academic, 2015).

[73] Patrik Schumacher, ‘Parametricism with Social Parameters’, in *The Human (Parameter): Parametric Approach in Israeli Architecture*, ed. Ionathan Lazovski and Yuval Kahlon (London, Tel Aviv: ZEZEZE Architecture Gallery, 2015), <http://www.patrikschumacher.com/Texts/Parametricism%20with%20Social%20Parameters.html>.

[74] Rawes proposes Spinoza’s *ratios* as an alternative to Parametricism: ‘We might say that it is a nonhuman "ecological geometry " in which nature is not determined into simple units by the idealized and hermetic application of computational scripts , which promote "unfettered" generativity for neoliberal ends.’ Rawes, ‘Spinoza’s Geometric and Ecological Ratios’, 219. See the film Equal By Design for more on this concept. Adam Low, *Equal By Design* (Lone Star, 2016), <http://www.equalbydesign.co.uk>.

[75] Marvin Minsky, ‘A Framework for Representing Knowledge’, 1 June 1974, [DSpace@MIT](mailto:DSpace@MIT) - Computer Science and Artificial Intelligence Lab (CSAIL) - Artificial Intelligence Lab Publications - AI Memos (1959 - 2004), <https://dspace.mit.edu/handle/1721.1/6089>.

[76] Ibid., 1.

[77] Ibid., 29.

[78] Roger C. Schank and Robert P. Abelson, *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures* (New Jersey: Lawrence Erlbaum Associates, 1977).

[79] Ibid., 1.

[80] Ibid.

[81] Rae Carlson, ‘Silvan Tomkins’s Legacy: A Grand Theory of Personality’, in *Exploring Affect: The Selected Writings of Silvan Tomkins*, ed. Silvan S. Tomkins and E. Virginia Demos, Studies in Emotion and Social Interaction (Cambridge, New York and Paris: Cambridge University Press; Maison des Sciences de l’Homme, 1995), 295.

[82] Silvan S. Tomkins, *Exploring Affect: The Selected Writings of Silvan Tomkins*, ed. Irving Alexander et al., Studies in Emotion and Social Interaction (Cambridge, New York and Paris: Cambridge University Press; Maison des Sciences de l’Homme, 1995), 313.

[83] Ibid. Note that the postnatal slap Tomkins describes is no longer common practice in UK hospitals.

[84] Ibid.

[85] Ibid., 314.

[86] Ibid.

[87] Ibid.

[88] Ibid., 315.

[89] Ibid.

[90] Ibid., 320.

[91] Ibid., 342.

[92] Tomkins’ writings link ideology to personality, tracing ‘polarity between the humanistic and normative orientations, between left and right, in fields as diverse as theology, metaphysics, the foundations of mathematics, the theory of aesthetics, political theory, epistemology, theory of perception, theory of value, theory of childrearing, theory of psychotherapy, and the theories of personality and personality testing.’ Ibid., 355. One of the central claims in his ideology research relates back to the earlier theory about the mechanisms behind script organisation; being loosely clustered, this necessarily created amplification effects, and increases an ideological polarity.

[93] Ibid., 356.

[94] The separate, yet enmeshed, nature of motivation and *affect* is key to Tomkins’ theory. He notes: ‘I almost fell out of my chair in surprise and excitement when I suddenly realised that the panic of one who experiences the suffocation of interruption of his vital air supply has nothing to do with the anoxic drive signal per se. A human being could be, and often is, terrified about anything under the sun.’ Ibid., 32.

[95] Ibid.

[96] Tomkins self-effacingly asks: ‘Could one design a truly humanoid machine? This would either expose the ignorance or reveal the self-consciousness of his creator, or both.’ Ibid., 441, quoting selection from Sillvan Tomkins and Samuel Messick (Eds.), Computer Simulation of Personality: Frontiers of Psychological theory (pp. 3-57), New York: Wiley (1963).

[97] Tomkins was one of Abelson’s PhD supervisors.

[98] Tomkins would declare: ‘The closest affinity of my views is with the script theoretic formulation of Robert Abelson (1975) and Schank and Abelson (1977). Although their use of the concept of script is somewhat different from mine, the theoretical structure lends itself to ready mapping one on to the other, despite terminological differences which obscure important similarities of the entire two theoretical structures.’ Tomkins, *Exploring Affect: The Selected Writings of Silvan Tomkins*, 321.

[99] Schank and Abelson, *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures*. Preface.

[100] Ibid.

[101] Ibid., 2.

[102] Ibid., 4.

[103] As the aforementioned Fortran manual helpfully explains: ‘Whereas a child may accurately deduce what we want from an instruction as vague as the first one [‘go to the supermarket and buy food’], the computer cannot because it does not have the capability of understanding, comprehending, or interpreting, and therefore cannot deduce. […] It cannot do this even though it has had years of previous experience with perfect programmes’ Colman and Smallwood, *Computer Language: An Autoinstructional Introduction to Fortran*, 5.

[104] Robert P. Abelson, ‘Psychological Status of the Script Concept.’, *American Psychologist* 36, no. 7 (1981): 715, <https://doi.org/10.1037/0003-066X.36.7.715>.

[105] Schank and Abelson, *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures*, 37.

[106] Ibid., 36–37.

[107] Ibid., 38.

[108] Ibid., 39.

[109] Ibid., 45.

[110] Roger C. Schank, ‘Conceptual Dependency: A Theory of Natural Language Understanding’, *Cognitive Psychology* 3, no. 4 (1972): 552–631.

[111] Abelson, ‘Psychological Status of the Script Concept.’, 723.

[112] Ibid.

[113] Schank and Abelson’s inclusion of tipping waiting staff in almost every restaurant script is a notable indicator of the cultural specificity of many scripts – tipping is far more prevalent in the US than the UK, and UK-based scripts would often omit this detail.

[114] This is an example use by both Abelson and Bower et al. Abelson, ‘Psychological Status of the Script Concept.’, 725; Gordon H Bower, John B Black, and Terrence J Turner, ‘Scripts in Memory for Text’, *Cognitive Psychology* 11, no. 2 (April 1979): 177–220, <https://doi.org/10.1016/0010-0285(79)90009-4>.

[115] Bower, Black, and Turner, ‘Scripts in Memory for Text’.

[116] Elvira García-Bajos and Malen Migueles, ‘False Memories for Script Actions in a Mugging Account’, *European Journal of Cognitive Psychology* 15, no. 2 (2003): 195.

[117] Ibid.

[118] Physical, mental ant abstract (possessive) transfers are encoded as ***PTRANS***, ***MTRANS*** and ***ATRANS*** respectively; moments for decision making are encoded as ***MBUILD***.

[119] One interesting avenue for script research may lie in *Hogeweyk* village in Amsterdam, a care home designed for people with dementia. Although not directly employing the term ‘script’ (yet using multiple other theatrical terms, such as ‘stage’ and ‘backstage’), the facility employs many elements that facilitate scripted interactions within its care-giving. Organised as a small, enclosed village in which residents are free to wander around, and fall into scripted behaviour patterns (e.g. buying food in a supermarket, going to the pub or theatre, attending a flower-fair). Staff do not wear care uniforms, but instead play roles that enable them to subtly provide care for residents: some work as waiters in the restaurants, others may appear as a friend who is cooking dinner. This enables the patients to fall into scripted behavioural patterns via social interactions. The particular living arrangements (houses and social interactions) are organised by socioeconomic groups, so that scripts that the patient is accustomed to are those most naturally occurring to that particular person.

Sally Stewart, ‘Redesigning Domesticity: Creating Homes for the Elderly’, *Architectural Design* 84, no. 2 (2014): 80–87; Demos et al., ‘The Commission on Residential Care’ (Demos, 2014), 162–63; Jeremy Story Carter, ‘Dementia Village Designed for Dignity’, Radio broadcast, *Blueprint for Living* (ABC RN, 3 October 2015), <http://www.abc.net.au/radionational/programs/blueprintforliving/designing-for-dementia/6805070>; Suraj Patel, ‘Dementia Patients in Dutch Village given “Alternative Reality”’, *Dementia Patients in Dutch Village given ‘Alternative Reality’* (BBC News, 16 December 2012), <http://www.bbc.com/news/health-20727157>.

[120] Minsky, Schank and Abelson, and Abelson all acknowledge each others’ work. Minsky, ‘A Framework for Representing Knowledge’, 28; Abelson, ‘Psychological Status of the Script Concept.’, 715; Schank and Abelson, *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures*, 8,10.

[121] Gregory Bateson’s *Theory of Play and Fantasy* poses similar ideas, but from an evolutionary-biological perspective. Gregory Bateson, ‘A Theory of Play and Fantasy’, in *Steps to an Ecology of Mind*, 13. printing. (Ballantine, 1985), 177–93.

[122] Bower, Black, and Turner, ‘Scripts in Memory for Text’; García-Bajos and Migueles, ‘False Memories for Script Actions in a Mugging Account’.

[123] Martin Esslin, *The Theatre of the Absurd* (Great Britain: Cox and Wyman Limited, Pelican Books, 1968).

[124] Several of the writers lived in Paris, and several of them wrote their plays in a second language.

[125] In his 1960 article, Esslin identifies Eugene Ionesco, Samuel Beckett and Arthur Adamov as members of the movement he titles the *Theatre of the Absurd*, before stating that each ‘would probably most energetically deny that they form anything like a school or movement.’ Martin Esslin, ‘The Theatre of the Absurd’, *The Tulane Drama Review* 4, no. 4 (1 May 1960): 4, <https://doi.org/10.2307/1124873>. Despite not having a formal location, many of the writers lived in Paris, and many of them wrote their plays in the second language of their adopted home.

[126] Martin Esslin, *The Theatre of the Absurd*, Third Pelican (London: Penguin, 1991), sec. The Tradition of the Absurd, pp. 327–398.

[127] This is not a contrivance; he Oxford English Dictionary cites two classes for the word: *adjective* (Type A), and *noun* (Type B). Given its obsolete nature, the original sense of the absurd – that is, out-of-harmony – has been disregarded for the purposes of this thesis. For the purposes of clarity, I will also use the distinction within quotes from other writers. It is also similar in form to the method Daniel Kahnemann uses in the book *Thinking, Fast and Slow* to distinguish between the two modes of thought that he proposes, Type 1 and Type 2. See Daniel Kahneman, *Thinking, Fast and Slow* (Penguin UK, 2012).

[128] ‘Absurd, Adj. and N.’, *OED Online* (Oxford English Dictionary, March 2011), <http://oed.com/view/Entry/792?redirectedFrom=absurd\#eid>.

[129] Samuel Beckett, ‘Waiting for Godot (1956)’, in *The Complete Dramatic Works*, [New edition] (Faber and Faber, 2006), 19.

[130] Eugene Ionesco, as quoted in M. Esslin, *The Theatre of the Absurd* (Great Britain: Cox and Wyman Limited, Pelican Books, 1968), p. 24. Note that Ionesco is referring to absurd[b].

Note that this sense of the absurdb was likely not rootless in the authors and playwrights who are identified with the movement, whose world-views were undoubtedly shaped by their experiences: Algerian-born Camus published The Myth of Sisyphus in a Nazi-occupied Paris; Beckett was a member of the French Resistance, and Ionesco had witnessed the rise of a fascist regime in Romania.

[131] Felix Belair, ‘Albert Camus Wins Nobel Letters Prize’, *New York Times*, 18 October 1957.

[132] Sense B.1.b ‘Absurd, Adj. and N.’

[133] Albert Camus, *The Myth of Sisyphus*, trans. Justin O’Brien, 12, from the 1955 translation ed. (London, England: Penguin, 1955), 1.

[134] Ibid., 9–13.

[135] Ibid., chap. An Absurd Reasoning.

[136] Ibid., 9.

[137] Ibid., 11.

[138] Ibid.

[139] Ibid., 13.

[140] Ibid.

[141] Paris was under Nazi rule from June 1940 until August 1944; *The Myth of Sisyphus* was published in 1942.

[142] Justin Wintle, *The Concise New Makers of Modern Culture* (Taylor & Francis, 2008), 55.

[143] Esslin, *The Theatre of the Absurd*, 1991, 135–36.

[144] Esslin describes Genet’s plays as being ‘concerned with expressing his own feeling of helplessness and solitude when confronted with the despair and s of man caught in the hall of mirrors of the human condition, inexorably trapped by an endless progression of images that are merely his own distorted reflection – lies covering lies, fantasies battening upon fantasies, nightmares nourished by nightmares within nightmares.’ Ibid., 200–201.

[145] Ionesco, as quoted in Esslin, p. 187.

[146] Gordon Pask, ‘A Comment, a Case History and a Plan’, *Cybernetics, Art and Ideas*, 1971, 76–99.

[147] Pask describes ‘aesthetic activities’ in four categories: the creation of a ‘tangible work of art’ such as a painted picture, achieved via ‘organizing a bit of symbolic environment’; creating instructions which are ‘interpretable as a work of art’, such as a music score or script; performance of a work of art, or ‘interpreting a work of art prescription, such as a piece of music’; and ‘appreciating or enjoying some work of art.’ Ibid., 76.

[148] *Waiting for Godot* will be discussed in more detail in Chapter 1 of this thesis.

[149] Camus, *The Myth of Sisyphus*, 119.

[150] Pataphysics is a discipline invented by Alfred Jarry, the writer of the influential absurdb play *Ubu Roi*, and defined as ‘the science of imaginary solutions’. The Oulipians initially met with the intention of forming a group within the College de Pataphysique. See Jean Lescure, ‘Brief History of the Oulipo’, in *The New Media Reader*, ed. Noah Wardrip-Fruin and Nick Montfort (Cambridge, MA: MIT Press, 2003), 172, 188 fn 1.

[151] Lauren Elkin, *The End of Oulipo? An Attempt to Exhaust a Movement*, ed. Scott Esposito (Winchester, UK; Washington, USA: Zero Books, 2013), 1.

[152] Beno Weiss, *Understanding Italo Calvino*, Understanding Modern European and Latin American Literature (Columbia, S.C.: University of South Carolina Press, 1993), 6.

[153] Chamier, quoted in Ibid., 90.

[154] Raymond Queneau quoted in Elkin, *The End of Oulipo? An Attempt to Exhaust a Movement*, 1.

[155] Raymond Queneau, ‘A Hundred Thousand Billion Poems’, in *The New Media Reader*, ed. Noah Wardrip-Fruin and Nick Montfort, trans. Stanley Chapman (Cambridge, MA: MIT Press, 2003), 149–69.

[156] Elkin, *The End of Oulipo? An Attempt to Exhaust a Movement*, 1.

[157] In fact, Calvino written about Queneau’s work as far back as 1947, with a review of his book *Pierrot amico mio* in the Italian newspaper *l’Unita*. Weiss, *Understanding Italo Calvino*, 108, footnote 18. Weiss also recommends Carlo Ossola’s article Carlo Ossola, ‘L’invisibile e il suo “dove”: “geografica interne” di Italo Calvino’, *Lettere Italiane* 39, no. 2 (June 1987): 220–51. Weiss, *Understanding Italo Calvino*, 108, footnote 9.

[158] Rocco Capozzi, ‘Cosmicomiche Vecchie E Nuove: Keeping in Tune with the Times’, in *Calvino Revisited*, ed. Franco Ricci, University of Toronto Italian Studies (Ottawa: Dovehouse Editions, 1989), 68; Weiss, *Understanding Italo Calvino*, 6.

[159] Weiss writes: ‘Calvino’s post-1963 approach to literature can be traced in significant measure to Quineau’s models – his interest in science and its effect on our way of thinking, the application of science and mathematical concepts to literature, the search for new literary forms, the combinatory and playful nature of writing,’ Weiss, *Understanding Italo Calvino*, 91.

[160] Italo Calvino, ‘Cybernetics and Ghosts’, in *The Literature Machine: Essays*, trans. Patrick Creagh (London: Secker and Warburg, 1987), 3–27.

[161] Ibid., 9.

[162] Ibid., 8; ibid., 18. Original emphasis.

[163] Italo Calvino, *The Complete Cosmicomics*, trans. Martin McLaughlin, Tim Parks, and William Weaver, Penguin Modern Classics (London and New York: Penguin Classics, 2009). The Cosmicomics were written between 1964-5

[164] This idea is quite different from scientific communication, as seen in contemporary sci-art works. See chapter 1 for an elaboration on this point.

[165] Calvino, *The Complete Cosmicomics*, chap. The Light-Years.

[166] Weiss, *Understanding Italo Calvino*, 6.

[167] Calvino’s entry into the Oulipo: Dennis Duncan, ‘Calvino, Llull, Lucretius: Two Models of Literary Combinatorics’, *Comparative Literature* 64, no. 1 (2012): 93. The original version of the ‘The Burning of the Abominable House’ was written for the Italian version of *Playboy Magazine*, but was later translated into English by Tim Parks (quoted here). Italo Calvino, ‘The Burning of the Abominable House’, in *Numbers in the Dark and Other Stories*, ed. Esther Calvino, trans. Tim Parks, Array (New York: Pantheon Books, 1995), 156–69. The story is referred to as ‘The Fire in the Cursed House’ in the New Media Reader. Noah Wardrip-Fruin and Nick Montfort, eds., *The New Media Reader* (Cambridge, MA: MIT Press, 2003), 183–87. Early Oulipian-influenced works include *Il castello dei destini incrociati* (‘The Castle of Crossed Destinies’) in 1969, and *Le citta invisibili* (‘Invisible Cities’) in 1972. See Weiss, *Understanding Italo Calvino*, 6.

[168] The project was later presented at the Centre Pompidou in Paris at *Atelier de Recherches Avancées* (Studio for Advanced Research); the creator of the programme used in Calvino’s book, Paul Braffort, was responsible for the atelier’s literary project. Paul Fournel, ‘Computer and Writer: The Centre Pompidou Experiment’, in *The New Media Reader*, ed. Noah Wardrip-Fruin and Nick Montfort (Cambridge, MA: MIT Press, 2003), 182.

[169] The death-inducing actions include: *to strangle* / *to induce to commit suicide* / *to stab in the back* / *to drug*.

[170] Wardrip-Fruin and Montfort, *The New Media Reader*, 187.

[171] Italo Calvino, ‘Prose and Anticombinatorics’, in *The New Media Reader*, ed. Noah Wardrip-Fruin and Nick Montfort (Cambridge, MA: MIT Press, 2003), 187. The use of a term derived from physics (such as clinamen) in relation to a work of literature is a classic trait of Calvino. His Cosmicomics sought to present a range of scientific and mathematical principles in literary form, often with formal constraints that cause, for example, stories’ structures to mirror each other, or for the motif of an unwinding spiral to be present throughout a work.

[172] Calvino, ‘Prose and Anticombinatorics’. Note that in this tome, the story is entitled ‘The Fire in the Cursed House’.

[173] Oulipo, *Atlas de littérature potentielle*, ed. Noël Arnaud, First, Collection Idées 439 (Paris: Gallimard, 1981).

[174] This was not always the case with Calvino’s work after joining the Oulipo, although heavy formal constraints can be found in many of his stories, including *If on a winter’s night a traveller* and many of the Cosmicomics. Italo Calvino, *If on a Winter’s Night a Traveler*, trans. William Weaver, Array (New York: Harcourt Brace Jovanovich, 1981); Calvino, *The Complete Cosmicomics*.

[175] Fournel, ‘Computer and Writer: The Centre Pompidou Experiment’.

[176] Ibid., 182.

[177] Ibid., 183.

[178] Note that this thesis, in the spirit of the Oulipo, is interested in the potential of constraint in work-creation; thus, it will focus mostly on the first technique Fournel described.

[179] In this thesis, computer scripts process images and movies (chapter 3), text, and physical movements (chapter 2).

[180] Stephen Gage, ‘Constructing the User’, *Systems Research and Behavioral Science* 24 (2007): 313–22.

[181] Spencer, *The Architecture of Neoliberalism*, 158.

[182] Gilles Deleuze, ‘Postscript on the Societies of Control’, *October* 59 (1992): 3–7.

[183] The essay was written in 1990, but published in 1992.

[184] Deleuze, ‘Postscript on the Societies of Control’, 5.

[185] Ibid., 6. The role of machines will be thoroughly explored in the *methodology* section of this chapter.

[186] Ibid.

[187] Ibid., 7. The literal use of such e-card systems (usually based on RFID technology) is now a staple of universities, corporations, and hospitals, to grant access to buildings and resources whereby differing levels of access occur.

[188] Tung-Hui Hu, *A Prehistory of the Cloud*, First (Cambridge, MA: MIT Press, 2015), xvi.

[189] Ibid., xv.

[190] This can occur for many reasons, mainly because the transaction type, amount, or location are different from an individuals’ own norms.

[191] Tung-Hui Hu, *A Prehistory of the Cloud*, xv.

[192] The Human-Data Interaction group describe big data ‘as data that is collected using a variety of signals and sources centred on an entity, while being multi-faceted in temporal and contextual sense.’ Hamed Haddadi et al., ‘Human-Data Interaction’, *University of Cambridge, Computer Laboratory, Technical Report*, no. UCAM-CL-TR-837 (2013): 4, <http://128.232.0.20/techreports/UCAM-CL-TR-837.pdf>.

[193] Claudia Aradau states: ‘Big data is produced by citizens within daily interactions and collected by private and governmental organisations with the purpose of extracting economic and symbolic capital. Ownership of the instruments for data generation (such as a smartphone or Twitter account) is separated from access to and ownership of the instruments of collection, storage and processing of data. Security institutions and private corporations own and secretly guard their instruments and methods.’ Claudia Aradau, ‘The Signature of Security: Big Data, Anticipation, Surveillance’, *Radical Philosophy* 191 (June 2015): 27.

[194] Haddadi et al., ‘Human-Data Interaction’, 3.

[195] Ibid. The *Human-Data Interaction* group is working to improve transparency in the mechanisms behind inferences in data, and generally, towards privacy on the Internet. See also Aradau, ‘The Signature of Security: Big Data, Anticipation, Surveillance’.

[196] Haddadi et al., ‘Human-Data Interaction’, 4.

[197] Aradau, ‘The Signature of Security: Big Data, Anticipation, Surveillance’, 27.

[198] Apple Inc., ‘Software License Agreement For iTunes EA1067’ (Apple Inc., 9 October 2013), sec. F9, <http://images.apple.com/legal/sla/docs/iTunes.pdf>. This particular provision has been part of Apple EULAs for many years, and can be found in nearly every software license the company issues.

[199] Rich Parris, ‘Online T&Cs Longer than Shakespeare Plays – Who Reads Them?’, *Which? Conversation*, 23 March 2012, Online edition, sec. Technology, <https://conversation.which.co.uk/technology/length-of-website-terms-and-conditions/>.

[200] This term appears in quotes, as this is one of a host of a finickity differentiations that Uber have used to their legal advantage in multiple territories that they operate within.

[201] Uber are renowned for ethically-dubious uses of data. In a since-redacted blog post in 2014, Uber used aggregated user data to infer which US cities had the highest incidence of one-night-stands (which they euphemistically termed ‘Ride of Glory’, defined as ‘anyone who took a ride between 10pm and 4am on a Friday or Saturday night, and then took a second ride from within 1/10th of a mile of the previous nights’ drop off point 4-6 hours later (enough for a quick nights’ sleep)’). This blog post was removed from Uber’s website, but an archived version is available from archive.org’s cached page. Voytek, ‘Rides of Glory | Uber Blog’, *Uber Blog* (blog), 27 August 2014, <https://web.archive.org/web/20140827195715/http://blog.uber.com/ridesofglory>.

[202] Deleuze, ‘Postscript on the Societies of Control’, 6.

[203] Google, Facebook, Apple, LinkedIn, Twitter, and many other influential technology companies are all sited in the same part of California.

This phenomenon is widely known: my computer’s built-in dictionary offers the following sample phrase for the term *inexorable*: ‘*the seemingly inexorable march of new technology*’.

[204] Colin Gordon, ‘Government Rationality: An Introduction’, in *The Foucault Effect: Studies in Governmentality*, ed. Graham Burchell, Colin Gordon, and Peter Miller (University of Chicago Press, 1991), 2.

[205] Ibid., 2–3.

[206] Tung-Hui Hu, *A Prehistory of the Cloud*, xvi.

[207] Ibid., xvii.

[208] Ibid., xiv.

[209] Haddadi et al., ‘Human-Data Interaction’, 4. In my case, Facebook is also comically confused; when signing up, I entered by birthdate 1944 (rather than 1986), and I have also never entered a marital status. As such, I am served adverts for joint pain relief, lawnmowers, Russian/Thai brides, technological gadgets, and, following a move to the USA during the recent election cycle, Donald Trump memorabilia. The reliability of Facebook’s filter bubbles seemingly does not extend to adverts.

[210] London’s transport system enables users to pay via Oyster card, or contactless credit or debit card. On trains, users must both ‘swipe in’ and ‘swipe out’ of their journeys. The combination of this dataset is surely a powerful new addition to banking databases.

[211] The Snowden leaks was a huge cache of documents released by former US military contractor Edward Snowden in 2013, which revealed the massive extent, mechanisms, and political structures of communications data collection on civilians by multiple national intelligence agencies. Aradau, ‘The Signature of Security: Big Data, Anticipation, Surveillance’, 25.

[212] Ibid., 22.

[213] Ibid., 25–26.

[214] Ibid., 25.

[215] Ibid., 26.

[216] Ibid., 26–27.

[217] Ibid., 28.

[218] ‘Machine, N.’, *OED Online* (Oxford University Press), accessed 30 May 2014, <http://www.oed.com/view/Entry/111850>. Note this thesis will not discuss the role of science as a technology, but an interesting perspective on this idea can be found in Srdjan Lelas, ‘Science as Technology’, *The British Journal for the Philosophy of Science* 44, no. 3 (1 September 1993): 423–42.

[219] ‘Machine, N.’, Definition 1.a.

[220] Ibid., Machine as mechanised tool: IV; Machine as genetalia: 9.

[221] Manuel De Landa, ‘The Machinic Phylum’, in *Technomorphica*, ed. J. Brouwer and C. Hoekendijk, vol. 1 (Rotterdam, Holland: V2\_, 1997), 31–59; Manuel De Landa, *War in the Age of Intelligent Machines*, Swerve Editions (Zone Books, 1991).

[222] De Landa, ‘The Machinic Phylum’.

[223] Ibid.

[224] Manuel De Landa, *War in the Age of Intelligent Machines*, 20.

[225] De Landa, ‘The Machinic Phylum’.

[226] Manuel De Landa, *War in the Age of Intelligent Machines*; Gilles Deleuze and Félix Guattari, *A Thousand Plateaus* (The Athlone Press, 1988). The term ‘war machine’ is littered throughout A Thousand Plateaus, but most notably in *Chapter 12. 1227: Treatise on Nomadology – The War Machine* (pp.351-423).

[227] Deleuze and Guattari, *A Thousand Plateaus*, 4.

[228] Manuel DeLanda, *A Thousand Years of Nonlinear History*, Paperback (Brooklyn, NY: Zone Books, 1997), 60.

[229] Ibid.

[230] Deleuze and Guattari, *A Thousand Plateaus*, 4.

[231] Ibid., 174–91.

[232] Ibid., 3.

[233] Ibid.

[234] Jakub Zdebik, *Deleuze and the Diagram: Aesthetic Threads in Visual Organization*, Continuum Studies in Continental Philosophy (London: Continuum, 2012), 1.

[235] Mark Garcia, ed., *The Diagrams of Architecture* (Chichester, England: Wiley & Sons Ltd, 2010), 18.

[236] We have seen a similar viewpoint in both Carpo and Forty.

[237] Mark Garcia, *The Diagrams of Architecture*.

[238] Garcia (2010) notes that Deleuze referred to at least three different definitions of the diagram throughout his texts, influenced by Francis Bacon, Marcel Proust and Michael Foucault; however, the ‘most influential’ (as quoted above) is taken from Deleuze’s writings on Foucault. Ibid., 23–24.

[239] Zdebik, *Deleuze and the Diagram: Aesthetic Threads in Visual Organization*. Zdebiek notes throughout this work that Deleuze has written expansively on the subject of the diagram, and his conception of what a diagram was subject to change throughout his career

[240] Ibid., 1.

[241] Ibid.

[242] The MNIST database consists of a set of 60,000 examples and 10,000 examples of handwritten digits compiled for the purpose of training handwriting-recognition algorithms. Learning to train a handwriting-recognition algorithm is a standard example of a machine-learning exercise; Google’s TensorFlow software (among others) provides this as basic training.

[243] Lelas, ‘Science as Technology’, 423.

[244] Ibid., 424.

[245] Ibid., 426.

[246] Ibid., 425.; this is exemplified in quantum physics, ‘in which theory, in its most basic formulation, cannot avoid reference to experimental arrangements.’ Ibid.

[247] Lelas, ‘Science as Technology’, 423.

[248] Heath Bunting, *The Status Project*, 2014 2002, Code, website, 2014 2002, <http://status.irational.org>.

[249] Ibid.

[250] Ibid.

[251] Heath Bunting, *A1034 A Human Being Normal*, 25 December 2013, Code, flow chart, map, 25 December 2013.

[252] Heath Bunting, ‘Tracing Mobility: Cartography and Migration in Networked Space’ (Trampoline, Nottingham Contemporary, England, 15 May 2010), <http://www.nottinghamcontemporary.org/event/tracing-mobility>.

[253] Sadie Plant, ‘Critical Gestures’, Tate, *Intermedia Art: New Media, Sound and Performance* (blog), May 2008, <http://www2.tate.org.uk/intermediaart/critical\_gestures.shtm>.

[254] Heath Bunting, *Border Xing Guide*, 2003 2002, Guidebook, website, database, 2003 2002, <http://www2.tate.org.uk/intermediaart/borderxing.shtm>.

[255] Heath Bunting, *A Terrorist*, 24 March 2009, Map, 1020 x 821 mm, 24 March 2009, Tate, London.

In 2014 I attended a workshop run by Bunting at D21 gallery in Lepzig. Several of the ideas learnt there have found their way into my subsequent work within this thesis. Heath Bunting and WaiWai, ‘Search Routines: Stories of Databases’ (D21 Gallery, Leipzig, 23 October 2014), <http://rhizome.org/community/14616/>.

[256] Van Neistat, *A Space Program*, 2016; Tom Sachs, *Space Program: Mars*, 16 June 2012, Various media, 16 June 2012.

[257] The ‘soil sample’ was, in fact, a piece of the Armory’s floor.

[258] Arthur Lubow, ‘Tom Sachs’s Workshop: Willy Wonka Would Approve’, *The New York Times*, 11 March 2016, <https://www.nytimes.com/2016/03/13/arts/design/tom-sachss-workshop-willy-wonka-would-approve.html>.

[259] The *Ten Bullets* film can be watched online. See Tom Sachs and Van Neistat, *Ten Bullets, By Tom Sachs*, 2012, <https://vimeo.com/34901903>.

[260] Tom Sachs and Van Neistat, *COLOR. By Tom Sachs*, 2011, <https://vimeo.com/33998046>.

[261] Stanley Kubrick, *A Clockwork Orange*, 1972. The theme music itself was based on Henry Purcell’s 1695 composition for the funeral of Queen Mary II.

[262] Sachs and Neistat, *COLOR. By Tom Sachs*.

[263] When the film discusses paint *sheen*, for example, a scene from Apocalypse Now plays onscreen, with Martin Sheen slowly emerging from a body of water.

[264] Sachs and Neistat, *COLOR. By Tom Sachs*.

[265] Ibid.

[266] Tom Sachs, ‘MCA Screen: A Space Program’ (Museum of Contemporary Art, Chicago, 13 October 2016).

[267] In a panel interview I saw in Chicago, Sachs discussed his transition from an scupltor who wanted to create perfect objects to one who wanted to leave his fingerprint in them for thousands of years, describing how the mark of the creator is the distinguishing feature of his particular mode of *bricolage*.

[268] Francis Alÿs, *When Faith Moves Mountains*, 2002, Land art, video, 2002, <http://francisalys.com/when-faith-moves-mountains/>; Francis Alÿs, *El Ensayo*, 2001 1999, Video, 2001 1999, <http://francisalys.com/el-ensayo/>.

[269] The film quotes 500 and 800 volunteers variously.

[270] Alÿs, *Francis Alÿs*, 2002.

[271] Francis Alÿs, *When Faith Moves Mountains* (Madrid and New York: Turner; Distributed by D.A.P./Distributed Art Publishers, 2005), 24.

[272] This slogan is printed in Spanish at the beginning of the book that accompanies the DVD documentation of the work: ‘maximo esfuerzo, minimo resultado’.

[273] One of the largest of such settlements is the site of the dune, Ventanilla, rendering the work a meeting point for the artistic and the actual enforced collective ensembles.

[274] Hence the allusion to ‘faith’ in the title perhaps suggests hope, reflected in the incomplete nature of the task. As Miwon Kwon points out in her essay on Alÿs (in language echoing Camus’ *Myth of Sisyphus*): ‘reaching the finish line means the killing of aspiration.’ Miwon Kwon, ‘Francis Alÿs’, *Artforum International.; New York* 46, no. 6 (February 2008): 282.

[275] Alÿs, *Francis Alÿs*, 2001 1999.

[276] Camus, *The Myth of Sisyphus*.

[277] Russell Ferguson, ‘Politics of Rehearsal: Francis Alÿs (2007)’, in *Failure*, ed. Lisa Le Feuvre, Documents of Contemporary Art (London; Boston, Massachusetts: Whitechapel Gallery; MIT Press, 2010), 195.

[278] Ibid. Along similar lines, Kwon notes the repetition of the Sisyphian lack of ability to reach the destination, but the continued hope this gives: ‘efforts that seem to go nowhere (produce nothing), that constantly take you to a prior point or all the way back to the beginning (regression, no development), that endlessly posit the possibility of a new outcome this time (deferred conclusion or satisfaction), are at play in all the works in the show […] what is most compelling about the walking, the climbing, the reaching (for the top of the hill), the repeating, the starting anew, and the rehearsing of the same thing over and over in Alÿs’s work is that these actions materialize or give form to the structure of hope.’ Kwon, ‘Francis Alÿs’.

[279] Alÿs, *Francis Alÿs*, 2002.

[280] Charlie Kaufman, *Synecdoche, New York* (Sony Pictures Classics, 2008). Kaufman wrote and directed the film.

[281] Synecdoche is the term for a ‘figure of speech in which a more inclusive term is used for a less inclusive one or vice versa, as a whole for a part or a part for a whole.’ ‘Synecdoche, N.’, *OED Online* (Oxford University Press), accessed 14 April 2017, <http://www.oed.com/view/Entry/196458.The> name of the character is derived from Cotard’s syndrome, which ‘comprises any one of a series of delusions ranging from the fixed and unshakable belief that one has lost organs, blood, or body parts to believing that one has lost one’s soul or is dead.’ John Pearn and Christopher Gardner–Thorpe, ‘Jules Cotard (1840–1889) His Life and the Unique Syndrome Which Bears His Name’, *Neurology* 58, no. 9 (2002): 1400–1403. True to his name, the lead character in *Synechdoche, New York* has a growing, and oddly comical, catalogue of ailments that increasingly interrupt any social interactions he has: an inability to produce tears means he has to use eye drops when he is sad; he cannot swallow without bouncing up and down; and so on.

[282] Spike Jonze, *Being John Malkovich*, 1999; Spike Jonze, *Adaptation*, 2002; Duke Johnson and Charlie Kaufman, *Anomalisa*, 2016.

[283] Charlie Kaufman, ‘Screenwriters On Screenwriting. The BAFTA and BFI Screenwriters’ Lecture Series’ (BFI Southbank, London, 30 September 2011), <http://guru.bafta.org/sites/learning/files/guru\_sws\_ck\_transcript\_final.pdf>; Adam Sternbergh, ‘In Conversation: Charlie Kaufman’, *Vulture* (blog), 16 December 2015, <http://www.vulture.com/2015/12/charlie-kaufman-anomaslisa-c-v-r.html>.

[284] Films for *Ant Ballet*, *Nybble*, *Scriptych*, *86400*, *24fps Psycho* and *Network / Intersect* can be found within the accompanying material to this thesis. The seventh project – the *Godot Machine* – was also made with unfinished filmic documentation in mind; however, as described in chapter 1, the project remains unfinished.

[285] Alfred Hitchcock, *Psycho*, 1960.

[286] Gondry directed Kaufman’s screenplays *Human Nature* and *Eternal Sunshine of the Spotless Mind*, as well as directing numerous music videos and films which have thematically or visually inspired much of my work. Michel Gondry, *Human Nature*, 2002; Michel Gondry, *Eternal Sunshine of the Spotless Mind*, 2004.

[287] The Pavillon Neuflize OBC, having aided the development of over 130 young artists from 2001-2017, is now sadly defunct.

[288] I taught in the Interactive Architecture Lab in various roles from 2011-14.

[289] See Ranulph Glanville, ‘An Observing Science’, *Foundations of Science* 6, no. 1–3 (1 March 2001): 45–75, <https://doi.org/10.1023/A:1011353225749>.

[290] Even Patrick Schumacher, who coined the term, and staunchly advocates parametricism, offers contradictory arguments for the movement in ‘Parametricism: A New Global Style for Architecture and Urban Design’, (originally published two years before the first landmark tome *The Autopoesis of Architecture*). The style is presented as having a ‘superior capacity to articulate programmatic complexity’ ‘evidenced at all scales’ Schumacher, ‘Parametricism: A New Global Style for Architecture and Urban Design’, 242. Yet among the taboos of parametricism – that is, the ‘paths of research to avoid’ (Ibid., 244.) – are ‘rigid geometric primitives such as squares, triangles and circles, […] simple repetition of elements, […] juxtaposition of unrelated elements or systems’ (Ibid.). Surely the *ultimate* system for ordering complexity would not be thrown off-balance or undermined by the inclusion of primitive forms?

Diagramming the Absurd *The Godot Machine and Ant Ballet* ==================================

This chapter addresses the *diagramming* and *framing* processes that underpin my design practice. It draws upon Gregory Bateson’s ‘A Theory of Play and Fantasy’, and Andrew Barry and Georgina Born’s work in defining sci-art practice, and refers to two projects: *Ant Ballet* and the *Godot Machine*. These projects were initiated before the start of my PhD (with iterations of both forming part of my MArch portfolio) but continued into the first year of doctoral research, and were central to the development of later work.[1] In particular, it was in the production of these pieces that diagramming first entered my practice, with both works taking the form of machines that manifested specific diagrammatic systems.

It should be noted that the *Godot Machine* and *Ant Ballet* are used here for purposes of reference only, and not as part of my thesis portfolio (this is clarified by appendicising all technical information for both projects). In addition to the methodological role they play, these works represent and define a major shift in the framing of my work away from the ‘sci-art’ genre.[2] As such, I use them here as a basis for the critique of that field, and the platform upon which to build a more theoretically robust definition of my practice. This chapter focuses on the re-establishing the intention behind these works, defining the framing and diagramming processes that emerged from them, and assessing their implications for other projects in this thesis. As an Arts and Humanities Research Council-funded PhD has a responsibility to discuss methods and processes involved in the creation of work, I see these works as essential reference points for the thesis, acting as a catalyst for future projects, as well as a framing device for subsequent chapters. These projects have also played an important role in moving my design work towards an *artistic* context: it was because of the *Ant Ballet* project (as exhibited at FutureEverything festival in Manchester) that I was offered the residency at the Palais de Tokyo, thereby also redefining the disciplinary scope of my practice.

### Frames

The conceptual frame in which a piece of art exists is central to an audiences’ understanding of it. The British cyberneticist Gregory Bateson wrote extensively about the relationship between the way humans mentally construct the world they inhabit and the way they perceive and create cultural phenomena, such as artwork. How do we know to treat art as art, or to separate the fiction in a story from everyday lived experience? Is this ability to separate the fictitious or fantastical from the real an innately human quality, or can it be seen in other animals? And what does this tell us about the way we see art? These questions are posed in Bateson’s essay ‘A Theory of Play and Fantasy’, in which he introduces the concept of mental frames.[3]

Bateson begins the essay with a vignette: while watching monkeys play in San Francisco’s Fleischer Zoo, he wonders how they are able to distinguish between play-fighting and real fighting, asking both how the delineation between the two forms of fighting happens, and how it is communicated. Drawing on numerous disciplines, including anthropology, linguistics, semiotics, psychology and the study of animal behaviour, Bateson uses this example as a model to investigate the way in which humans conceptualise and analyse their experiences and thoughts in the real world and decipher meaning from communication.[4] He begins by discussing language. Playing with another individual (as in the case of the two monkeys), requires an ability to communicate, but it also requires meta-communication: that is, communication about the communication. In the case of the play-fighting monkeys, the actions they perform clearly mimic the actions of combat, but somehow both monkeys know that this is play fighting, rather than real fighting. For example, a play bite symbolises a real bite, but does not elicit the consequences of the latter. Bateson therefore concludes that playing communicates a message: ‘these actions in which we engage do not denote what those actions *for which they stand* denote.’[5] Bateson claims that this is similar to Alfred Korzybski’s famous argument about the relationship between a map and the territory it describes. Korzybski, a scholar in field of general semantics and linguistics, distinguished map and territory as distinct entities, arguing that a map is merely a model of the territory, and thus in being a model, the map becomes a simplified version of the territory:

A map *is not* the territory it represents, but, if correct, it has a *similar structure* to the territory, which accounts for its usefulness. If the map could be ideally correct, it would include, in a reduced scale, the map of the map; the map of the map, of the map; and so on, endlessly […].[6]

For Korzybski maps are an analogy for languages, which must ‘be considered *only as maps*. A word is not the object it represents’.[7] When applied to Bateson’s monkey example, within the game, the monkeys’ play-bites act as signifiers of the bites they would do if the fight were real. So, within the monkeys’ play, the relationship between the actions they are performing and the actions they represent (i.e. play-fighting to real fighting) is akin to the map’s relationship to the territory it represents. The monkeys both know that this particular fight is a game, and some sort of communication is necessary to enable this to happen. The animals do ‘not quite mean what they are saying, but, also, they are usually communicating about something that does not exist.’[8]

Bateson argues that these games also occur in the human realm. In our appreciation of art (among other pursuits), for example, we too have to realise that we are indulging in a form of play, that the symbolic representations contained within the objects we are looking at are in reality mere representations:

At the human level, this leads to a vast variety of complications and inversions in the fields of play, fantasy, and art. Conjurers and painters of the *trompe l’oeil* school concentrate upon acquiring a virtuosity whose only reward is reached after the viewer detects that he has been deceived and is forced to smile or marvel at the skill of the deceiver. Hollywood film-makers spend millions of dollars to increase the realism of a shadow. Other artists, perhaps more realistically, insist that art be nonrepresentational; and poker players achieve a strange addictive realism by equating the chips for which they play with dollars. They still insist, however, that the loser accept his loss as part of the game.[9]

In play, the players must be reminded that they are playing. But play contains an internal paradox: there are messages within the message that tell the receiver that the action is play; in other words, that it is untrue. Play must be separated from the ‘real’ actions it symbolises. This process, Bateson argues, occurs through a ‘psychological frame’ and ‘context’.[10]

What, then, is a frame? Bateson claims that there are two examples that could be used to discuss the analogy: a picture frame, or a mathematical set. For the sake of clarity in this argument, I will only focus on the former. A psychological frame, like a picture frame, is a delimitation device: the frame around a painting marks the outer limits of the artwork, and ‘tells the viewer that he is not to use the same sort of thinking in interpreting the picture that he might use in interpreting the wallpaper outside the frame.’[11] A similar, but non-physical device can be found in real-world scenarios where we have to ‘frame’ actions: jobs, plays, interviews and languages all require framing, insofar as behaviour inside these frames is understood to be distinct, and carry different symbolic meaning, to the actions that take place outside of it. A physical picture frame is itself an ‘excessively concrete’[12] device representing an externalisation of our internal mental processes, since ‘human beings operate more easily in a universe where some of their psychological characteristics are externalised.’[13]

Psychological frames (and by extension, picture frames) are both inclusive and exclusive devices. Simultaneously, they act to include certain messages by excluding others, and exclude certain messages by including others. For example, a picture viewer asks the viewer to ‘attend to what is within and do not attend to what is outside.’[14] Bateson continues:

The frame itself thus becomes a part of the premise system. Either, as in the case of the play frame, the frame is involved in the evaluation of the messages which it contains, or the frame merely assists the mind in understanding the contained messages by reminding the thinker that these messages are mutually relevant and the messages outside the frame may be ignored.[15]

The frame, then, is a ‘metacommunicative’ device;[16] any message containing a frame ‘*ipso facto* gives the receiver instructions or aids in his attempt to understand the messages included within the frame.’[17]

Bateson’s psychological frame concept contains similarities with Schank and Abelson’s script theory.[18] Schank and Abelson’s scripts are sets of rules, which are activated when a person encounters a certain scenario; a number of these scenarios are examples of play (for example, football or squash). Although Schank and Abelson do not explicitly make the point, their concept of a scene requires a Batesonian frame, the imposition of which enables the triggering of scripts. The ability to play through imagined Schank-and-Abelsonian scripts in one’s head (such as imagining an encounter in a restaurant) could be seen as an example of Batesonian framing.

Within the world of artistic production, both *psychological frames* and *script theory* carry implications: the context within which work is presented, and even the genre the work fits into, much like a physical frame on a wall, delineates the limits and extent within which an artwork or project will be judged; and the script associated with the context – in other words the genre of work – delineates implicit and explicit rules, norms, and protocols, which are generally followed. Within the world of artistic production, defining the remit and scope of the virtual frame an artist works within is an important determinant of how their work is portrayed, understood and interpreted. Traditional Balinese painting, for example, will be interpreted according to different rules (or *scripts*) to a Van Gogh.[19] Similarly, work displayed in the *context* of an art gallery will be interpreted differently to the same work presented in a science museum, by virtue of the psychological frame it uses and the scripted behaviour this elicits.

What relevance does an argument about psychological and knowledge frames have in this thesis? This chapter discusses two projects, which were instrumental in defining the scope and frame of the practice I now employ. Both projects worked with ants, with the aim of manipulating their behaviour, either as individuals or entire colonies. The development of these projects led to, and helped to shape initial research for this thesis; however, the original framing and exhibition of the *Ant Ballet* project as ‘sci-art’ (the meaning of which will be discussed shortly) placed undue emphasis on certain aspects of the project, which in turn undermined its absurd, diagrammatic intentions. This is discussed through a pair of exhibitions, one in which the work was exhibited in a scientific institution, and another where it was exhibited in the context of an art and technology festival.

## Projects

### Godot Machine

A central, famous, theme of the Samuel Beckett play *Waiting for Godot* is that ‘nothing happens, twice.’[20] The play depicts two days in the lives of Vladimir and Estragon, which act as synecdoche for their entire existence; there is a sense of hopelessness to their every action, an inevitability to the repetition of events, a forgetting of incidents, places and names. The ‘controller’, the ever-absent Godot, is removed from the situation, leaving the audience feeling as though the characters are puppets, their strings being pulled from afar. It is a portrait of a pair of confused lives subject to abstract controls, with little sense of individual agency.

Similarly, there is a scene in George Lucas’ first feature film, the dystopic sci-fi thriller *THX-1138,* where the main protagonist wakes up to find that he is in a featureless, potentially infinite, white room, and that no matter which direction he walks in, he gets nowhere.[21] Whilst the film as an entirety may be seen as a crude high-tech approximation of George Orwell’s *1984*, and a continuation of the escape-from-dystopia plot consistently found in sci-fi, I found the image of the infinite void compelling when I first watched the film in 2009.[22] The sense of despair and helplessness present in both the *THX-1138* scene, and *Waiting for Godot* (as well as the image of Sisyphus in Camus’ *The Myth of Sisyphus*) was something that I wanted to explore through a machinic diagram:[23] I was mesmerised by the emotional reaction I had to both of these works, and wanted to build something that evoked similar affect from an audience. However, building a machine that would literally transport a person to a similar state as the aforementioned works of literature and film would not be logistically or financially possible, and thus another strategy was required.

Engaging with fiction requires the viewer to enter a Batesonian *frame*; to knowingly realise that the fiction depicted on-screen or in the pages of a novel is fantasy. The same could be said of reading Foucault’s description of Jeremy Bentham’s *Panopticon*, a design for a prison (or high-surveillance education system), ultimately unrealised during Bentham’s lifetime.[24] Foucault’s initial diagrammatic description of the *Panopticon* is as follows:

We know the principle on which it was based: at the periphery, an annular building; at the centre, a tower; this tower is pierced with wide windows that open onto the inner side of the ring; the peripheric building is divided into cells, each of which extends the whole width of the building; they have two windows, one on the inside, corresponding to the windows of the tower; the other, on the outside, allows the light to cross the cell from one end to the other. All that is needed, then, is to place a supervisor in a central tower and to shut up in each cell a madman, a patient, a condemned man, a worker or a schoolboy. By the effect of backlighting, one can observe from the tower, standing out precisely against the light, the small captive shadows in the cells of the periphery. They are like so many cages, so many small theatres, in which each actor is alone, perfectly individualised and constantly visible. The panoptic mechanism arranges spatial unities that make it possible to see constantly and to recognize immediately. In short, it reverses the principle of the dungeon; or rather of its three functions - to enclose, to deprive of light and to hide – it preserves only the first and eliminates the other two. Full lighting and the eye of a supervisor capture better than darkness, which ultimately protected. Visibility is a trap.[25]

In Foucault’s analysis, Bentham’s utilitarian diagram exists as a description, which we know is a work of invention. Yet the reader can empathise with the various characters, and even picture them residing in the building, via the disembodied frame they construct. The Panopticon then becomes a framed, hypothetical diagram of surveillance and control; it does not exist in the real moment of reading, but its virtual presence takes command. Foucault describes the prison functioning as a ‘kind of laboratory of power.’[26] I argue that the real power of this hypothetical design lies in the readers’ tendency to construct the design within their own mind and subsequently project themselves into it through a Batesonian frame. In the same way that Bateson uses Korzybski’s map-territory relationship to differentiate between the actions of monkeys play-fighting and the actions that the play-fighting symbolise (i.e. real, violent fighting), there is a difference between reading Foucault’s description of the Panopticon as a model of power, and the functioning of a real-world Panopticon. In a similar fashion, my intention with the *Godot Machine* project was to construct a machine which functioned as a diagram, a visual representation of a power structure embodied in a medium that would be immediately and viscerally recognised, framed almost as a work of fiction.

The concept of the *Godot Machine* is simple: an ant sits atop a sphere. If it tries to walk forwards, the sphere rotates backwards. If it tries to walk to the right, the sphere rotates to the left. Irrespective of the ant’s attempts to move in any direction, it will always be mechanically rotated to return to the top of its own little world. For this to happen, the ant is monitored from above by a camera, which is connected to a computer control system and series of actuators under the sphere, which can in turn rotate it in any direction. The environment the ant can see is also carefully controlled, so that the ant can never visually orient itself with regards to the room that the machine is placed in. The project serves as a diagram of Beckett’s *Waiting for Godot* (hence the project title): no matter what actions the ant takes, it cannot change its fate. This was the first diagrammatic project that I worked on, and a complete technical description of the project development can be found in the appendices.[27]

### Ant Ballet

*Godot Machine* was an absurda+b machine in the most literal sense. The machine itself had a ridiculous function (absurda), whilst the diagram of power relations was translated into an actual mechanical device, designed to provoke the realisation of the absurdb in the viewer. The project development was also relatively linear, whereby multiple versions of a design solution were prototyped, and the most effective solution was eventually chosen. Whilst working on the *Godot Machine*, I also began developing a project entitled *Ant Ballet*, which explored the less tangible Deleuzian idea of the machine-as-system, via a more complex conceptualisation of the absurdb diagram.[28] *Godot Machine* had analogised the central themes of the Theatre of the Absurd – namely loss of agency, disorientation and invisible power structures – via the manipulation of the individual ant.[29] *Ant Ballet* aimed to take this idea one step further, by controlling a large group of ants by interfering with their natural communication system. Ants are commonly known to form and follow pheromone trails in order to find food.[30] Since the early 1990s, the emergent behaviour demonstrated by this model of communication has fascinated computer scientists to the extent that it has frequently been used as a model for solving complex problems.[31] Inspired by the almost computational logic built within this system, *Ant Ballet* project used artificial pheromones, made in a laboratory by organic chemists with whom I collaborated, to script the movement of a colony of ants. It did so via a machine that spread ant pheromones across a two-metre diameter ‘stage’ which acted as a literal theatre of absurd.[32] Details regarding the technical and theoretical development of this project can be found in the appendices.

Much of the inspiration for *Ant Ballet*, and the consultation of scientific experts, was inspired by the film-making technique of Stanley Kubrick: in particular the film *Dr. Strangelove (Or How I Learned to Stop Worrying and Love the Bomb)*.[33] The film itself is a masterpiece of the absurd, featuring classically absurdist themes: the breakdown of communication systems, an entropic structure, and lack of individual agency.[34] The film was released in 1964, around 15 months after the Cuban Missile Crisis, at a time when the threat of nuclear war was a very real possibility in the minds of many people, and focuses on exactly that subject. In the film, an errant US air-force base commander launches a nuclear attack on Russia which, through a series of mishaps and operational shortcomings, cannot be recalled. Over the course of the film, it is revealed that Russia has secretly built a doomsday device which would trigger the country’s entire nuclear arsenal if any military sites are attacked. In a rare twist for a hit film, it culminates in the nuclear destruction of the world, but it is also full of dark humour. Much like the work of writers within the Theatre of the Absurd, the actions of characters (and in this case the destruction of the world), are inevitable and unavoidable. It is both absurda and absurdb.

In the production of the film, Kubrick went to extreme lengths to ensure its technical accuracy. The depictions of numerous protocols, attitudes, and interiors have been deemed accurate by experts in the field.[35] The story itself was developed from a novel by a former Royal Air Force flight lieutenant Peter George, following its personal recommendation to Kubrick by the head of the Institute of Strategic Studies in London; throughout the making of the film Kubrick read over 50 books and consulted with twelve experts on the subject of thermonuclear war.[36] The viability of the films’ plotline and characters accentuated the absurdb nature of the film itself, or rather, its proximity to reality heightened the potency of the absurdb realisation among the audience. In the creation of *Ant Ballet*, I aspired to similar levels of realism: if I were to make an absurdb statement, it would be one that was scientifically accurate. Where the *Godot Machine* employed engineering techniques, *Ant Ballet* required collaboration with scientists from different disciplines to work. Like Kubrick, the intention was not the accurate depiction of scientific realities onscreen, but rather using this medium to express an absurdb idea. Although the project depicted a real experiment, a real mechanism, real ants and their real reaction, it could equally be a work of fiction.

Ant Ballet culminated in a film and a series of objects, and was the first of my projects to place such an emphasis on narrative structure and performance.[37] Once I had completed the experiment in Barcelona (where the necessary species of ant colony could be found), and used this to create a film, the project was exhibited at various places. The first exhibition outside of UCL, which took place after my MArch, was at the Zoological Society London (ZSL) London Zoo;[38] here, lacking the ability to use real ants (for the same reasons that the experiment was completed in Barcelona – see the appendices), the installation consisted of a simulated version of ant movement, adapted from the ant simulation software I had already programmed as part of the experiment, projected onto a white table-top, with a robotic arm ‘spreading’ pheromones onto the table. The chassis of the original *Ant Ballet* machine was used, but with a newly-made table surface, light ring and robotic arm. Virtual ants would form trails, and the arm would ‘spread’ virtual disruptive pheromones (the effect of which could be seen in the projected image), and the ants would disperse, only to lay new pheromone trails over time. At the edge of London Zoo’s BUGS building, beside a bright floor-to-ceiling window, the installation was housed in a dark tent, lined with theatrical blackout fabric, with three viewing holes.[39] The table, two metres in diameter, had approximately one metre of clearance to the side of the tent, and the audience had to get close to the viewing holes in order to see inside (Figure 1-7). The film was projected onto the side of the tent, whilst inside and around it, signs explained both the function of the machine, and scientific knowledge about ant behaviour. Part of the conditions of exhibiting an installation in the Zoo was that it had to be educational, and highlight the conservation work that ZSL’s scientists do. Therefore, the information was designed to be easily understood by a young audience, was light and friendly in tone, and focused mainly on conveying scientific knowledge about ant behaviour.

The presentation of the project in this manner had a problematic impact on its public reception as an artwork: whilst the work itself (as captured in film and later print[40]) succeeded in embodying an absurdb diagram, this specific manifestation of the project did not. The absurd nature of the project, its diagrammatic qualities, and its inherent humour, were all lost beneath the veneer of educational entertainment.[41] The reason is simple: although the project was produced in collaboration with scientists, in this particular presentation, the artistic intention became subservient to the projects’ scientific content. This was exacerbated by the inability to include real ants, in a setting that was directly opposite a live leaf-cutter ant exhibit. Visitors had the expectation of seeing live animals, and therefore, rather than being viewed a diagrammatic work of art, my installation was a potentially underwhelming addition to an engaging live zoological experience. Within the artistic context, the scientific nature of this project (both in terms of its collaborative aspect – with a team of organic chemists at UCL – and with regards to its setting at ZSL) led to the framing of the project as an example of ‘sci-art’. However, this was not my original intention: my goal had been to produce an absurd machine, which involved scientific collaboration, rather than a scientific collaboration whereby the outcome just so happened to be absurd.

The problematic relationship between art and science in ‘interdisciplinary’ projects has been subject to scrutiny by authors Georgina Born and Andrew Barry in a number of reports.[42] In *Art-Science*, Born and Barry define the ‘emergent field of art-science’ as ‘part of a heterogeneous space of overlapping interdisciplinary practices at the intersection of the arts, sciences and technologies.’[43] The sci-art field has gained prominence in recent years with a number of bodies within the UK established to fund projects involving artist-scientist collaboration: the Wellcome Trust has been a major funding source for such projects since its ‘Sciart’ programme was founded in 1996; the Sciart Consortium was formed in 1999 (joining the Wellcome Trust with ‘Arts Council England, the National Endowment for Science, Technology and the Arts, the Calouste Gulbenkian Foundation, the Scottish Arts Council and the British Council’); and in 2003 Arts Council England and the Arts and Humanities Research Council formed the Arts and Science Research Fellowship programme.[44] These organisations implicitly (and sometimes explicitly) refer to a perceived chasm between the arts and the sciences as a rationale for their existence. This idea was identified and explicated in C.P. Snow’s famous *Two Cultures* lecture of 1959, which remains influential to this day.[45] Snow argues:

There seems then to be no place where the cultures meet. I am not going to waste time saying that this is a pity. It is much worse than that. Soon I shall come to some practical consequences. But at the heart of thought and creation we are letting some of our best chances go by default. The clashing point of two subjects, two disciplines, two cultures – of two galaxies, so far as that goes – ought to produce creative chances. In the history of mental activity that has been where some of the break-throughs came. The chances are there now. But they are there, as it were, in a vacuum, because those in the two cultures can’t talk to each other. It is bizarre how very little of twentieth-century science has been assimilated into twentieth-century art.[46]

While Snow’s thesis calls for a bridging of the disciplines in order to forge new forms of knowledge, the benefits he outlines are distinctly scientific or technical, as opposed to artistic. Snow was seeking technical solutions to large-scale problems of his day (population growth, the Cold War, income inequality) through merging of disciplines, yet in doing so, he insinuates that art only obtains validation in the broader societal realm when it brings functional knowledge to society. This observation about the perceived process of artistic legitimisation that is seen to underpin sci-art collaborations is a starting point for both Born and Barry in ‘Art-Science’ and Paul Glinkowski and Anne Bamford in their analysis of the Wellcome Trust’s Sciart programme.[47] As Barry et al. explain, similar attitudes are expressed in contemporary sci-art funding:

One of the key justifications for funding art-science, particularly in the UK, has been the notion that the arts can provide a service to science, rendering it more popular or accessible to the lay public or publicising and enhancing the aesthetic aspects of scientific imagery.[48]

This is exemplified by the Wellcome Trust’s funding, which is ‘explicitly intended to bridge the two cultures by enlisting artists to foster the public’s relationship with science.’[49] As Glinkowski and Bamford state:

Working alongside the arts had helped to make science more accessible to the public, and had thus improved scientific communication. It was suggested that artists had, in some cases, helped to improve a perceived ‘image problem’ ascribed to scientists and to the scientific profession. […] Artists working on [Wellcome Trust-funded] Sciart projects were felt to have acted as a proxy for the public, opening up scientific practices to a wider gaze. By bringing into the public domain new perspectives on the work that was being conducted in laboratories and other places of science, it was suggested that artists were, in effect, acting as the ‘public’s representative’. A significant aspect of the artists’ contribution to ‘public engagement with science’ was thus as independent scrutinisers – asking questions and provoking insights that might not otherwise be possible, either from the perspective of the general public or from within the scientific community itself.[50]

Acting in this manner, art becomes a mouth-piece of science; a method of communicating scientific knowledge over artistic expression. The *Ant Ballet* installation in London Zoo exemplified this relationship; the diagrammatic absurdity of the project was a secondary message to the *valid* scientific knowledge that could be imparted to the public. It was disappointing to see the original artistic intention of the work diluted to this extent. However, this experience proved to be incredibly valuable to me, as it exposed the impact that *framing* can have on the perception of an artwork, and prompted me to re-evaluate, solidify and theorise the original intention behind the project. Presenting this project as sci-art, in a venue associated more with education than artistic expression, created a frame within which a public could only focus on the science. Within this environment, artistic content is largely perceived as a series of aesthetic choices through which science is communicated.

However, the potential of science-art collaborations is not limited to this imbalanced relationship model. Born and Barry argue that there is potential for new modes of knowledge that do not subjugate one discipline below the other:

We propose that art-science should be understood as a multiplicity, and that part of its interest lies in not being reducible to the imperative to render scientific knowledge more accessible or accountable. Indeed art-science poses definitional and conceptual challenges since, while it exists as a practical, intentional category for artists and scientists, cultural institutions and funding bodies, it forms part of a larger, heterogeneous space of overlapping interdisciplinary practices at the intersection of the arts, sciences and technologies – including new media art and digital art, interactive art and bio-art […] while these domains abut adjacent interdisciplinary scientific and technological fields from robotics, informatics, artificial and embodied intelligence to tissue engineering and systems biology. There is thus a great deal of activity but little codification; ‘art-science’ amounts to a pool of shifting practices and categories that are themselves relational and in formation.[51]

Fortunately, I could re-frame the project shortly after the London Zoo installation in a way that resisted the ‘codification’ Born and Barry highlight. In May 2012, I produced an installation for the FutureEverything festival in Manchester.[52] I had first made contact with FutureEverything a few years previously, when a project I had worked on received a runner-up prize at their inaugural awards.[53] The festival itself has a broad remit, and has grown from being an avant-garde music festival (entitled FutureSonic, established in 1996) to being at the forefront of critical questions in technology, staging an art exhibition and conference alongside a series of music and film events in and around Manchester.[54] The festival featured artists working in disparate genres but united by their engagement with technology, attracting an audience consisting of the general public, as well as media and technology specialists (MediaCity, the main BBC studios in the North of England, and Granada Studios are both located nearby). Having realised several issues with the ‘framing’ of *Ant Ballet* at London Zoo, I worked with FutureEverything’s curation team to ensure that the project itself would be presented with the emphasis on artistic intention.[55] I made three new films and built a new, aesthetically simplified version of the machine.[56]

The exhibition took place on the top floor of the 1830 Warehouse, a Grade I-listed building within the Science Museum’s Museum of Science and Industry. The historic setting created several logistical challenges, as artists were prohibited from mounting works that could potentially damage or alter the building in the process of installation (such as screws). The space consisted of four 16:9-formatted films projected along one wall, each approximately 2.5m wide, with a round machine, 2m in diameter, suspended approximately half a metre above the floor in the middle of the room. The machine was a specially-made maquette of the original Ant Ballet machine (as used in the original Barcelona experiment and at London Zoo), but aesthetically simplified so that it appeared to be merely a white floating surface, with a robotic arm which would only become visible when it was disrupting the virtual ant trails. The robotic arm itself was minimalist, consisting of black aluminium tubular rods, servos and bespoke 3D-printed nylon connectors. At the end of the arm, the pheromone-spreading actuator, instead of being a replica of the real pheromone spreaders, was a 3D-printed conductors’ rod. The simulation showed virtual ants, each a white pixel, moving on the surface of the machine and laying and optimising green trails. When the machine ‘activated’, a spotlight would illuminate the conductors’ wand, which would tap and distribute virtual pheromones. The ants’ behaviour could instantly be seen on the table: the well-formed trails would break apart, the pheromones would evaporate and disappear, and the ants would begin again. The conductors’ wand would operate once every few minutes – enough that the ants could effectively recuperate, and that a casual audience member would have enough time to observe both the formation of ‘natural’ trails and the disruption of the trails by the machine. The machine also dispensed with the *Dr. Strangelove*-inspired light-ring that was used in the original machine and its London Zoo counterpart, instead using the high-powered projector suspended above to illuminate the table surface, and using a white circle from the same projector to illuminate the arm when it was ‘activated’.

Across the four screens, four films played on looped projections. Whilst each film was not playing, its screen would be illuminated in a pastel colour with a one-word title such as ‘Making’ or ‘Info’.[57] The screens were inspired by interface monitors from Kubrick’s film *2001: A Space Odyssey* (in which the an entropic plotline and breakdown in communications emulate the absurdist overtones of *Dr Strangelove*) and featured similar graphics, animation, and sparse wording to those on the fictional space-ship controlled by the computer HAL (I had visited the Kubrick Archives to investigate how the original interfaces had been animated).[58] Each film presented an aspect of the project: the first focused on control, and the emergent properties of pheromone trails as opposed to hierarchical control systems; the second presented infographics which explained the ant movements; the third focused on the making of the project; and the final film was documentation of the Barcelona experiment and the only video with sound. The intention behind this arrangement was to highlight the referential and diagrammatic nature of the installation. The Barcelona film referred to the original experiment, but played its 90 second loop only once every three minutes; the three silent films, on the other hand, were made intentionally to explain and emphasise the machine in the centre of the room as a *simulation* of ant behaviour, rather than a mere copy of the initial scientific experiment. In other words, the installation emphasised the absurd *idea* underpinning the project, rather than the scientific specifics of the ant experiment: the machine was presented as a map to the territory of the real machine. Unlike in the London Zoo exhibition, FutureEverything gave me the opportunity to highlight the absurdist and metaphorical aspects of the project by distancing the work from the live insects, and therefore repositioned the scientific aspect as a complimentary, rather than dominant, facet of the artistic practice.

I spent time in the opening week of the exhibition observing how the audience engaged with the machine and the films. The installation was the first ‘room’ in the gallery, and the layout drew people through the space. Most spent around 3-5 minutes watching films – some flitted between films and machine, whilst others worked their way through the films sequentially. The sparse timing of the pheromone-releasing machine created a spectacle every time it activated, and in the large, sparse room, the machine itself was often a hub around which the audience gathered (even whilst watching the screens). There were numerous factors which made this installation a success in contrast to its earlier exhibition: the modest budget (£500) allowed for rebuilding of the machine specially for the venue; the ability to design the audience experience rather than simply fit the machine into a spare area in a thoroughfare (the layout of the room was designed to entice an audience from afar, revealing parts of the project as they rounded a corner, creating a sense of intrigue); the fact that the work was featured in a new media art exhibition, rather than scientific or educational context; all of these factors contributed to my new-found ability to frame the project, and the messages it conveyed, in the manner I wanted.

The project also garnered media attention. The day after the exhibition launched, I was interviewed by BBC News, as well as Brazilian and Iranian television networks, and national magazines, and the project was featured on numerous blogs worldwide.[59] Whilst such media attention is not by any means an indicator of the quality of work, the role it plays in promotion of an artist cannot be underestimated. The spreading of *Ant Ballet* (and the projects’ main video) via the internet led directly to later commissions, including the residency at the Palais de Tokyo which enabled other projects in this thesis (*Scriptych*, *86400*, *24fps Psycho*, *Network / Intersect*) to take place.

Before I began the PhD thesis, I had intended to continue working on the *Ant Ballet* project, refining the design, developing the technical and theoretical aspects to create multiple permutations and iterations of the machines, and create performances, installations and films of the same theme. During the initial months of my thesis research, I worked on a project with my *Ant Ballet* collaborator Dr. Sumner in which I built technical equipment to test whether British garden ants (*Lasius niger*) are attracted to electricity (as has been anecdotally reported), which was then tested in a study at the ZSL Institute of Zoology by an undergraduate student. It was through careful analysis of my experiences in this project, as well as the failed and successful installations, which led me to realise my earlier arguments about the importance of the frame. I took the conscious decision to move away from the field of sci-art for the next few projects in order that I could focus on the creation of truly absurd diagrams.

## Chapter conclusion

In this chapter, I have discussed the development of two projects, and the role that framing has on the perception of work. I have argued that in the case of *Ant Ballet*, the sci-art moniker (and its associated terms) was not useful in framing the project, leading to the creation of an unsuccessful installation at London Zoo. The specific relationship between science and art within sci-art practice can, of course, exist in multiple permutations. As has been discussed, Born and Barry highlight three modes as being particularly prevalent.[60] The first, refers to the appropriation of scientific knowledge to *justify* artistic production. Closely related to this is the second permutation, involving the production of artwork whereby the intention is to communicate pre-existing scientific knowledge: ‘Science is conceived as finished or complete, and as needing only to be communicated, understood or applied, while art provides the means through which the public is mobilized or stimulated on behalf of science.’[61] This latter is an approach I strongly disagree with and have tried to avoid in my own work. Science is a continuum of knowledge, formed through consensus and continual posing of theories.[62] As Kuhn has described it, normal science is a ‘puzzle-solving’ activity, one which establishes myriad smaller problems to be solved in order to get closer to proof of a larger theory.[63] Scientific knowledge is not always agreed upon: ‘History suggests that the road to a firm research consensus is extraordinarily arduous.’[64]

The third mode of science-art partnership, which is strongly advocated by Born and Barry, denotes a mode of collaboration that instigates the generation of a new form of knowledge. They cite the work of Barbara Cassin and Hannah Arendt to claim that this mode of sci-art practice could produce knowledge that is *different* from either discipline. Sci-art, as they see it, is a public experiment, which they define using the Greek term *epideixis*: ‘the art of “showing” (*deiknumi*) “in front” (*epi*), in the presence of a public, to make a show.’[65] They explain:

As a form of epideixis, public experiments do not so much present existing scientific knowledge to the public, as forge relations between new knowledge, things, locations and persons that did not exist before – in this way producing truth, public, and their relation at the same time.[66]

Whilst *Ant Ballet*, being created with an absurd diagram in mind, and acting through performance itself, may fit into this category of work, I believe it is actually closer to the work of Kubrick in *Dr. Strangelove*. The project is an artwork, displayed in a performative manner to the public, which uses scientific knowledge, experts, and methodologies to convey an absurdb diagram to a public. First and foremost in the project lies the absurd intention; the fact that the project uses scientific methods, necessitating collaboration with scientists, should not change this. Far from weakening the project, or the nature of the collaboration itself, not defining the work as ‘sci-art’ enables the interested observer to find out more about the project if they desire (through publications such as *New Scientist* or *Bio Art: Altered Realities*), or engage with the work as it was intended – an expression of an absurd machine.[67]

### Form, communication and the absurd

It is notable that the most successful exhibition of *Ant Ballet* was the one in which the machine itself was explicitly a non-representational model of the original experimental machine. Whilst the project was framed as sci-art within its London Zoo exhibition, and contained the projects’ original machine in a non-functional state, it was read by an audience as simply being at best a not-fully-functional machine, or at worst, the failure of a sci-art project to accurately communicate on behalf of science. However, when the machine itself was clearly a simulation standing in for the real machine, as with the FutureEverything exhibition, it was far more successful in communicating its absurdb message. The minimalist machine contained similar messages to the play messages of Bateson’s monkeys: whilst this may look real, it is just a simulation of a real thing, a map to some territory. At FutureEverything, the audience could see the relationship between the abstracted, simplified machine in the room with its simplified pixelated-representation of ants and pheromone trails, and the *real* machine and the *real* ants they could see portrayed on the film screens.

Through this project, I realised that the type of absurdb diagrams I wanted to create in my practice would necessarily employ a level of abstraction in order to be read as diagrams. Although such a statement may seem obvious to the reader now, it took me the experience of designing, building, and failing, only to take the learnings and reapply them to a new context, to reach this conclusion. However, this learning proved valuable in the creation of the projects described in the next chapter: *Nybble* is another absurd machine, this time a performance representing a specific process within computation. Had the project taken the same approach as *Ant Ballet*’s incarnation at London Zoo, it would not have been as successful. Similarly, *Scriptych*, the second project described in the next chapter, employs a complex system and set of abstract ideas about language processing to operate. However, the mechanisms behind the system are barely visible to the audience, instead allowing them to focus purely on the relationship between the movements of the performers and the computational behaviour they are eliciting.

[1] Both of the main *Ant Ballet* installations that are discussed towards the end of this chapter (London Zoo and FutureEverything) were completed after I had graduated from the Bartlett, and FutureEverything in particular represented a significant extension to the pre-existing body of work which has not been presented for examination before.

[2] This does not mean that my practice rules out the idea of collaboration with scientists, or applying scientific principals or methodology to my work, but rather that the intention of work should not be made secondary to the communication of scientific knowledge. This is clarified in the section on *Ant Ballet* at London Zoo and FutureEverything exhibitions.

[3] Gregory Bateson, ‘A Theory of Play and Fantasy’, in *Steps to an Ecology of Mind*, 13. printing. (Ballantine, 1985), 177–93. The essay was originally delivered as a lecture in 1954.

[4] Note that Bateson’s conceptions of frame are similar to, but distinct from from Minsky’s ‘frames’ in Marvin Minsky, ‘A Framework for Representing Knowledge’, 1 June 1974, [DSpace@MIT](mailto:DSpace@MIT) - Computer Science and Artificial Intelligence Lab (CSAIL) - Artificial Intelligence Lab Publications - AI Memos (1959 - 2004), <https://dspace.mit.edu/handle/1721.1/6089>.

[5] Bateson, ‘A Theory of Play and Fantasy’, 185. Original emphasis.

[6] Alfred Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics*, Fifth edition, second printing (Brooklyn, N.Y., USA: International Non-Aristotelian Library, Institute of General Semantics, 2000), 58. Original emphasis.

This argument is exemplified in the Jorge Luis Borges short story *On Exactitude in Science*, in which an empire becomes so obsessed with cartography that it builds a 1:1 map of its territory; the map is useless, and ends up a tattered historical relic. Jorge Luis Borges, ‘On the Exactitude of Science’, in *Collected Fictions*, trans. Andrew Hurley (New York: Penguin, 1998), 325.

[7] Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics*, 58. Original emphasis.

[8] Bateson, ‘A Theory of Play and Fantasy’, 188.

[9] Ibid. Original emphasis.

[10] Ibid., 192.

[11] Ibid., 193.

[12] Ibid., 192.

[13] Ibid., 193.

[14] Ibid.

[15] Ibid.

[16] Ibid.

[17] Ibid., 192–93. Original emphasis.

[18] Schank and Abelson’s script theory in turn contains references to Marvin Minsky’s ‘frame theory’, which Minsky in turn notes is partly based on Schank and Abelson’s work. Minsky makes no note of Bateson, however. Minsky cites Schank and Abelson’s separate works in his 1974 paper A framework for representing knowledge. Minsky, ‘A Framework for Representing Knowledge’, 1. Schank and Abelson in turn cite Minsky’s paper in both their initial joint conference paper on scripts (1975), and the later book Scripts, plans, goals and understanding (1977). Roger C. Schank and Robert P. Abelson, ‘Scripts, Plans, and Knowledge’, in *Proceedings of the 4th International Joint Conference on Artificial Intelligence-Volume 1* (Morgan Kaufman Publishers Inc., 1975), 151; Roger C. Schank and Robert P. Abelson, *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures* (New Jersey: Lawrence Erlbaum Associates, 1977), 10.

[19] Bateson discusses both traditional Balinese painting and Van Gogh, though not explicitly in relation to its psychological framing, elsewhere in *Steps to an Ecology of Mind*.

[20] Vivian Mercer, ‘The Uneventful Event’, *Irish Times*, 18 February 1956; Samuel Beckett, *Waiting for Godot: A Tragicomedy in Two Acts*, En Attendant Godot (London: Faber & Faber, 1956).

[21] Lucas would go on to produce successful franchises such as Star Wars and Indiana Jones. Note that in THX-1138, the character does eventually find others; the film may have been a little tedious otherwise. George Lucas, *THX 1138*, 1971.

[22] George Orwell, *Nineteen Eighty-Four* (London: Penguin Books, 2008). For more dystopian sci-fi, see for example, Yevgeny Zamyatin’s novel *We* (1921/4), Ayn Rand’s *Anthem* (1937), films such as *Metropolis* (1927), *Logan’s Run* (1976), *Alphaville* (1965). Yevgeny Zamyatin, *We*, trans. Bernard Guilbert Guerney (London: Cape, 1970); Ayn Rand, *Anthem* (Caldwell, Idaho: Caxton Printers, ltd., 1969); Michael Anderson, *Logan’s Run*, 1976.

[23] Albert Camus, *The Myth of Sisyphus*, trans. Justin O’Brien, 12, from the 1955 translation ed. (London, England: Penguin, 1955).

[24] M. Foucault, *Discipline and Punish: The Birth of the Prison*, trans. A Sheridon (New York, NY, USA: Vintage Books, 1977), 200–228.

[25] Ibid., 200.

[26] Ibid., 204.

[27] Please note that much of the technical development work for the Godot Machine was completed during my Masters research.

[28] *Ant Ballet* had the working title of *Physical Virus* for several months; however, the more absurda (and memorable) title was settled upon thanks to a conversation with Abi Palmer.

[29] Examples include the residents of the town in Ionesco’s *Rhinoceros*, who one by one turn into rhinoceroses, against their will, and the two protagonists in Beckett’s *Waiting for Godot*, who are continually waiting for a person they do not know for equally unclear reasons. Eugène Ionesco, *Rhinoceros*, trans. Martin Crimp (Faber & Faber, 2007); Beckett, *Waiting for Godot: A Tragicomedy in Two Acts*.

[30] Ant pheromones are used for conveying several types of information: sex, aggregation, dispersal, alarm, territory and surface pheromones all exist in various ant species. Sex pheromones bring ants together for the purpose of mating. (Brian D. Jackson and E. David Morgan, ‘Insect Chemical Communication: Pheromones and Exocrine Glands of Ants’, *Chemoecology* 4, no. 3 (1993): 126, <https://doi.org/10.1007/BF01256548>.) Aggregation pheromones simply ‘cause members of the same species to aggregate in a particular area […] for mating or to a food source or a suitable habitat.’ (Ibid., 127.) Dispersal pheromones, also known as spacing pheromones, and used to regulate or prevent overcrowding of food sources, etc. (Ibid.) Surface pheromones, also known as cuticular hydrocarbons, these pheromones exist on ants’ body surfaces and allow them to identify which colony other ants belong to. This is particularly important for food exchange. (Ibid., 130.)

[31] One of the major authors on this subject is Marco Dorigo, who has published numerous papers detailing the systems that ants use and the computer models of these as applied to computer science challenges such as the travelling salesman problem. See for example: Marco Dorigo, V. Maniezzo, and A. Colorni, ‘The Ant System: An Autocatalytic Optimizing Process’ (Technical report, 1991); Marco Dorigo, Vittorio Maniezzo, and Alberto Colorni, ‘Positive Feedback as a Search Strategy’ (Milan: Politechnico di Milano, 1991); A. Colorni, M. Dorigo, and V. Maniezzo, ‘Distributed Optimization by Ant Colonies’, vol. 142 (Proceedings of the first European conference on artificial life, Paris, France, 1991), 134–42; Marco Dorigo, Gianni Di Caro, and Luca M Gambardella, ‘Ant Algorithms for Discrete Optimization’, *Artificial Life* 5, no. 2 (1999): 137–72; M. Dorigo and T. Stützle, *Ant Colony Optimization*, A Bradford Book (Cambridge, MA; London, UK: Bradford Book, MIT Press, 2004).

[32] William Myers, *Bio Art: Altered Realities* (Thames & Hudson, 2015), 192–94.

[33] Stanley Kubrick, *Dr. Strangelove (Or How I Learned to Stop Worrying and Love the Bomb)*, 1964.

[34] Kubrick himself appears to have been aware of this similarity: after the film’s release, he sent a press clipping reviewing the film entitled *The Movie of the Absurd* to the head of Polaris Productions. Stanley Kubrick, ‘The Movie of the Absurd: Press Clipping Sent from Staley Kubrick to Nathan Weiss’, n.d., SK/11/9/50, The Kubrick Archive, London College of Communication.

[35] Fred Kaplan, ‘Truth Stranger Than “Strangelove”’, *New York Times*, 10 October 2004, Online edition, <http://www.nytimes.com/2004/10/10/movies/truth-stranger-than-strangelove.html>. Note that one exception to this accuracy in the is the War Room itself.

[36] Gene D. Phillips and Rodney Hill, *The Encyclopedia of Stanley Kubrick*, Great Filmmakers (New York, NY: Facts on File, 2002), 88; Kaplan, ‘Truth Stranger Than “Strangelove”’.

[37] Myers, *Bio Art*, 192.

[38] The exhibition was in the BUGS building at ZSL London Zoo from November 2011 until May 2012, curated by Bridget Nicholls of the insect-arts organisation Pestival.

[39] This was a compromise instated due to budget constraints, the extreme natural light levels in the room, and their impact on the projections.

[40] Myers, *Bio Art*, 192–95.

[41] This form of educational entertainment is sometimes given the portmanteau ‘edutainment’. See, for example, Greg Beato, ‘Turning to Education for Fun’, *The New York Times*, 19 March 2015, Online edition, <https://www.nytimes.com/2015/03/20/education/turning-to-education-for-fun.html>.

[42] See Andrew Barry, Georgina Born, and Marilyn Strathern, ‘Interdisciplinarity and Society: A Critical Comparative Study: Full Research Report’ (Swindon: ESRC, 2007); Andrew Barry, Georgina Born, and Gisa Weszkalnys, ‘Logics of Interdisciplinarity’, *Economy and Society* 37, no. 1 (February 2008): 20–49, <https://doi.org/10.1080/03085140701760841>; Georgina Born and Andrew Barry, ‘Art-Science’, *Journal of Cultural Economy* 3, no. 1 (2010): 103–19, <https://doi.org/10.1080/17530351003617610>; Andrew Barry and Georgina Born, *Interdisciplinarity: Reconfigurations of the Social and Natural Sciences*, Culture, Economy and the Social (Taylor & Francis, 2013).

[43] Born and Barry, ‘Art-Science’, 103.

Sci-art is known by numerous monikers: the Wellcome Trust variously use *sciart* and *sci-art*; Born and Barry use *art-science*; Weszkalnys uses *science-art*. The terms all have rough equivalence. For the sakes of clarity, I will use *sci-art* unless quoting from a source who uses a different term.

[44] Ibid., 108.; see also Paul Glinkowski and Anne Bamford, *Insight and Exchange: An Evaluation of the Wellcome Trust’s Sciart Programme* (Wellcome Trust London, 2009), <http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh\_grants/documents/web\_document/wtx057228.pdf>.

[45] C. P. Snow, ‘The Rede Lecture, 1959’, *The Two Cultures: And a Second Look (London: Cambridge University Press, 1964)*, 1964. The Two Cultures is referred to by several recent reports on sci-art: see, for example Glinkowski and Bamford, *Insight and Exchange*; Born and Barry, ‘Art-Science’. For *The Two Cultures* in popular culture, see for example, BBC Radio 4’s coverage of Snow: Melvyn Bragg, ‘The Value of Culture: Two Cultures’, *BBC* (London, England: BBC Radio 4, 2 January 2013), <http://www.bbc.co.uk/programmes/b01phhy5>.

[46] Snow, ‘The Rede Lecture, 1959’.

[47] Glinkowski and Bamford, *Insight and Exchange*; Born and Barry, ‘Art-Science’.

[48] Barry, Born, and Weszkalnys, ‘Logics of Interdisciplinarity’, 29.

[49] Born and Barry, ‘Art-Science’, 108.

[50] Glinkowski and Bamford, *Insight and Exchange*, 9.

[51] Born and Barry, ‘Art-Science’, 104.

[52] I must again thank Heechan Park for the help in constructing the exhibition.

[53] The project was called Open\_Sailing (now *Open\_H20* and *Protei*), initiated by Cesar Harada in the Royal College of Art’s Design Interactions department.

[54] In 2012 FutureEverything’s festival included: a performance of Matthew Herbert’s *One Pig*, a musical show documenting the soundtrack of a pig’s entire life; sound installations by Daniel Jones and Matthew Bulley; interactive video work by Kasia Molga and Brendan Walker; thousands of small clay figurines being distributed across Manchester by artist Laurence Epps; conference presentations from Icelandic MP and WikiLeaks collaborator Brigitta Jonsdottir, and then-MP of Art and Culture Ed Vaisey.

[55] The key curator in the exhibition was Deborah Kell.

[56] I wish to thank Heechan Park again for his help in the construction of this machine.

[57] The first and third screens used a pastel pink background, whilst the second and fourth used a pastel turquoise.

[58] Stanley Kubrick, *2001: A Space Odyssey* (Metro Goldwyn-Meyer, 1968).

[59] The exhibition also featured on the influential art blog *We Make Money Not Art*, and was subsequently featured in *Wired* *Magazine*, as well as others. Regine Debatty, ‘An Ant Ballet at FutureEverything’, *We Make Money Not Art* (blog), 17 May 2012, <http://we-make-money-not-art.com/futureeverything/>; Jeremy Kingsley, ‘Colony Choreography: Making Ants Dance with Synthesised Pheromones’, Wired UK, 17 October 2012, <http://www.wired.co.uk/article/colony-choreography>.

[60] Born and Barry, ‘Art-Science’.

[61] Ibid., 105.

[62] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, Fourth (University of Chicago Press, 2012).

[63] Ibid., 42.

[64] Ibid., 15.

[65] Born and Barry, ‘Art-Science’, 116. Original emphasis. The term *epideixis* was defined in the manner Born and Barry describe by Cassin, and discussed by Arendt.

[66] Ibid. Original emphasis.

[67] Sandrine Ceurstemont, ‘Artificial Pheromone Controls Invasive Ant Dance’, *New Scientist TV* (blog), 17 March 2012, <https://www.newscientist.com/blogs/nstv/2012/03/artificial-pheromone-controls-invasive-ant-dance.html>; Graham Lawton, ‘Fleadom or Death: Reviving the Art of the Flea Circus’, *New Scientist* 216, no. 2896–2897 (2012): 53–55, <https://doi.org/https://doi.org/10.1016/S0262-4079(12)63266-7>; Myers, *Bio Art*.

Performing Data Structures *Nybble and Scriptych* ==========================

Much of my design practice involves computer scripting. In the previous chapter, I described two projects which relied heavily on computer scripting: *Ant Ballet* used an inverse-kinematics programme to drive its robot arm and spread pheromones; the *Godot Machine* used a programme which used computer vision to drive the movement of a ball.[1] Chapter 3 introduces two projects, *86400* and *24fps Psycho*, where I used computational scripting to generate new films from archival footage.[2] I regard the act of writing code itself a design process: it requires a mode of thought that is procedural and concentrated; it is distinct from drawing, yet offers a similarly iterative process of refinement and improvement. This chapter will discuss the way in which designers, and in particular I, think *about code* and think *in code*. It begins with an introduction to principles of code writing, and a pair of code-diagramming precedents used by Italo Calvino and Alan Turing. It then presents two projects that form part of my research and design portfolio as part of this PhD, both of which use different principles and methodologies to frame a conversation around thinking about code.

My introduction to writing code seriously (besides playing around with website creation in the early 2000s) came when I joined the Bartlett. I took a series of classes in the Interactive Architecture Lab which introduced me to two languages which I would then use for almost every project for the next few years: Processing and Arduino.[3] Both languages are open-source, and were specifically written to enable artists and designers easy access to higher-level computer compiling languages and microcontrollers. Both also call their files ‘sketches’ – a tactical decision which both unites digital and analogue practices. The ‘sketch’ (rather than, say, *file*, *script*, *document*, or *programme*) contains clear implicit meaning: firstly, that code itself need not be daunting; writing a prototypical piece of code should be as natural as drawing on paper. Secondly, the nomenclature aims to position writing code squarely into the early stages of design process, rather than being an additional thing to think about after the designing is done. Both languages offer exactly the promises Ousterhout described in his article on scripting, and these languages acted as a bridging tool for me to learn more advanced modes of programming.[4]

The form of integrated coding I experienced at the Bartlett seems to reflect the pedagogical practices I have witnessed first-hand at several other design schools over the past few years. Today, it is not uncommon to see parametric scripting, small electronic prototypes, applications and websites, or other various coded outcomes to student projects.[5] As discussed in the introduction to this thesis, some teaching methods relating to particular aspects of scripting culture, namely parametricist design practice, are highly exclusionary, and rely on rote copying-and-pasting of code examples, or rely extensively on particular libraries and algorithms which are then unquestioningly repeated.[6] But other aspects of the computer-scripting world are relatively easy to inhabit as an autodidact; there are numerous tutorials, example files, libraries, forums, and so on online, which can be used to extend pre-existing skills. My own entry to coding was via classes at the Bartlett, but once I knew the basics of a couple of languages, and knew where to look, and what to look for, extending my vocabulary and skillset was simply a matter of investing time, and being willing to make mistakes. My intention in writing code is different to the traditional computer programmer, for whom lean, efficient code which performs to the highest standard technically possible is often the goal; I aim to use code and code-based thought to investigate, to learn, or to express design intent.

## Code writing and code thinking

In most instances, before I write code, I use several diagrammatic techniques to work out what I want the code do. These could be in the form of pseudo-code, state transition diagrams, flow charts, or diagrams of code-based ‘mechanisms’, with labelled inputs, outputs and procedures.[7] These diagrams are functional sketches; they show a potential solution to some form of data processing. Like working sketches, they are often altered, improved upon, or superseded later in the design process. Their function is to enable me to mentally model what is going to be happening within the computer itself, to interrogate the logic and data-flows, and make improvements before the functions are obfuscated by interdependent lines of code written in a specific language.

Although arguably becoming more central to certain designers’ process, writing code does require modes of practice that are in themselves distinct from other design processes. Code is written in *code* *language*, and like spoken languages, code languages require learning, practice and often an attitudinal change with regards to the way in which things are done. Communities of people who write code are often tribe-like in their allegiance, and code languages tend to impose a mode of working that cause them to be particularly suited to certain tasks or workflows. PHP, a scripting language used primarily on websites, for example, is notorious for quick development (although lamented by many computer programmers for being ‘dirty’);[8] Python and its associated communities pride themselves on the ‘Zen of Python’ and use terms such as ‘pythonic’ to describe best practice when writing in the language.[9]

The essential process that one enters when diagramming a computer programme is the mental modelling of the programme they are going to write. In essence, one must think *as* a computer; to understand how at each step the programme will store, retrieve and manipulate symbols, variables, and objects. To draw a linguistic analogy, we might think about the difference between *having* and *being* in English and Spanish. In English, we draw no grammatical distinction between the state of *being* implicit in human gender, age, activity, or state of sensing (e.g. warm/cold). However, in Spanish, each of these attributes is approached differently:

Whilst in both English and Spanish, the solution to being (or having) cold may be to turn the radiator up, the effect of the temperature rise is expressed differently; in English, it refers to a state of being (*I am cold*) and in Spanish the state of being is expressed through a possessed attribute (*tengo frio*: *I have cold*). The presence of temporary and permanent states of being (e.g. *estoy* / *soy*) make the quick articulation of a vocation, as opposed to a temporary task, a simple verbal substitution, whereas in English, this would be declared or implied through context. This is a similar nuance to differing modes of computer programming: the object-oriented programmer may create a class of objects that store a variable for coldness (the equivalent of *being* cold), whereas another programming language may create a series of objects where ‘coldness’ is a secondary, external variable (the equivalent of *having* cold). Another may invoke coldness as a state. The differences in the handling of virtual objects, the changing of states and attributes, and the order in which things are processed, all contribute to the utility of a language at certain tasks.

Much of the time in my own practice, I use flow-charts, draw data flows, and write pseudo-code to work out the effect I would like my programme to have. This then allows me to put ‘sample data’ through the virtual programme and see the effect. For example, here is a sample piece of pseudo-code for a thermostat, designed to run continuously:

\*\*\*Turning radiator ON for 5 SECONDS increases temperature by 1º. Leaving radiator OFF for 30 SECONDS decreases temperature by 1º. Every 5 SECONDS, read TEMPERATURE:

* If TEMPERATURE less than TARGET, switch radiator ON.
* If TEMPERATURE larger than or equal to TARGET, switch radiator OFF.\*\*\*

I would then ‘run’ this code several times on paper, writing down different starting temperatures, and the results as I went along.[10] Once I was happy that the pseudo-code would deliver my desired results, I would then turn this into real code (the following to be run in Python):

***target = 18 currentTemp = getTemp()***[11] ***if (currentTemp < target): radiator = 1 else if (radiator > 1): radiator = 0***

This process is not unusual for a programmer. Pseudo-code and flowcharts formed part of my first code lessons; the methodology is rife online, and anecdotally, every programmer I have spoken to about the subject uses some form of pseudo-coding if they are mounting a complex task.

Another well-known pseudo-coder was Italo Calvino. As discussed in this thesis’ introduction, Calvino was a member of the Oulipo and active experimenter with combinatorial forms of story writing. Calvino described his early theories of combinatorial writing in his 1967 lecture *Cybernetics and Ghosts*.[12] Alluding the theory of DNA, which enables ‘the endless variety of living forms’ to be ‘reduced to a combination of certain finite quantities’, he turns the same logic to linguistics:[13]

Here again, it is information theory that imposes its patterns. The processes that appeared most resistant to a formulation on terms of number, to a quantitative description, are not translated into mathematical patterns.[14]

This is perhaps most exemplified with the story the ‘Burning of the Abominable House’*.*[15] In writing this story, which was itself based on combinatory principles, Calvino effectively *became* the computer, running his pseudo-code instructions line by line to create enough possible permutations to tell the story. His widow, Esther Calvino, recounts:

There had been a somewhat vague request from IBM: how far was it possible to write a story using the computer? This was in 1973 in Paris when it wasn’t easy to gain access to data processing equipment. Undaunted, Calvino gave the project a great deal of his time, carrying out all of the operations himself. The story was finally published in the Italian edition of *Playboy*. Calvino didn’t really feel this was a problem, although he had originally planned for it to be published in *Oulipo* as an example of *ars combinatoria* and a challenge to his own mathematical abilities.[16]

The expense of computers did not just create human-computers of Italian writers in the 1970s. Alan Turing, whose 1936 paper ‘On computable numbers, with an application to the Entscheidungsproblem’ set forth the concept of the universal computing machine (the basis of every modern computer), and whose pioneering work developing early computers led to the cracking of the Enigma code (shortening WWII by several years), was himself unable to access a computer in 1951 whilst trying to write a programme that enabled a digital computer to play chess.[17] Turing was convinced that programming computers to solve complex problems such as playing chess would yield unexpected advances in other sectors:

Research into the techniques of programming may in fact lead to quite important advances, and help in serious business and economics – perhaps, regrettably, even in the theory of war[.][18]

His first attempts at writing a chess programme were on paper, without computer, and he tested them by playing friends and secretaries – with Turing playing the role of computer himself, running through the algorithms for each move.[19] Turing used the concept of computers playing chess to argue the following principle:

If one can explain quite unambiguously in English, with the aid of mathematical symbols if required, how a calculation is to be done, then it is always possible to programme any digital computer to do that calculation, provided the storage capacity is adequate.[20]

The idea of becoming a human computer to complete complex mathematical tasks seems absurda today, when so much of our contemporary calculation is done via digital computers. It would seem even more absurda if the person doing the computing were a famous author, or played a significant role in the devising of computers. But as both Nancy Katherine Hayles and David Allen Grier note, *human computers* (a job predominantly performed by women), were commonplace in the 1930s and 40s.[21] Carrying out large, often mundane, calculations required that banks of women may work together on separate parts of the same task. It is only in 1946, after the pioneering work of John von Nuemann and Alan Turing, that the term came to mean a non-human device which would calculate. The first OED citation of term ‘computer’ is in fact from 1613, referring to a person who makes calculations. Grier claims that ‘the start of large-scale scientific research’ now ‘known informally as “big science”’ can be ‘traced to the [human] computing offices of the eighteenth and nineteenth centuries.’[22]

Today, however, digital computation is increasingly ubiquitous. ‘Cloud-based’ computing, ‘internet of things’, smartphones, and digital assistants such as Google Assistant and Amazon Alexa have all emerged in the past few years, and all bear the promise of extending the reach of computation.[23] The systems behind Google Assistant and Amazon Alexa in particular are marketed as making use of artificial intelligence and/or machine learning, two widely used terms that are now even commonly found in tabloid news headlines.[24] Many large-scale consumer technology companies (Google, Apple, Facebook, Amazon, and more) are investing in artificial intelligence research;[25] machine learning is also at the heart of emerging self-piloting technologies such self-driving cars and delivery drones.[26] The recent boom in artificial intelligence is not the first; theoretical and practical research in the field has been carried out for at least fifty years. An earlier boom in research in the late 1970s and early 1980s was in part fuelled by researchers such as Minsky, and Schank and Abelson; the subject was so prevalent in the public consciousness that in 1984, the BBC commissioned philosopher John Searle to give the Corporation’s annual Reith Lectures on advances in computing, artificial intelligence, and their potential philosophical ramifications.[27]

Searle is best known for his Chinese Room argument, which functions as a ‘refutation of strong artificial intelligence.’[28] Introduced in a paper entitled ‘Minds, Brains, and Programs’ in 1980, the debate around the implications and validity of the argument is still raging today.[29] The argument was originally posed as a response to researchers such as Schank and Abelson, who advocated that artificial intelligence programmes which could make use of linguistic scene-recognition would in some way be able to express understanding of scenes;[30] Searle advocates strongly against this viewpoint, arguing that computers will never be able to understand in the way that humans do, even if they can pass the Turing Test.[31] Searle summarises the argument concisely as follows:

Imagine a native English speaker, let’s say a man, who knows no Chinese locked in a room full of boxes of Chinese symbols (a data base) together with a book of instructions for manipulating the symbols (the program). Imagine that people outside the room send in other Chinese symbols which, unknown to the person in the room, are questions in Chinese (the input). And imagine that by following the instructions in the program the man in the room is able to pass out Chinese symbols that are correct answers to the questions (the output). The program enables the person in the room to pass the Turing test for understanding Chinese, but he does not understand a word of Chinese.

The point of the argument is this: if the man in the room does not understand Chinese on the basis of implementing the appropriate program for understanding Chinese, then neither does any other digital computer solely on that basis because no computer, qua computer, has anything the man does not have.[32]

I was drawn to the Chinese Room argument due to its inherently analogue reasoning about the nature of artificial intelligence (the metaphor does not rely on a digital computer *per se*), and the implicit spatial and performative nature of the images elicited by Searle’s description. Through a diagram, purely described in language, Searle is able to make a rational, yet performative argument which challenges pre-existing notions about concepts such as mind and cognition.[33] *Nybble* is a project I developed which sought to make explicit the diagram Searle described through the participation of a bank of distinctly non-digital *human computers* blindly following instruction. It was performed in a digital festival in 2013. Three years later, *Scriptych* was a project which employed machine learning techniques to create a new mode of interaction with a computer database, using spatial metaphors to think about multi-dimensional data structures. It was performed in the Opera Garnier in Paris, by dancers from the Opera itself, although in an area not traditionally used for the company’s performances. Both projects made use of dancers and were performances, and both did not make a traditional computer interface (i.e. screen) visible.

## *Nybble*

In June 2013, I was an exhibitor in the V&A Museum’s Digital Design Weekend. This annual celebration, which I had first attended in 2009, coincided with the final weekend of London Design Festival, in which the V&A were also participants. As such, it attracted large amounts of people interested in both digital culture and design. I was approached by the Digital Programmes Manager, Irini Papadimitriou, with whom I discussed creating a new piece of work to engage people with the concepts *surrounding* computation, rather than showcasing a new piece of computational artwork. Earlier that year, and completely independently, I had been a participant in a workshop run by an Arts and Humanities Research Council (AHRC) research consortium between the V&A Museum and UCL’s Centre for Sustainable Heritage entitled Design with Heritage (DwH). The consortium’s aim was to investigate potential ways in which new and emerging technology could be used to enhance and augment exhibitions and artefacts within museums, and their working method was to gather industry professionals and independent practitioners together in intensive one-day workshops to rapidly identify and propose projects to investigate issues surrounding two topics: potential new methods in which existing and emerging technology could be used to enhance and augment exhibitions and artefacts within museums. I was fortunate to be awarded a small grant to investigate audience navigation in museums, which was used to produce the project that became *Nybble*.

At the time, the concept of artificial intelligence and machine learning was re-entering the public consciousness, and more media coverage was devoted to the subject. I had recently heard about Turing’s chess programme and began my engagement in issues surrounding machine learning and artificial intelligence.[34] I had also taught students computer programming and electronics via Arduino and Processing, and consistently found that students who were otherwise well-versed in using computers for advanced design purposes were often ill-able to describe the underlying principles of computing, or the lineage of technological and philosophical development which had led to the computers we use every day. It seemed that there was a widespread misconception about what a computer is and does; the focus in media representation of technology is often concerned with the form factor technology adopts (e.g. the specifications and aesthetics of a new gadget) rather than the wider ramifications of what it can do, and how this affects society. The aforementioned works of Turing and Searle had both been conducted without the use of digital computers, yet their work continues to have resonance today. I wanted to create a work Digital Design Weekend where computation was on display, but a digital computer was not.

I decided that an exhibition whereby a bank of humans could act out the inner workings of a computer, much like Calvino and Turing had done, would be an interesting way to present computation. The humans would form part of a huge computer, calculating something that only an audience would see; thus, the human computers inside the installation, would be acting out Searle’s Chinese Room argument. This would be a larger-scale version of the type of diagramming that I had previously attempted with the *Godot Machine* and *Ant Ballet*. The performance would also extend my work into the world of the Absurd, though through an inversion of the traditional Absurdist performance; if the absurdb is constructed through an ultimately doomed quest to find meaning in a universe devoid of it,[35] this piece would appear devoid of meaning for its performers and audience without a ‘key’, yet deliver an arbitrary message to those determined enough to persist and try to crack the code.

This structure was influenced by the arguably absurdb 1959 novel *The* *Sirens of Titan* by Kurt Vonnegut.[36] The punch-line of the sci-fi story is that the whole of humanity’s development and progress – technology, languages, religions, and culture – have in fact been mysteriously influenced by forces from afar, in order that an elaborate and highly specific life-trajectory would be taken by one man, resulting in war on earth and mass destruction – all so that one small part of a broken machine on Mars would be replaced, enabling it to continue its journey across the universe to deliver a message. Finally, it is revealed that the message itself consists of a single point, meaning ‘Greetings’ in its native language.[37] Although smaller in scale, and notably devoid of conspiracy theory-paranoia, this project would ask audience and participants to decode something that tested the limits of their perception (and patience), yet itself conveyed a meaningless message, echoing the absurdb assertion that humanity is doomed to search for meaning in a universe devoid of it. Many of the concepts surrounding this idea were the result of conversations with colleagues in who shared a studio, co-tutors, my PhD supervisors, and my frequent collaborator, Abi Palmer.

### Methodology

Please note, for the sake of clarity, the project is presented here in thematic, rather than strictly chronological order. Much of the project development, as with most projects I work on, occurred concurrently as a result of the design process.

Early in the design process, I began researching the mechanics of computation. The part of a computer that is most like the process that the Chinese Room argument describes is the Central Processing Unit (CPU). The primary function of computers is to interpret and manipulate symbols; and in order to process information in the correct order, a precise timing mechanism is required. This acts as a synchronisation and sequencing device that ensures information is processed in the right order.

The process of parsing characters from binary information held in a computer’s memory to symbols occurs every time a character is displayed on a computer screen. In essence, it is the most basic process a computer can do. At the simplest level, a sentence stored in computer memory is a string of binary bits – in the case of magnetic hard drive, these are magnetically charged particles that are either in an *on* or *off* state (represented as a ***1*** or a ***0***).[38] In the case of the 1972 American Standard Code for Information Interchange (ASCII), a common text-storage system, seven bits are used to represent any one of 128 characters, encompassing capital and lowercase letters, numbers, punctuation symbols and computer teletype instructions (see Figure 2-20). For example, the uppercase letter *H* is represented by ***0001001***. A sentence could be represented by simply stringing multiple strings together – so *Hello* would be ***0001001 1010011 0011011 0011011 1111011***.[39] I decided that parsing information, character by character, would be an appropriate subject for the performance to diagram. I also decided that it would be interesting to employ a bank of human computers to parse information through dance, standing in the V&A Museum. This would fit with the principles that I sought to investigate through the DwH programme, as well as display a computational principle for the Digital Design Weekend.

I then needed a means of making the performance as visible as possible – and changing the way that people moved around the space. The mode of operation would have to employ some sort of binary state in order to unambiguously reflect digital storage, conveying information in a highly visible way, but still require the audience to decode it. Like a CPU, whose internal clock is invisible to a computer user, the internal instructions fed to each dancer would be hidden from the public, yet synchronise the actions of the dancers. I decided to use four dancers because that would simultaneously allow for a multitude of characters to be conveyed via a lookup table, and provide a means of making the performance large, and visible to the public. The early considerations about the scale and array of dancers also took into account the way the performance would be recorded on video; the performance was designed with filmic intentions from its initial conception.

I commissioned costume designer Magdalena Gustafson to work on costumes that would extend the physical reach of the designers. Being interested in the binary nature of the movements the dancers would be able to move to, we devised a system whereby each dancer would wear two large ‘sails’, around 3.4m high, which would attach to their back via a pair of masts affixed to a backpack (the backpacks themselves were constructed from modified baby transporters; the poles were modified lightweight fishing rods). The ‘boom’ of each sail would be held in the dancers’ hand, and extend their reach by approximately 2.2m in each direction. This would allow the dancers to use a semaphore-like mode of signalling to move into one of four positions: both sails down; both sails up; left-hand sail down/right-hand sail up; right-hand sail down/left-hand sail up; and both sails down. These positions were called ***0-3*** (in computing, zero is usually the first number that is used for counting).

I worked with the curator to find a site suitable for the dance so that dancers, wearing large bodily extensions, could exhibit safely. Internal spaces within the institution are highly regulated due to the number of valuable artefacts. We decided to place the dancers in the John Madjeski Garden: it had high visibility, and an almost stage-like setup around a pond, and the people there tended to be taking a ‘break’ from the main exhibition spaces to eat and drink – in short, a captive audience. The costume designer and I decided to use bold, electric blue and light green colours for the sails, both to compliment the iconic Dale Chihuly chandelier in the V&A’s main entrance (the first thing most people see on entering the museum), and to stand out against the vivid orange of the bricks within the courtyard. The sails would have a clear directionality; if the dancer were facing towards the audience, they would only see blue, whereas rear-facing dancers would reveal a flash of bright green, aiding the interpretation of the code the dancers would be parsing.

The development of the code was an area that required solving early in the process. Abi, who become be the controller, and I discussed multiple possibilities, but our priority was the ease and accuracy of conveying a message to each of the dancers on the day, telling them what to do. We decided to use a walkie-talkie system to communicate with the dancers; this would enable the transmission of instructions without the public’s knowledge. We decided on a message to parse: a popular misquote from Beckett’s *Waiting for Godot* which accurately encapsulated what the dancers would actually be doing:

Dance first. Think later. It’s the natural order.[40]

The use of a misquote was a conscious decision; the message was sufficiently meaningless, and devoid of context, that the entire dance could be rendered absurda and absurdb. In order to ensure that the dancers accurately represented Searle’s argument, none were told the message until after all the performances were over.

The next decision was about the code-table that the dancers would be effectively parsing. Four dancers moving to four different positions, and each facing one of two directions simultaneously could represent 512 potential symbols in an ASCII-style table. This was far too much detail – if the overall dance were to portray a message in English, it would require only capital or lowercase letters (52), plus a small array of punctuation symbols. In order that the audience stood some chance of being able to interpret the dance, I reduced the potential symbols the dancers could represent to 64. The dancers would all move simultaneously to one of the four listed positions above (representing the column in Figure 2-19) and the direction that the dancers faced would indicate the row. With this table configuration, the word ‘Hello’ would consist of five moves.[41] This was, technically, a sub-optimal mode of information storage – I could have used a lookup table which utilised each of the dancers’ four positions in two directions separately, giving 4096 symbols, but had no real need for this level of complexity. It also aided the process of telling the dancers what to do: they were universally told to move to the same ‘position’, but the direction they faced was an individual variable.

In order to enable the creation of a set of instructions for the controller to read, which would contain all 196 dancer positions to convey the 49 characters in the message, along with the dancers’ names, I built a simple programme in a Microsoft Excel spreadsheet that would provide detailed instructions, character-by-character, for each of the dancers. The task may have been easier to carry out in a lower-level programming language, using a simple three-dimensional array, but I enjoyed the absurda nature of using a spreadsheet to determine an artistic performance. I believe that the spreadsheet is a largely unseen influential force in artistic and architectural practice; much of the work of producing a performance such as *Nybble* is balanced through the spreadsheets which carry the financial budgets and task and time allocation. The impact of the Excel spreadsheet is perhaps one of the most mundane, yet influential, means by which numerous decisions are really made within both art and design. I also took pleasure in using mundane, office-related software to drive an artwork in a festival which is supposed to celebrate the radical newness of digital design.

The dance sequencing itself was devised partly through dance workshops (which will be discussed later), but mostly through the assessment of how CPUs handle information stored in memory. When retrieving information from Random Access Memory (RAM), 50% of the memory is used as address; that is, merely to *locate* the information the computer is to process, whilst the other 50% is used to store the information itself. This implied that around half of the time spent processing information is spent locating it, or preparing to process. The dance we would carry out would follow a similar formula; the dancers would spend half of their time receiving instructions, and half of the time ‘processing’ them. Of course, this would happen at an order of magnitude slower than a digital computer; parsing the 49 characters of the message we conveyed would take approximately 25 minutes. Each symbol being represented would be one move; a position for all the dancers to collectively move to, and a direction for each one to face individually. The instructions, and synchronisation cues, would be delivered by the controller (played by Abi) who would speak into a walkie-talkie over the top of a synchronisation soundtrack.

### Soundtrack

As a CPU is dependent on its internal clock for synchronisation, the dancers in *Nybble* would use a hidden timing mechanism to stay synchronised. This would enable the bank of dancers, who would be positioned several metres apart, to receive instructions and coordinate their moves to match each other. The dancers would each wear a walkie-talkie radio with an earpiece, tuned to the same frequency. At the other end, the controller would transmit a timing signal and instructions to the dancers. This meant that the signals of the soundtrack would have to be easily intelligible via a low-resolution radio bandwidth. In addition, I wanted the soundtrack to have the audio aesthetic of the 1940-50s Britain which Alan Turing had inhabited, and echoes of the Shipping Forecast. This last influence was of particular importance as I have been an avid listener of the late-night Shipping Forecast on BBC Radio 4 for years, enjoying its soothing and rhythmic mode of delivering semi-coded information, yet never really known what the numbers meant – a similar state to how I imagined the audience would receive this work.

The audio track would have to be distinctive, carrying both spoken and audio cues, so that if one of the radios ceased functioning, or the whole message did not transmit, the dancers could still quickly assess where they were in the sequence. Every second, a computer-generated, austere male voice would announce a count, between two and eight, with the ‘one’ count being replaced by the instruction to ‘hold’ or ‘go’ – that is, the dancers should adopt their pause positions or move. Between count, a sine wave beep (much like the ‘pips’ before the hour on BBC Radio 4) would play to establish continuity, and at the final count of the bar, a double-count would play:

***Hold pip 2 pip 3 pip 4 pip 5 pip 6 pip 7 pip 8 pip, pip Go! pip 2 pip 3 pip 4 pip 5 pip 6 pip 7 pip 8 pip, pip***

In the time when dancers were transitioning between positions, they would be given an instruction as to how to move (e.g. ‘fire’, ‘underwater’). These instructions were the result of three workshops in which Abi worked with the dancers and established the particularities of giving live instructions for them to work with. The dancers needed something to focus on whilst moving into position, and the variation that this improvisation provided in also served to provide visual interest for the audience. The synchronisation track and instructions were delivered via walkie-talkie; the synchronisation track, which was looped, was played on repeat through an iPod, the earpiece of which was taped to the microphone of the controller’s headset. This meant that the controller could speak over the soundtrack, and the low-resolution radios (designed for use in loud environments such as nightclubs) would transmit the loudest noise. Each dancer wore a walkie-talkie, clipped to their rucksack, and a one-way earpiece.

The installation’s name was chosen close to the work’s performance, and was the result of a conversation with artist and (at the time) co-tutor in the Interactive Architecture Lab, Ruairi Glynn. The name emerged through thinking about the quantity of information each dancer would convey; their four potential positions would be analogous to half a byte (eight ‘bits’) of information. Within computing, half a byte is known as a ***nybble*** – this is a word-play on the similarity of ***byte*** to ***bite***. The concision of the word, along with its implicit humility, summarised the ethos of the performance.

### Dancers

This project represents the first time I had worked with dancers, and my expertise in this field was minimal. My friend Andrea Mongenie, who had been a casting agent for the London Olympics opening ceremony, offered a wealth of advice. In order to attract attention to the project, I created a trailer film from promotional footage of IBM computational systems, taken from the Prelinger Archives.[42] The teaser was designed to illicit interest from potential dancers. It combined the following dialogue with images of a computer parsing text:

The computer is then given the problem in the form of numbers or instructions pertinent to arithmetic. It is the arithmetic logical task that the computer is organised to do. Once instructed, it can do as much arithmetic in a minute as a man in a lifetime.

A man in a lifetime…the lifetime of all mankind is but a brief moment in the long history of this earth of ours. And only yesterday in the history of mankind has man made any significant advance in his control over his earthly environment.[43]

I placed an advert on industry-standard casting websites, and held a casting session at a dance studio within UCL Union. We used a gender-blind system to track and rank candidates based on their experience, ability to receive and interpret instruction, hold a pose, and other relevant measures.[44] Once we had chosen the performers, Abi held three rehearsal sessions where the dancers were gradually introduced to the ideas contained within the performance, getting used to the bodily extensions that they would later be dancing with. In the third session, held in UCL’s Main Quad, the dancers were shown, and given the opportunity to test movement in a prototype costume made by Magdalena.

The performances were recorded, and time-lapses of the performance, an animated guide to the code-base, and the edited video showing the way in which the performance worked, can be found in this thesis’ accompanying media.

## Scriptych

Nearly three years after *Nybble*, during my residency at the Palais de Tokyo, I completed a second dance-based project, this time working in collaboration with the Opera de Paris (an arrangement that had been made by Ange Leccia, the founder and director of the Pavillon residency). The six artists who were resident would each team up with a choreographer and dancers from the Opera to create a performance or intervention in the publically-accessible areas of the Opera Garnier building for two evenings. We began working on this project as soon as we joined the Pavillon programme.[45]

In the intervening time between *Nybble* and *Scriptych*, advances in artificial intelligence and machine learning had been widely publicised through media, and truly entered the public discourse. One of the major advances that had come to my awareness was the use of high-dimensional vector spaces to transform complex problems, such as translating languages and recognising the content of images, into spatial problems – albeit spaces consisting of potentially hundreds of vectors. This means that, much as Searle argued over thirty years before, computers could solve problems with the appearance of understanding their context and meaning, when really they were working through mathematical means. The application of machine learning to solve problems that we might categorise as about meaning (e.g. image-recognition, linguistic analysis) has been explored extensively by teams at Google.[46]

With words, for example, the Word2vec algorithm (developed by Tomas Mikolov et al at Google) requires a huge dataset of words (the training dataset used is often the first 5 billion words from Wikipedia), which are then parsed into sentence form.[47] The algorithm tokenises all words, and sequentially calculates every words’ frequency, and its average distance from all other words. From this it can create a unique multi-dimensional vector for that word, consisting of several hundred dimensions. Through these complex word-vectors, implicit relationships between words emerge, allowing for a form of word-algebra to take place. The famous example that is regularly used to explain Word2vec is that the words for:

***(king – man) + woman = queen***

Similarly, the relationship between Athens and Greece is shown to be mathematically similar to Oslo and Norway (as is the relationship between brother and sister, and grandson and granddaughter), whilst common adjective-to-adverb relationships (e.g. apparent and apparently, rapid and rapidly) can be explained mathematically.[48] These word-relationships are common across languages, so that the vector for a word in English is likely to be similar to its equivalent in Spanish. As the MIT Technology Review reported in December 2014, a similar technique was tested with images.[49]

The reduction of language to a series of mathematical vectors which would only be legible to computers reminded me of the frequent communication breakdowns in plays of the Theatre of the Absurd. As I had previously done with Searle’s Chinese Room argument in *Nybble*, I wanted to carry out a new project to explore ideas surrounding this type of machine learning. I also wanted to carry out a performance in a way that experimented with a different approach to *Nybble*, developing a project that would contain scripting and rapid, iterative design as an integral part of the process in order to explore different modes of producing dance performances. However, I wished to retain the use of explicit constraints placed on performers.

In November 2015, the six artists in the Pavillon residency began having meetings with the Paris Opera in which artists would be paired with choreographers in order to produce an evening of performance in the Opera Garnier. From an early stage in the process, I knew that vector space would be intrinsic to the methodology of producing this work. In the period preceding the Opera project, I had spent two months in Chicago (where my partner had started a new job) before moving to Paris. Both transitions had made me question my own ability to communicate; I had become intrigued by the syntactic differences between British English and American English, which meant that I often struggled to, for example, order coffee – and in Paris, my grasp of French was pitiful. My own inability to communicate effectively became fuel and inspiration for *Scriptych*.

The first meeting with Opera was on the 19th of November. During this round-table discussion, I had expressed my desire to work with vector-space, and integrate some means of converting dancers’ movements into vectors, and consequently into words. Numerous dances contain ‘spatial conversations,’ whereby the movements of two or more dancers react to each other (or an audience), but this project would aim to take this idea a stage further: technologically mediated spatial conversations. The initial idea was primitive, and based solely around this principle; it was only when the true conversation and collaboration started between myself and the choreographer Simon Valastro that the performance evolved rapidly. This project was developed concurrently with other projects contained in this thesis – *Network / Intersect* and *24fps Psycho*, and its working title, until approximately one month before the performance took place, was, rather unoriginally, *Vector Space Translation*.

The group of artists visited the site of the performance, Opera de Garnier, both as building visitors, and to see several shows which featured the dancers and choreographers we would be working with. The building is much-discussed in architectural literature, and on one particularly memorable occasion we were taken on a long tour of the myriad hidden spaces which enable the building to operate: pulleys and levers under the stage, rehearsal studios, tunnels, and so on. The building appeared to function as a large machine inhabited by its dedicated staff. I was particularly taken by the grand staircase which is encountered immediately after entering the building from the main entrance: Forty writes of the building’s architect Charles Garnier’s belief that the stair ‘is one of the most important arrangements (*dispositions*) in theatres because it is indispensable to the ease of arranging the exits (*dégagements*) and the circulation, but more because it produces an artistic motif.’[50] Upon entering the theatre, I was struck by the staircase’s inherent theatricality; visitors were transformed into performers, elevated for all to see. The same was true of the balconies surrounding the staircase: spaces of high visibility, and also granting vistas to visitors. Opera Garnier is a building for socialising as much as seeing performances, and the staircase signals the beginning of a journey into theatricality. The building seemed to epitomise Gage’s statement that ‘Architecture is differentiated from building in that it is deemed to induce sensations of delight or wonder in its observers.’[51]

### Design process

My initial idea for the project revolved around translating dancers’ movement into vector-spatial data, converting this to words, and displaying some sort of ‘conversation’ between a pair of dancers. In order to prove this concept, I had to develop two things – an interface to interpret movement, and data to be interpreted. Over the period of January – March 2016, I experimented with Gensim, a Python-based framework for modelling with large datasets (which included Word2vec functions).[52] Over this period, I acquired multiple large-scale datasets (approximately 45Gb) and trained models with the intention of learning fundamentals of the principles to see the differing effects of various datasets and vector sizes, using online tutorials and guides.[53] My initial experiments yielded results that were of some use: it appeared that an optimum number of vectors was 300 per word, and ‘cleaner’ datasets yielded less erroneous results. However, each word library that I was creating was around 300,000-600,000 words, with words reflective of the miscellaneous sources: although the libraries contained many recognisable words and word-derivatives, they also contained highly technical words (e.g. ***obgyn***, ***vioxx***, ***bextra***), online abbreviations (e.g. ***wts***, ***fccjobs***, ***niccr***), mis-spelled or conjoined words (e.g. ***constructech***, ***advertisementbut***, ***supportfootnotes***) and some which were meaningless and bizarre (e.g. ***shinnecocks***, ***athanassios***, ***imclone***, ***limbaughricans***, ***ogio***).

The Gensim Word2vec Python library that I was using enabled several querying mechanisms: words could be directly queried (e.g. searching for the word ***king*** and returning its vector), or closest-match vectors could be calculated (e.g. searching for a particular vector and returning the closest word in the array of words in the ‘dictionary’). The latter is the technique used for the word-algebra described above: in the ***king – man + woman = ?*** example, the word ***queen*** is returned as a result of a search for the nearest vector once the mathematical calculation for ***king – man + woman*** has been done. This method would be the one I’d use for the Scriptych word-retrieval mechanism: the dancers’ movements would be converted into vectors, then the nearest word for that vector would be returned from the library. However, I would have to make significant changes to improve the quality, and reduce the quantity of words available in order to be able to retrieve any from human movements with a degree of accuracy. Doing this would entail devising a new way to conceptualise movement in space.

One of the technical problems to solve was precisely how the dancers’ moves would be translated into vectors. This was something developed through conversation with the choreographer and dancers, and a period of iterative design and testing in the Opera. After a few meetings, I was paired with the choreographer Simon Valastro.[54] Whilst approaching the project from two different angles, and with different levels of knowledge about each other’s disciplines, we shared common principles about the rules of the project: we both wanted to work on a project that would push both of us out of our comfort zones, with a high risk of failure; the performance would contain a narrative structure that could be interpreted by an audience, rather than simply being abstract dance; and we were both keen that the technology involved would have to really work, in real-time in front of an audience.

My initial design for the word-retrieval system was laughably absurda. It used the gyroscope data of an X-OSC board (a small wireless interface board with gyroscope and accelerometer built-in, which functioned much like the popular Arduino Uno microprocessor) and took 100 triple-axis measurements at intervals of 100ms to generate a 300-dimensional vector, which could then be used to retrieve a word. This meant that the dancers would have to be consistent in their movements, in each of three movement axes, thirty times in a row over three seconds (I conceived of this method since the introductory word-vector examples all encode words in 300 vectors). However, this level of precision is far greater than even the best industrial robot may be able to produce. It was comically bad. I began to meet Simon regularly morning to make the mechanisms responsive to the way he actually moved.

Each day, I would visit Simon’s studio in the Opera in the morning before his rehearsals so we could play with the latest version of the software. We would test the interface, and try to develop movements which would work. Then, after lunch, whilst he had to rehearse for the ballet he was working on (William Forsythe’s *Creation*), I would work on improving the code in line with new ideas from the day’s rehearsal. Our lunches proved fertile spaces for conversation about theoretical changes that could be made, which I would build though the afternoon and evening. This proved to be an extremely productive way of developing the interface, and the end result was a highly useable word-retrieval system that could be easily customised to suit the physiology of each user.

The two main barriers to achieving a usable interface point were the reduction of the size of the word library that Gensim/Word2vec created, and the number of vectors each word contained. Simon and I discussed the cinematic nature of the choreography we wanted to develop: the balconies of our site, seen from the opposite side of the Grand Hall, were at approximately a 16:9 ratio, the same as a film screen. Our audience would be international, and therefore, any project presenting spoken words would have to use a vocabulary that could be easily understood. We decided to generate a new library of words taken exclusively from Hollywood film dialogue, using the Cornel Movie Dialogues Corpus.[55] This resulted in a new library of 17,067 words, many more of which were far more intelligible than those generated earlier.[56] In addition, we realised that since our purposes for using the vector-space were different to most computer scientists – we would not be doing any complex word arithmetic or calculations – we would be able to encode the words in only three dimensions, instead of three hundred. This meant that we now had a three-dimensional database of words, a concept that is far easier to comprehend since both Simon and I were used to dealing in the three dimensions of the physical world.

The next challenge was to create a mode of locating words within this three-dimensional space. The simplest solution would have been to simply make the dancers move to access a physical position and touch a particular position, for example, with their fingertips, and perhaps use a depth-tracking sensor such as a Microsoft Kinect to measure the dancers. But there are limitations to this mode of movement, and we opted not to use this technique for several reasons. Firstly, the field of range for such sensors is not very large, and therefore the dancers would likely be restricted to a virtual ‘cube’ around their bodies. Secondly, this mode of interaction is a lot like the now tired touch-screen interfaces which have populated sci-fi films such as *Minority Report* for at least the past fifteen years.[57] A dance using an interface like this would simply be a rehashing of old ideas. And thirdly, the hardware required to make this happen would have to be fixed in place, in some way interfering with and ‘technologising’ the Opera Garnier.

As such, we worked with a different measurement of movement: the accelerometers and gyroscopes from a pair of iPhones. On one of our earliest meetings, Simon and I had switched to using our own iPhones instead of the X-OSC board. This had initially been a matter of convenience – the X-OSC had required a fiddly and unreliable setup process each time we met, which wasted a lot of our time. But both of us always had our iPhones to hand, which contained a multitude of sensors and wireless capacity which we would be able to use at any time. Using the app GyrOSC, we were able to take an iPhone’s internal sensor data and convert this to streaming Open Sound Control (OSC) messages.[58] The messages could then be received and interpreted by an instance of Max software running on my laptop computer, ready to be interpreted and used to loop up words in the database.[59] A further useful function of the GyrOSC software was the ability to remotely trigger a short vibration on the dancers’ phones from the computer, providing a means of invisible haptic feedback to the dancers. There were a few technical issues which we managed to resolve: the sensors in the different models of iPhone we had were calibrated differently, so the same movement gave different results or was prone to ‘slippage’ (which we resolved by replacing one of the phones for a newer, more accurate model). We also devised a means of affixing a phone to a dancers’ body after much trial and error: phones would be inserted into a small neoprene pouch (made by the Opera’s costume department) with a Velcro panel, the phones would be strapped to the underside of a dancers’ wrist via a black elasticated sports bandage. We settled on this location as it offered a wide range of articulation to be measured, yet enabled the phone itself to be relatively hidden. The use of the neoprene pouches hid the phones themselves, thus preventing the work being read as an advert for a certain technology – or even appearing to be phones. Furthermore, the addition of the sports-bandages enabled the development of a ritualistic process of strapping for each dancer, which we would integrate into the first ‘act’ of the performance.

For the vector-library interface, I developed a novel technique of converting the dancers’ movements to words. Each dancer would have a phone strapped to their right wrist, which would continuously transmit their respective live gyroscope and accelerometer data across a Wi-Fi network to my laptop. This data, labelled ***d1*** or ***d2*** depending on the phone, would be picked up via Max software. Max would then map these numbers to a range of values. However, these values would only be recorded if Max was in a designated ‘listen’ mode.

The ***x/y/z*** gyroscope information read by Max was converted to an integer from ***0-3*** (4 total values). This meant that any angle reached by the dancers’ wrists could be transformed to a three-part array, such as ***[0*** ***0 0]*** or ***[3 1 2]***, and the thresholds for mapping the data were adjusted to suit each dancers’ range of movements.[60] The accelerometer readings indicated the phones’ current movement. If this fell below a threshold for a designated period of time – one musical ‘count’ – Max would add the current three-part gyroscope integer array to its current ‘move’ – signalled to the dancer via a brief vibration of the phone on their wrist. If the accelerometer recorded no movement for two ‘counts’ the move would finish (signalled to the dancers via two brief phone vibrations), and be converted to a Genism Word2vec query which could return a word.

Each three-part array is called a move, and the string of moves is called a sequence. A move may be ***[2 2 3]*** or ***[2 0 1]*** and a sequence may be constructed of one move, such as ***[3 1 0]*** (*night*) or ***[2 2 0], [0 2 3], [3 0 2]*** (*computer*) or even ***[2 2 1], [1 1 3], [0 1 3], [2 0 0], [0 0 1], [1 1 1], [1 0 2], [0 2 2], [2 3 1], [0 2 3], [2 2 3], [2 3 3]*** (*sensible*). Most sequences in the final performance consisted of between 1 and 3 moves.

The transformation of these sequences to spatial navigation is one part of the technical innovation within this project, and the best of my knowledge, represents an original innovation. The technique is as follows: the 17,067 words are stored as three-dimensional vectors within a database. This database is virtually represented within a cube, with an uneven distribution of words generated by Gensim/Word2vec. Each word therefore can be represented as a fixed point within this cube, so that searching for ***[0.96784878, 0.98643523, -0.0787757]*** would return the word ‘absurd’. The job of the phone that the dancers wear on their wrist is to translate their movements into spatial navigation within the virtual cube, thus moving to the coordinates that best represent the desired word. The challenge was creating a reliable, replicable means by which the dancers’ movements could be translated to this spatial navigation within the virtual cube, using only the rotational data from the iPhone’s built-in gyroscopes (which can only record rotational angles along three axes). In other words, a phone’s rotational data would have to translate to virtual spatial movements. The resolution of the gyroscopes was down-sampled so that each angle was represented by an integer from ***0-3***. The sequences that the dancers perform represent a mode of navigating this space, with each ‘move’ in a sequence representing zooming in to a more specific part of the cube. Each ‘move’ represents subdividing the current cube into a ***4 x 4 x 4*** array of smaller cubes. A move to ***[0 0 0]*** would select the near most bottom left sub-cube, whilst ***[3 3 3]*** would select the cube furthest top right. Multi-part sequences apply this technique recursively, so that each move within a sequence represents a smaller ‘zoom’ by an order of four. The final word results from a nearest-word search from the central most point of the final cube of the navigation. This navigation technique allows the user to move to a small set of positions (four positions in each axis) yet generate a 3d position with the degree of accuracy necessary for any necessary word in a relatively small number of moves.

In order to be able to predict the words that dancers would be dancing with – and provide them with a written performance script to dance to – I wrote a Python programme to map the necessary navigation for each word. Most common words took 1-3 moves per sequence to reach, which was far easier than the initial hypersensitive prototype I had shown Simon previously. Both dancers would be ‘speaking’ words via their movements (see Figure 2-27). Given the irregular spacing of the words in the three-dimensional space (due to the clustered method of specialisation by the Word2vec functions), a few of the initial sub-cubes were ‘empty’. One of these was used as a ‘flush’ position, which would enable the dancers to clear the current array if they suspected they had hit the wrong position. Since most useful words can be reached within five moves the act of creating a word generally takes around 3-5 seconds.

I believe this method of navigation – translating three-axis arm rotation into three-dimensional, scaling movements through an array of increasingly small cubes in order to retrieve particular vectors – is novel.

Here are some one-position move examples:

I created a dialogue for the performance, which would act as its script, using only words accessible within 3 move sequences. The dialogue was about the impossibility of conversation – in equal part inspired by the direct experience I had trying to maintain communications with my partner across time-zones with faltering digital connectivity, and by the central tenet of Gordon Pask’s Conversation Theory, which I believe has roots that are in line with absurdb principles. Pask’s 1976 book *Conversation Theory: Applications in Education and Epistemology* discusses the mechanisms by which conversations take place. Since concepts are formed by minds based on experiences, and experiences are subjective, Pask argues, all communication between two sentient beings can hope to do is reach a mutually satisfying definition of the same concept.[61] This renders *true* and total communication impossible; although, much like a machine which can pass the Turing Test, there are ways to ensure that the other mind is understanding *enough* of what one is saying to get by. The dialogue I wrote was designed to appear as a conversation between two people separated from each other, but , both are more interested in their own viewpoints than listening to one another. The structure is palindromic: one dancer’s lines are merely the others’, reversed.

Several of the words required multi-position moves; in tests, these slowed the pace of the dialogue and made it hard for an audience to understand that the dancers were talking to each other; each extra position added another couple of seconds and slowed the pace, and intelligibility of dialogue between the dancers down. However, due to the uneven spatial distribution of words in the dictionary, many of the initial 64 ‘positions’ that the dancers could move to were ‘open’. To speed the word-retrieval up, we chose to create ‘shortcut’ moves within several of these positions, so that all the words in the dialogue would be constructed of single-position movements. We also decided that the delivery of these words should be spoken as a sentence, so that dancers were assembling chunks of text, rather than individual words (which had a strange, floating, appearance in tests, and made following dialogue hard). This required building an anticipatory ‘listen’ function within Max that would assemble strings of words into sentences, something that would require the construction of a control-interface.

Working over the period of around a month, Simon and I progressed from the development of a viable interface to the development of a viable performance. We decided to give the performance a three-part structure, so that the audience would firstly see two dancers on the opposite balconies, moving with the distinctive visual grammar that Simon had developed to suit the interface. Two suited men would then enter the balconies, and wrap their arms with the straps whilst positioning the iPhones. This second phase would then show the dancers ‘learning’ to talk using their movements: generating simple words from movements, which would be played through speakers on their side of the Grand Hall. This would lead to their attempts at communication, working through the dialogue script I had written. Then, in the third phase, signalling frustration at their inability to effectively communicate, the performance would descend into a wall of unintelligible, manic and overlapping speech, accompanied by frantic and rapid choreography. This would be balanced by a slower reprise, where the first two lines of the dialogue (‘all that remains / a fragment’) would be repeated by the female dancer. The three acts of highly scripted movements interacting with a computer, would be entitled *Scriptych*; a play on the word triptych (meaning three associated works intended to be appreciated together). The misrepresentation of the concept of the triptych, in which the works are usually not connected, is a conscious reflection of the miscommunication caused by translation throughout the piece.

The differing stages of the performance required the construction of a control interface, so that the ‘listening’ functions of the Max programme would be searching for the right number of words at the right times. There was a difference between the stage when the dancers were dancing without phones (which should produce no words), the stage where the dancers were creating one word at a time, the period of scripted dialogue, and the frenetic section. The data processing would all occur via a ‘hub’ of Max running on my computer. Max would constantly receive input with accelerometer and gyroscope readings from the dancers’ two iPhones, as well as signalling input from an iPhone and iPad that Simon and I would operate to control the overall performance. These control interfaces would also use OSC to send and receive signals – in this case, running bespoke interfaces through the app TouchOSC.[62] From the iPad I could control the reading behaviour that Max would use to listen for the dancers’ movements. I could also re-orient the gyroscopes on the dancers’ arms, which would misalign after the period of intense freneticism in part 3 of the dance. We also divided the performance into eleven periods with different associated musical levels (which is described below). OSC was also used internally in the laptop to communicate between Max and Python – the use of one communication protocol for the entire performance simplified the workflow.[63]

### Soundtrack

At the same time as the initial gyroscope readings, I started to build software to generate music for the performance. This was the second project I had developed using Max software, after *24fps Psycho* (see chapter 3). The visual diagramming mode it uses to programme became intuitive to me over the months I was using it for, and it enabled multiple conversations to occur between Simon and myself about fairly abstract computing, using the visual language of the software (by the end of the process, Simon was able to correct some of my mistakes). The OSC protocol had been developed as a more advanced version of MIDI, allowing the lightweight transmission of streaming music data. It seemed only logical to use this same protocol to generate music.

The initial music software was an *arpeggiator* – a piece of software which would play ascending and descending notes within a chord which would be generated from the OSC inputs. The aesthetic of this music was inspired by the recent Radiohead single *Burn the Witch*, and the orchestral work of Johnny Greenwood in the soundtrack to the film *There Will Be Blood*; I liked the tension created by the staccato string sections in both.[64] I also thought the ***D# minor*** scale used in *Burn the Witch* created a high level of suspense, which would be well-placed within this project. The arpeggiator would be based on a ***4/4*** timing. Initially, I built a primitive scale-finder which would identify all possible notes within a given scale. The three axes of the iPhone’s gyroscope, ***x/y/z***, would be used to select a bass, middle, and high note from four possible noted of each, based on thresholds within the incoming signal. If the phone’s base rotation was ***0-89º***, it would play one note; ***90-179º***, the next note, and so on. The three axes generated three notes in a chord (low, middle and high). A numerical selector enabled the user to choose how many notes would play each bar: ***0-4*** (the fourth note would be the second note, repeated). The notes generated in Max would then trigger a staccato string sound in Ableton Live music generation software.

The arpeggiator alone would not be enough to fill the entire entrance to Opera Garnier for nine minutes. Fortunately, the Pavillon was already working with the Institute National d’Audiovisuel (INA), and for the evening of performance we would be using equipment and engineers from the GRM, INA’s experimental music division. I was also able to work with Julien Perez, a former Pavillon resident and composer in the GRM’s studios. By this time, Simon and I had already discussed at length the ‘aesthetic’ the soundtrack was to have. The GRM sound setup consisted of 8 highly controllable speakers throughout the room, and sophisticated software to enable sound to be highly spatialised. Julien and I created a drum beat which travelled from speaker to speaker with every hit; another, more intense, drum track; a ‘heartbeat’; two bass tracks; and a record-hiss style white noise track. These were all designed to work with the same timing structure, and the timing of the measurements of the phone movements, so that the dancers could measure their movements according to the ambient music. The music would be layered in a pre-choreographed order, so that the entire performance went through different emotional stages, from a slow, white noise-and-heartbeat-laden beginning, to a strings-accompanied arpeggiating (generated by one of the dancers’ movements), slightly heavier middle section with the dialogue (generated by the dancers), to a period of intense movement, music and heavily overlaid speech (generated by the dancers). This penultimate stage was then followed by a moment of calm and silence, a pause by the dancers to gather their breath, and a slow return to fragmentary words of dialogue and a subtler iteration of the music from the second part.

The creation of the soundtrack brought a range of technical issues to light. Firstly, through early tests of the arpeggiator in Simon’s studio, we had found that the best way to build tension in the performance was to incrementally increase the number of notes the arpeggiator played, so that instead of progressing from nothing to a full 4-note arpeggiated chord, we would start playing only the first note of the bar, then the first two, and so on. We could then use a similar sound motif later in the performance to signal its closure. Since the processing of signals for the performance itself would take place on my computer, it made sense to also use it for part of the soundtrack – the voices, and synthesised, arpeggiated viola notes. However, on the evening of the performance, the GRM would install the 8-part speaker array into the Opera, which would offer the spatialised soundtrack. The interface for the speaker array was a large, specially built mixing desk with numerous inputs and outputs – but without a prolonged period for hardware and software testing, we had to compromise on the playback technique for the music. During the performance, the rest of the soundtrack would be played back as a ‘sound bed’: multiple channels of pre-recorded audio which could be faded in and out as appropriate. We developed a basic mode of synchronising playback so that all the tracks would be in time with the generated music from my computer. The soundtrack would move between ‘sections’ through Julien’s adjusting the playback levels.[65]

This live music generation caused a slight challenge: the other soundtracks that would play during the evening would all be exclusively pre-recorded or live. These pre-recorded tracks would be played through a dedicated computer with audio outputs into a large mixing desk, with adjustable output volumes. My soundtrack was different, mixing live audio input – which had to be in time – with a spatialised pre-recorded soundtrack. Julien and I recorded a complementary 8-part soundtrack in the same time signature as the arpeggiator (***120 bpm 4/4***). This consisted of: a low, throbbing hum; a ‘heartbeat’ drum noise every 8 beats; a non-spatialised drum beat; a spatialised fast drum beat which circled the 8 speakers; and a spatialised bassline which would appear to move around the room. These sounds could be combined, along with the generated voices and arpeggiator, to create varying levels of tension and freneticism without changing the underlying time-signature. Before each performance, I would synchronise my computer’s arpeggiator with the pre-recorded soundtrack on Julien’s computer. The control of the operation took place the floor above the performance, so our viewpoint of the dancers was always aerial. This went on to influence the aesthetics of the resulting documentation.

### Performance

We worked with two dancers for a period of several weeks before the performance at the Opera. This enabled us to adjust the physical parameters of the readings to suit the dancers. The method that both dancers employed demonstrated to me some of the myriad ways in which dancers can interpret instruction, and how people understand technical systems. Simon had worked with the limited palette offered by the software and hardware we were using to create a choreography based around the short dialogue. The storyline was simple: a male and female dancer walked onto a balcony on the left and the right of the grand staircase in the Opera. They began, individually, to perform moves in a morose manner, unaware of each other’s presence, as if they are practicing on their own. After a few minutes, they adopted a static standing position; a suited man approached each dancer and applied a device to their arm with a black strap. The music changed; the female dancer started moving, whilst the male dancer remained still. Both dancers’ movements began to create individual fragmentary words (in reality this part was improvised each night, with dancers choosing their favourite positions). A subtle music cue then caused the dancers to pause. The female dancer then performed a few lines of dialogue; the male dancer appeared to respond, offering a greeting. Both of the dancers, although they appear to be talking to each other, were positioned parallel to each other, facing forwards towards the audience, rather than at each other. Slowly it became clear that they were not, in fact talking to each other, but rather repeating the same lines forwards and backwards. They became frustrated at their inability to communicate, and lashed out furiously, moving erratically and frantically, both spewing words at a frenetic rate. Finally, they stopped, caught their breath, and attempted a conversation again. It was futile. They left the stage to the lines:

***all that remains***

***a fragment***

### 

Film

The performance had been conceived of with the audiences’ viewpoint in mind; early in the development process I had visited the Opera Garnier and taken photos and video from every possible vantage point that a visiting audience member might have, to see both how the performance would look from their perspective, and how the performance might look onscreen. The use of the particular balconies by the staircase had been the subject of much debate, but was finally settled upon due to the cinematic qualities of the space when seen from the front (the almost-perfect 16:9 ratio the two dancers would fill within their respective balconies). However, despite filming the entire rehearsal performance from this perspective, the most effective filming method emerged via the perspective from the control booth. Since all technical aspects of the show were being directed from the level above the dancers and the audience, Simon, Julien, the production team and myself all got used to watching the performance from above. I affixed two identical Black Magic Pocket cameras to matching points on the ironwork of the Opera above the dancers’ balconies; the balconies themselves both filled a camera frame with dramatic lighting on the dancers as they moved to fill the space. Of all the angles that myself and the INA production team filmed, the aerial views were both the most disembodied, and revealed the most about the way the dancers moved within the space. The fact that the cameras captured an identical background image of the balconies behind the dancers meant that the footage of both dancers could be superimposed on top of each other; the film finally unites the two dancers on one screen, although as they appear to variously embrace and move over the top of one another, they display the physical disconnection that was present in the live performance. The aerial view also dehumanises the view of the dancers, so that we can see their muscles and physical movements, but not the expressions on their faces.[66] This makes the film more in line with the disembodied, meaningless communication experience it is meant to convey.

## Chapter conclusion

This chapter has introduced and explained two projects that both explore modes of thinking about code through performance. *Nybble* and *Scriptych* each represent an honesty of form: they communicated their respective content through a manner which was simultaneously playful (bright colours and large costumes in *Nybble*, and almost computer-game-esque movements in *Scriptych*) and easily legible. The form of the performances was shaped both by the desire to communicate the inherent ideas, and the practical considerations such as site limitations, or positioning dancers for visibility. The pair of projects demonstrate the importance of happenstance in production; the films produced within each project each have an element that emerged from the production itself, rather than being strictly designed. The inclusion of such elements into the completed projects reflects my own desire for the projects’ form to honestly reflect the processes that were used to create it.

With *Nybble*, the film-documentation has two stages: initially, the performance is shown as an audience would have seen it – a series of wide-angle and detail shots, only with interspersed title cards, and the inclusion of the audio soundtrack to the performance without any narration. After a short while, the audio from the performance itself fades in, with instructions to the performers go to certain positions or dance in a certain way. This audio was only transmitted to the performers on the day – not seen by the audience, but heard by each of the four dancers as they performed. It unites the internal world of the dancers with the external world of the audience. In this respect, the filmic documentation operates in a manner which is unique to video work: it is used to create a perspective which was impossible for anybody physically present at the performance itself. This was the result of simply recording the sound-output from a spare walkie-talkie; the use of film editing allows for the creation of a narrative which might not otherwise have existed.

Similarly, the aerial views in the film for *Scriptych* were the result of the production desk location and the availability of identical cameras within the Palais de Tokyo. The aerial viewpoint that the cameras saw granted a unique perspective: two dancers physically separated, but through the matching balconies, able to be edited together to occupy the same space onscreen. Editing film allows for the creation of new perspectives; existing footage can become something new, and performances can be woven together to highlight a viewpoint that would have been physically or temporally impossible for one person to occupy. This is, of course, stock and trade for film-makers, who might edit together video and audio recorded in completely different locations at different times to create a synthetic ‘whole’ which appears to the audience to be consistent. The ideas of such synthesis are further explored in the coming chapters of this thesis.

Finally, both projects managed to use the themes of the absurdb in a machine manner. The performers in *Nybble* became part of an absurda human computer, performing a function they could not see. Their costumes were patently absurda: large and ungainly, restricting their range of movements. The message they conveyed was a deliberately skewed version of a quote from an absurd play; no matter how hard the dancers attempted to interpret their own actions, their role in conveying a message was obscured to them. Similarly, the message conveyed in *Scriptych*’s dialogue was absurd, created using the almost Oulipian constraint of having to be reversible, with the central subject of the impossibility of communication (as influenced by second-order cybernetics). The dancers themselves were initially subject to absurda demands for precision (although this diminished as the system improved over time). The creation of the interface used in *Scriptych* was novel, and represents an original contribution to knowledge: to the best of my knowledge, this is a unique system for interacting with a database of embedded word vectors. I am satisfied that in this case, my original contribution to knowledge is also suitably absurda+b for this thesis.

[1] Both of these projects were written in Processing and interfaced with Arduino microcontrollers.

[2] Both of these projects were written extensively in Python; *24fps Psycho* also used a Max interface to play videos live. Cycling ’74 and IRCAM, *Max 7*, version 7.3.1, Apple Macintosh (Cycling ’74 / IRCAM, 2016), 7.

[3] Processing and Arduino classes were run by Ruairi Glynn, Marilena Skavara, and Daniel Hirschmann.

[4] John K Ousterhout, ‘Scripting: Higher Level Programming for the 21st Century’, *Computer* 31, no. 3 (1998): 23–30.

[5] This statement comes through first-hand experience visiting and teaching at various design and architecture schools internationally.

[6] See Peg Rawes, ‘Spinoza’s Geometric and Ecological Ratios’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London and New York: Bloomsbury Academic, 2015).

[7] *Pseudo-code* is a means of planning what computer code will do in advance, using natural language or sentences to describe what the eventual code *should* do. Often, my pseudo-code remains in the final programme, but in commented form – that is, human-readable but ignored by the machine compiler. I was introduced to state transition diagrams by Stephen Gage, Richard Roberts and Ruairi Glynn during my masters in architecture.

[8] The name PHP is somewhat of a programming joke: it is a ‘recursive acronym’ for *PHP: Hypertext Processor*. The PHP Group, ‘What Is PHP?’ (The PHP Group), accessed 6 December 2016, <http://php.net/manual/en/intro-whatis.php>.

[9] ‘The Zen of Python’ is a collection of ‘20’ principles that Python devotees should strive towards, written by programmer Tim Peters in 1998. The part-humorous, part-serious principles are ‘baked in’ to the language in the form of an Easter Egg (a hidden ‘bonus’ feature within a regular programme); running the command ***import this*** into the interpreter returns the list of principles. ‘PEP 20 -- The Zen of Python’, Python.org, accessed 7 December 2016, <https://www.python.org/dev/peps/pep-0020/>. Python itself is named after Monty Python’s Flying Circus; the fact that there are only 19 principles in the 20 principles is in itself a reflection of the Monty Python-esque humour found throughout the documentation of the language. The Python Software Foundation, ‘General Python FAQ’ (The Python Software Foundation), accessed 6 December 2016, <https://docs.python.org/2/faq/general.html\#why-is-it-called-python>.

[10] Through this working, I might calculate that it would take 40 seconds to reach the desired temperature from a starting point of 10º, 15 seconds from 15º, 60 seconds from 20º, 90 seconds from 21º, and so on.

[11] Python enables the wrapping of common tasks into sub-routines called functions; ***getTemp()*** would here be a function in which the software would query the temperature-sensing hardware and deliver a number back to the main programme.

[12] Italo Calvino, ‘Cybernetics and Ghosts’, in *The Literature Machine: Essays*, trans. Patrick Creagh (London: Secker and Warburg, 1987), 3–27.

[13] Ibid., 11. Note that Calvino’s allusion to DNA code is distinct from that used by parametricists to rationalise their craft, which has been heavily criticised by Rawes in ‘Spinoza's Geometric and Ecological Ratios’. Calvino’s point was that basic combinatorics, as found in DNA (which consists of only four bases) has been used by nature to create the entire gamut of known life. Rawes, ‘Spinoza’s Geometric and Ecological Ratios’.

[14] Calvino, ‘Cybernetics and Ghosts’, 10.

[15] Italo Calvino, ‘The Burning of the Abominable House’, in *Numbers in the Dark and Other Stories*, ed. Esther Calvino, trans. Tim Parks, Array (New York: Pantheon Books, 1995), 156–69.

[16] Esther Calvino, ‘Preface’, in *Numbers in the Dark and Other Stories*, by Italo Calvino, trans. Tim Parks, Array (New York: Pantheon Books, 1995), 2. Original emphasis.

[17] A. M. Turing, ‘On Computable Numbers, with an Application to the Entscheidungsproblem’, *Proceedings of the London Mathematical Society* 42, no. 2 (1936): 230–65; Prof Jack Copeland and Dave Lee, ‘Alan Turing: The Codebreaker Who Saved “Millions of Lives”’, *BBC News*, 19 June 2012, sec. Technology, <http://www.bbc.com/news/technology-18419691>.

[18] Alan M. Turing, ‘Digital Computers Applied to Games’, in *Faster than Thought: A Symposium on Digital Computing Machines*, ed. Bertram Vivian Bowden (London: Sir Isaac Pitman and Sons, Ltd, 1953), 288.

[19] Fortunately the programme was able to be tested on Manchester University’s machine several months after Turing’s original paper. Turing notes that when tried on computer, the ‘technique of programming was rather crude, and many requirements, increasing the speed of operation, are possible.’ Ibid., 296.Ibid., 296.This led to a computer that was ‘disappointingly slow when playing chess – in contrast to the extreme superiority over human computers where purely mathematical problems are concerned.’ Ibid.

[20] Alan M. Turing, ‘Digital Computers Applied to Games’, 289.

[21] Nancy Katherine Hayles, *My Mother Was a Computer: Digital Subjects and Literary Texts* (Chicago and London: The University of Chicago Press, 2005); David Allen Grier, *When Computers Were Human* (Princeton and Oxford: Princeton University Press, 2005). This particular line of work had a long lineage: a pair of adverts in the New York Times dating from 1892 and 1893 demand ‘Human Computer Wanted’ (a curious first word, as there were no other types of computer at the time). Private advertiser, ‘A Computer Wanted’, *New York Times*, 2 May 1892, sec. Advertisements; Private advertiser, ‘Government Computers Wanted.’, *New York Times*, 1 January 1893, sec. Advertisements.

[22] ‘Computer, N.’, *OED Online* (Oxford University Press), accessed 9 November 2013, <http://www.oed.com/view/Entry/37975>; Grier, *When Computers Were Human*, 5.

[23] Tung-Hui Hu argues that the concept of ‘The Cloud’ is, in fact, a construction and an extension of pre-existing power structures. An interesting socio-historical articulation of this argument can be found in Tung-Hui Hu, *A Prehistory of the Cloud*, First (Cambridge, MA: MIT Press, 2015).

[24] The Daily Mail runs regular Artificial Intelligence scare stories which veer from prophetic doom-mongering to the comically absurda. Headlines from recent years include: ‘*Artificial Intelligence is as dangerous as NUCLEAR WEAPONS: AI pioneer warns smart computers could doom mankind’* and ‘*Could robots turn people into PETS? Elon Musk claims artificial intelligence will treat humans like 'labradors'*’. The former headline was accompanied by a still image from the film *Terminator*; headlines such as this only serve to perpetuate pre-existing, polemic attitudes towards a complex set of technologies and philosophical positions. Richard Gray, ‘Artificial Intelligence as Dangerous as Nuclear Weapons’, *Mail Online*, 17 July 2015, <http://www.dailymail.co.uk/sciencetech/article-3165356/Artificial-Intelligence-dangerous-NUCLEAR-WEAPONS-AI-pioneer-warns-smart-computers-doom-mankind.html>; Ellie Zolfagharifard, ‘Could Robots Turn People into PETS? Elon Musk Claims Artificial Intelligence Will Treat Humans like “Labradors”’, *Mail Online*, 25 March 2015, <http://www.dailymail.co.uk/sciencetech/article-3011302/Could-robots-turn-people-PETS-Elon-Musk-claims-artificial-intelligence-treat-humans-like-Labradors.html>; James Cameron, *The Terminator*, 1984.

[25] Google’s London-based artificial intelligence company *DeepMind*, acquired in January 2014, recently used their *AlphaGo* algorithm to beat professional player Lee Sedol at four of five games of Go. Paul Marks, ‘Google Buys AI Firm DeepMind to Boost Image Search’, *New Scientist* (blog), 27 January 2014, <https://www.newscientist.com/article/dn24946-google-buys-ai-firm-deepmind-to-boost-image-search/>; David Silver et al., ‘Mastering the Game of Go with Deep Neural Networks and Tree Search’, *Nature* 529, no. 7587 (28 January 2016): 484–89.

Google and Facebook have also both released machine learning platforms, called *TensorFlow* and *Big Sur* respectively, which allow users to experiment with their languages and protocols; this has been interpreted by industry analysis such as Tom Simonite as a cynical move to effectively improve their software through user feedback, identifying new capabilities, and also attract developer talent to the companies themselves. Martín Abadi et al., *TensorFlow: Large-Scale Machine Learning on Heterogeneous Systems*, 2015, <http://tensorflow.org/>; Kevin Lee and Serkan Piantino, ‘Facebook to Open-Source AI Hardware Design’, Facebook Code, 10 December 2015, <https://code.facebook.com/posts/1687861518126048/facebook-to-open-source-ai-hardware-design/>; Tom Simonite, ‘Why Google, Facebook, Microsoft and IBM Are Desperate to Give Away AI Technology’, MIT Technology Review, 10 December 2015, <https://www.technologyreview.com/s/544236/facebook-joins-stampede-of-tech-giants-giving-away-artificial-intelligence-technology/>.

[26] Technology companies such as Google and Apple, as well as car manufacturers such as ‘Tesla Motors, Audi, Mercedes-Benz, Volvo, and General Motors’ are all testing self-driving vehicles. Training these vehicles relies heavily on machine learning. Will Knight, ‘What to Know Before You Get In a Self-Driving Car’, MIT Technology Review, 18 October 2016, <https://www.technologyreview.com/s/602492/what-to-know-before-you-get-in-a-self-driving-car/>.

[27] John R. Searle, ‘Minds, Brains and Science: Walk to Patagonia’, *Reith Lectures* (BBC Radio 4, 28 November 1984), <http://www.bbc.co.uk/programmes/p00gq1fk/episodes/guide>; John R. Searle, ‘Minds, Brains and Science: Grandmother Knew Best’, *Reith Lectures* (BBC Radio 4, 21 November 1984), <http://www.bbc.co.uk/programmes/p00gq1fk/episodes/guide>; John R. Searle, ‘Minds, Brains and Science: A Froth on Reality’, *Reith Lectures* (BBC Radio 4, 7 November 1984), <http://www.bbc.co.uk/programmes/p00gq1fk/episodes/guide>; John R. Searle, ‘Minds, Brains and Science: The Freedom of the Will’, *Reith Lectures* (BBC Radio 4, 12 December 1984), <http://www.bbc.co.uk/programmes/p00gq1fk/episodes/guide>; John R. Searle, ‘Minds, Brains and Science: A Changing Reality’, *Reith Lectures* (BBC Radio 4, 5 December 1984), <http://www.bbc.co.uk/programmes/p00gq1fk/episodes/guide>; John R. Searle, ‘Minds, Brains and Science: Beer Cans and Meat Machines’, *Reith Lectures* (BBC Radio 4, 14 November 1984), <http://www.bbc.co.uk/programmes/p00gq1fk/episodes/guide>.

[28] John R. Searle, ‘The Chinese Room Argument’, ed. Robert Andrew Wilson and Frank C. Keil, *The Mit Encyclopedia of Cognitive Science* (MIT Press, 2001), 115.

[29] John R. Searle, ‘Minds, Brains, and Programs’, *Behavioral and Brain Sciences* 3, no. 3 (1980): 417–57. A series of rebuttals and an examination of the implications of the Chinese Room argument can be found in David Cole, ‘The Chinese Room Argument’, ed. Edward N. Zalta, *The Stanford Encyclopedia of Philosophy* (Metaphysics Research Lab, Stanford University, 2015), <https://plato.stanford.edu/archives/win2015/entries/chinese-room/>.

[30] Cole, ‘The Chinese Room Argument’, 7; Roger C. Schank and Robert P. Abelson, ‘Scripts, Plans, and Knowledge’, in *Proceedings of the 4th International Joint Conference on Artificial Intelligence-Volume 1* (Morgan Kaufman Publishers Inc., 1975), 151–157; Roger C. Schank and Robert P. Abelson, *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures* (New Jersey: Lawrence Erlbaum Associates, 1977).

[31] The Turing Test is a hypothesis put forth by Alan Turing in 1950 which proposes that a computer programme which could convincingly answer questions put to it by a human interrogator would mark a significant advance in artificial intelligence. It has long been a disputed benchmark of artificial intelligence research, and even the inspiration for sci-fi fiction such as the Philip K Dick novel *Do Androids Dream of Electric Sheep*?, later popularised as the film *Blade Runner*. A. M. Turing, ‘Computing Machinery and Intelligence’, *Mind* 59, no. 236 (1 October 1950): 433–60, <https://doi.org/10.2307/2251299>; Graham Oppy and David Dowe, ‘The Turing Test’, ed. Edward N. Zalta, *The Stanford Encyclopedia of Philosophy* (Metaphysics Research Lab, Stanford University, 2016), <https://plato.stanford.edu/archives/spr2016/entries/turing-test/>; Philip K. Dick, *Blade Runner: (Do Androids Dream of Electric Sheep)* (New York: Ballantine, 1982); Ridley Scott, *Blade Runner* (Warner Bros. Pictures, 1982).

[32] Searle, ‘The Chinese Room Argument’, 115.

[33] Critics of Searle’s argument include, among others, Ray Kurzweil, Paul and Patricia Churchland, and Andy Clark. Kurzweil argues that Searle’s argument could in fact be focused on human brains: ‘I believe that the scale of Searle’s misrepresentation of ideas from the AI community stems from a basic lack of understanding technology.’ Ray Kurzweil, ‘Locked in His Chinese Room: A Response to John Searle’, in *Are We Spiritual Machines?: Ray Kurzweil vs. the Critics of Strong A.I.*, ed. Jay Wesley Richards (Seattle: Discovery Institute Press, 2002), 170.; Churchland and Churchland argue that the Chinese Room highlights general ignorance of the mechanisms and workings of human cognition and semantics, a view part-echoed by Clark, who discusses the relationship between Schank and Abelson’s scripts and understanding and what he terms ‘connectionist systems.’ Paul M. Churchland and Patricia Smith Churchland, ‘Could a Machine Think?’, *Scientific American*, January 1990; Rudi Lutz (eds.) Andy Clark Rudi Lutz (auth.), Andy Clark, *Connectionism in Context*, 1st ed., Artificial Intelligence and Society (Springer-Verlag London, 1992), 76–78; Cole, ‘The Chinese Room Argument’.

[34] I became interested in Turing via a seminar with Ranulph Glanville at the Bartlett in 2009, and my involvement in design and building mechanisms for the *Universal Tea Machine* in 2012: an Alan Turing-inspired eccentric tea-making calculator conceived by Smout Allen, You and Pea, and Iain Borden, commissioned by the Mayor of London for the Olympics, and fabricated by Westby Jones.

[35] In theatre, this quest usually occurs through an initial establishment of normalcy followed by an entropic descent into meaninglessness (see, for example, Eugène Ionesco, *Rhinoceros*, trans. Martin Crimp (Faber & Faber, 2007); Eugène Ionesco, *Four Plays*, trans. Donald M. Allen, First (New York: Grove Press, 1958), chap. The Chairs, pp.111–160.).

[36] Kurt Vonnegut, *The Sirens of Titan* (New York: Delacorte Press, 1959).

[37] The novel also contains numerous absurda+b themes.

[38] The mode of string-storage described here refers to plaintext storage without compression.

[39] Spaces added for letter-delineation clarity; in reality, this word would just be one string of numbers.

[40] The actual quote that this has been paraphrased from is:

ESTRAGON: Perhaps he could dance first and think afterwards, if it isn’t too much to ask him. VLADIMIR: [To POZZO.] Would that be possible? POZZO: By all means, nothing simpler. It’s the natural order.

Samuel Beckett, ‘Waiting for Godot (1956)’, in *The Complete Dramatic Works*, [New edition] (Faber and Faber, 2006), 7–88.

[41] ‘Hello’ would consist of: ***dancers in position 0: reverse, forwards, forwards, forwards; dancers in position 1: forwards, reverse, forwards, reverse; l: dancers in position 2: reverse, reverse, forwards, forwards; l: dancers in position 2, dancers: reverse, reverse, forwards, forwards; o: dancers in position 2, dancers all reverse***.

[42] Richard Moore, *Computer And The Mind Of Man: Logic By Machine* (KQED-TV, National Educational Television, 1962), <https://archive.org/details/Logic\_by\_Machine>. The Prelinger Archives are a public-domain archive of both professional and home-made films from the USA, available from <http://www.archive.org>. Footage from this archive is also presented in chapter 3, in *24fps Psycho*.

[43] Ibid.

[44] One limitation of the DwH grant was that we were not able to pay performers. I am immensely grateful to all who took part; credits can be found in the appendix.

[45] I had known about the Palais de Tokyo and Opera Garnier collaboration when I had been offered the position at the Palais de Tokyo some months earlier, so had begun to work on technical aspects of the project in advance.

[46] See the following articles in MIT Technology Review: Emerging Technology from the arXiv, ‘How Google Converted Language Translation Into a Problem of Vector Space Mathematics’, MIT Technology Review, 25 September 2013, <https://www.technologyreview.com/s/519581/how-google-converted-language-translation-into-a-problem-of-vector-space-mathematics/>; Emerging Technology from the arXiv, ‘How Google “Translates” Pictures into Words Using Vector Space Mathematics’, MIT Technology Review, 1 December 2014, <https://www.technologyreview.com/s/532886/how-google-translates-pictures-into-words-using-vector-space-mathematics/>.

[47] Tomas Mikolov et al., ‘Efficient Estimation of Word Representations in Vector Space’, *arXiv:1301.3781 [Cs]*, 16 January 2013, <http://arxiv.org/abs/1301.3781>.

[48] Ibid., 6.

[49] Emerging Technology from the arXiv, ‘How Google “Translates” Pictures into Words Using Vector Space Mathematics’.

[50] Garnier, as quoted in Adrian Forty, *Words and Buildings: A Vocabulary of Modern Architecture* (New York: Thames & Hudson, 2000), 90.

[51] Stephen Gage, ‘The Wonder of Trivial Machines’, in *Protoarchitecture: Analogue and Digital Hybrids*, Architectural Design (John Wiley, 2008), 17.

[52] Radim Řehůřek and Petr Sojka, ‘Software Framework for Topic Modelling with Large Corpora’, in *Proceedings of the LREC 2010 Workshop on New Challenges for NLP Frameworks* (Valletta, Malta: ELRA, 2010), 45–50.

[53] These included text from the Natural Language Toolkit, which includes over 50 large-scale corpora of written language; this includes the Brown Corpus, numerous online and news logs, the complete works of Shakespeare, and more. Steven Bird, Edward Loper, and Ewan Klein, *Natural Language Processing with Python*, First (Sebastopol, CA: O’Reilly Media, Inc., 2009).

[54] Simon had been a dancer at the Opera since 1998, and was part of its new training programme to transition dancers into being choreographers.

[55] Cristian Danescu-Niculescu-Mizil and Lillian Lee, ‘Chameleons in Imagined Conversations: A New Approach to Understanding Coordination of Linguistic Style in Dialogs.’, in *Proceedings of the Workshop on Cognitive Modeling and Computational Linguistics, ACL 2011*, 2011. Available from <https://www.cs.cornell.edu/~cristian/Cornell\_Movie-Dialogs\_Corpus.html>.

[56] The screening process for words ensured they had appeared within the movie dialogues corpus at least five times.

As a side note, part of the initial work training this new library included cleaning up thousands of lines of codified, tokenised, Hollywood film dialogue. As part of the process, I alphabetised the entire corpus of dialogue lines. Reading through the data, I was struck by how oddly poetic these disparate statements were, connected only by their appearance in one of many films, and the first letter (and often word) of the line. I used several of the lines from this data to create a series of Oulipian-style poems. One of these, entitled *48 lines about love from Hollywood films, alphabetically ordered*, can be found in appendices.

[57] Steven Spielberg, *Minority Report*, 2002.

[58] Kevin Schlei, *GyrOSC*, version 2.4.2, iOS (Bit Shape Software, LLC., 2010), <http://www.bitshapesoftware.com/instruments/gyrosc/>. Open Sound Control is a lightweight protocol for streaming live messages across a network. Operationally, it is similar to MIDI, but offers a great deal of flexibility and is well documented.

[59] Cycling ’74 and IRCAM, *Max 7*, 7.

[60] Working with one male and one female dancer, both classically trained in ballet, revealed a difference in the modes of movement each one used.

[61] Gordon Pask, *Conversation Theory: Applications in Education and Epistemology* (Amsterdam: Ellevier Scientific Publishlng Company, 1976).

[62] Hexler, *TouchOSC*, version 1.9.8, iOS (Hexler Limited, 2008).

[63] The only element that did not use OSC was the speech, which was generated from Max using a terminal command and the Macintosh’s built-in speech function, with a male and female voice signalling the dancers’ gender. Please note that using the dancers’ gender with associated voice was a decision based purely on the audience legibility of the show; the abstraction of the dancers’ moves being turned into speech was immediately obvious if the spoken voice reflected the gender of the dancer.

[64] Radiohead, *A Moon Shaped Pool*, Digital download (XL Recordings Ltd, 2016); Johnny Greenwood, *There Will Be Blood*, Digital download (Nonesuch, 2007).

[65] In reality this was done via pre-set level positions for each section, set on the desk; Julien would receive an audio cue from Simon, who was monitoring both the performance and the ‘stage’ of the routine, via walkie-talkie.

[66] The matching aerial views came courtesy of Opera Garnier’s symmetrical ironwork, which it transpires is perfect for affixing cameras to with only rudimentary measurements; and also having access to two identical BlackMagic cameras through the Pavillon.

Noise and Difference *86400 and 24fps Psycho* ========================

This chapter explores the third of four notions of *script* found in this thesis: computational scripting. This mode of scripting implies the least amount of agency for the interpreter of the script (the computer); it is dictated by binary logic from which it cannot deviate. The chapter describes two projects, both of which use computational scripting and existing archival imagery to create new films. Both projects are linked thematically and formally, and were both shown at the same festival at the Palais de Tokyo. The first of the projects, *86400*, used Google Images to create a film which displayed the most appropriate image for every second in a day, resulting in a 24 hour long looped film which could play in perpetuity. The second, *24fps Psycho*, itself a failed experiment, displays principles which build towards the creation of a never-ending film-wandering algorithm loosely modelled on the taxi company Uber’s concept of a ‘perpetual trip.’

### Context

The time from November 2015 until April 2016 was the most intensive work period I have experienced; my residency at the Palais de Tokyo offered the opportunity to develop and exhibit ideas that I had been researching for the past few years, providing a series of deadlines, as well as institutional support, and exhibitions in which to show work. The importance of these points to my own creative practice cannot be understated: having a place to work, resources to work with, and a date to aim for is the best method I have found for transforming the many kernels of ideas that propagate my computer and sketchbook into working, functional projects which can be exhibited and provoke conversation. This was certainly the case whilst at the Palais de Tokyo: I had access to two studios, one in my live-work space at the Cité Internationale des Arts, and a dedicated large, shared studio for the Pavillon artists within the Palais de Tokyo itself, as well as the support of a dedicated production and curatorial team.[1]

Much like the atmosphere at the Bartlett, the environment is constantly changing in the Palais de Tokyo as exhibitions and events are assembled and disassembled asynchronously, and multiple events take place near-daily. Upon leaving the studio in the evening, having been immersed in work and isolated from the rest of the building, I could just as easily be confronted by a room full of tuxedoed executives sipping champagne at an awards gala as a *haute couture* catwalk show, or a crowd of revellers dancing to house music, or performance poetry.[2] One of the annual events that takes over the entire Palais de Tokyo is the Do Disturb festival, an eclectic celebration of dance, performance art, and design.[3] Both of the projects discussed in this chapter formed part of the Do Disturb programme in April 2016.[4]

In the build-up to the festival, I was working on four of the seven projects featured in this thesis (*86400*, *24fps Psycho*, *Scriptych*, and *Network / Intersect*), as well as travelling to multiple countries. Despite being predominantly based in Paris, I also spent two and a half months in Chicago, a month in Korea, and several weeks in Australia.[5] In order to stay in touch with family, friends, and colleagues during this time, it was necessary to remain constantly aware of the current hour in multiple time zones, as well as to jump from one mode of work (e.g. computational scripting) to another (e.g. live-action film direction) on a daily basis. This continuous switching of modes was largely facilitated using computers and smartphones, which helped me keep track of shifting time zones, organise my schedule, keep in touch, collect and collate notes and ideas, and, in the case of the computer, carry out the work itself.

In the period since my doctoral research began, there have been significant changes in the way in which people use portable electronic devices. Ofcom’s 2015 ‘Communications Market Report’, released with the by-line ‘The UK is now a “smartphone society”’, shows that 66% of the adult population own smartphones, and nearly half of those state that they are ‘hooked’ on their phones.[6] What’s more, these devices have changed the way people behave. The report indicates that smartphones have pervaded even the most intimate areas of personal life: ‘Half of young people aged 18-24 check their phones within five minutes of waking and two-fifths check it less than five minutes before going to sleep.’[7] What’s more, many local services previously handled via personal interaction, such as ordering food or hailing a taxi, can now be done remotely via apps such as Uber. The material ramifications of app-based technology and ‘cloud computing’ are real and widespread: Barcelona, for example, has imposed heavy fines on the hotel-alternative Airbnb due to its impact raising rent prices in the city;[8] the impact of taxi service Uber has been widely reported as acting aggressively in London and other cities worldwide;[9] the EU courts have enacted multiple rulings regarding the collection and retention of data on European citizens and cities by Google.[10] The impact of smartphone apps to facilitate, for example, navigation around a city, international communication, the ordering of food deliveries, or the scheduling of time, were especially apparent to me as I spent significant amounts of time in foreign countries. With the exception of South Korea (whose telecommunication industry is closely wedded to government, and have produced ‘local’ versions of apps such as Uber, WhatsApp, iMessage and Google Maps), I was able to use the same apps and services near-seamlessly in the UK, France, the USA, and Australia.[11] Google Maps and CityMapper enabled navigation of a city; Uber enabled me to hail taxis to and from anywhere (and also order food); WhatsApp, Gmail, iMessage, FaceTime and Skype more enabled me to communicate with family, friends and colleagues across the world.[12] Every social networking, messaging, or email service I used worked in the same manner as it had in London, provided I had a SIM card in my phone which enabled use of data networks, or access to Wi-Fi. Had I been in the same position in the mid-2000s, or even the early 2010s, this would not have been the case; I remember spending hours in foreign cities searching for internet cafes to send messages home. In the early 2010s, I began noticing a general shift towards apps as services, and a reliance on ‘cloud’ computing, and unseen, remote databases, and in 2013-14, I began to investigate the most readily apparent of these computational companies: Google. I took interest in this company, as I have personally witnessed their growth and spread into many spheres of public life.

I remember the first time I heard about Google, when its sole offering was a search engine, in 1998. Still a schoolboy, a friend had told me of the ‘best’ search engine, which selected its results by machine rather than the pre-approved directory method of the other major search engines of the day.[13] At the time, I thought the name was hilarious (although the humour threshold for my adolescent self was admittedly fairly low). Over time, I became a near-daily user of Google Search for homework, then Gmail, Google Docs, Google Sheets, Google Blogger, Google Calendar, Google Reader, Google Maps, Google Scholar, Google Street View, Google Books, and numerous other Google services. In the intervening years between my schooling and the present, Google have grown exponentially, with an ever-expanding and diversifying offering of products and services.

In 2009, I bought a Google Android phone. My experience of navigating London, to where I had recently moved, changed instantly – it became nearly impossible to get lost since a geolocated phone was in my pocket (unless, of course, the phone ran out of battery). I also had continuous access to email, news, calendars, documents – and the internet. My experience of London itself was thus largely shaped by the technology of the time, and much of this technology came from one San Francisco-based company. In 2013 (a few months into my doctoral research), I began to research Google as a corporation. My fascination stemmed from the fact that their products and services touched such a large part of so many peoples’ daily lives, yet little is publicly known about the company itself.[14] I found that, on the whole, Google are quite un-Googleable; little information is publically available about staff or corporate structure. This leads to a one-way expectation of transparency, whereby Google provides numerous services in exchange for its users’ personal information, yet never discloses its own corporate operations. Its own tax setup is notoriously complex and subject to criticism.[15]

I pored through the publically-available US tax returns from 2004 until 2013 (the year the company incorporated to the last date available at the time), and built a Google Sheets spreadsheet of declared assets, incorporations, and sales of subsidiary companies.[16] I made a Google Map of the addresses of company headquarters and directors’ addresses as listed on the forms in an attempt to map the locations of the company.[17] It appeared that in 2011 the company had undergone a large corporate restructuring; they went from owning 28 companies in 2005, to 117 in 2010 (an acquisition rate of nearly one company per month) to owning just two companies in 2011: Google Ireland and Google Ireland Holdings. This structure is a perfect example of what the Irish Treasury call the ‘Double Irish’, a tax-avoidance measure which ‘relies on arbitrage between the different tax rules used in different countries.’[18]

Midway through this research, the company restructured again, part-splitting and becoming a subsidiary of the umbrella company Alphabet.[19] Although I was fascinated by several things within Google, my primary interest was their ability to continually expand their reach and scope, and the public perception of what the company *was*. From the origins as an algorithmically-driven search company, they had become a word ubiquitous with experimentation, a data-driven approach to computing myriad things. It came as no real surprise to me that Google were exploring self-driving cars, that they had piloted schemes to fly high-speed wireless access point balloons over developing nations to provide web access, that they were digitising thousands of books, installing high-speed internet in cities in the US, or participating in numerous other activities.[20]

I found their self-driving cars particularly interesting.[21] Whilst self-driving cars have been a serious subject of study since at least the 1930s, the computational technology to make them a mass-market reality has only recently emerged.[22] Keen to project an image of harmlessness and innocence, Google’s (now Waymo’s) self-driving cars have the appearance of enlarged children’s toys.[23] Using LiDAR scanners, the cars build a highly accurate point-cloud map of the city they are in, as seen from the cars’ perspective.[24] The cars also have access to a pre-existing 3D map of the area; the cars continually compare the scene they can ‘see’ at any one moment with the one that has already been created. Any difference is something that is to be recorded and used to make calculations.[25] This technique is interesting, as it relies on huge amounts of spatial data to interpret its environment, and the construction, optimisation and maintenance of huge databases. If the cars are implemented in the real world (as opposed to their current prototypical status), they may then also constitute an audacious mapping project: a millimetre-perfect three-dimensional map which is updated every time a car drives along a street.

The Google self-driving car differencing technique reminded me of Gregory Bateson’s influential lecture ‘Form, Substance and Difference’ (later published as an essay).[26] In the talk, Bateson lays out a clear argument that: ‘information – the elementary unit of information – is a *difference which makes a difference*.’[27] In the case of Google’s self-driving cars, anything that is found in the latest LiDAR scan that is not in the existing model is a difference – Bateson called ‘difference which occurs across time […] “change”.’[28] For Bateson, the idea of difference is key to cognition. His argument is an extension of Alfred Korzybski’s dictum *the map is not the territory*, (as discussed in chapter 1 of this thesis).[29] The map that Google’s self-driving cars use is effectively a diagram of differences, changes in a territory large enough to warrant a change in the cars’ behaviour.[30]

Another company who announced its research into self-driving cars at around the same time was Uber, the controversial app-based ride-hailing company. Formed in June 2010, and utilising the inbuilt GPS and Wi-Fi geolocation technologies synonymous with smartphones, Uber is a service which enables users of a smartphone-based app to order a taxi to their location at any time (usually within cities).[31] Taxi drivers and customers (referred to as ‘riders’) both use different interfaces within the same app to hail rides, and to find customers; the service is dependent on a large, dynamically-updating database which keeps track of all active riders and drivers at any one time.[32] In a similar manner to Google, Uber practises data asymmetry with its drivers and customers; drivers are never made aware of where their next customer wants to go until they have entered the vehicle, thus ‘starting’ the trip, whereupon they are provided with their end-destination and directions for their journey (all provided via the app screen);[33] the movements of all riders and drivers are also monitored at all times via a master interface the company variously called ‘Heaven’ or the ‘God View’.[34] Like many other app-based companies, the method for interaction that the apps offer is an Application Programme Interface (API), a standardised protocol by which information can be passed from a central server to a device, with most of the information processing taking place on a company’s remote server.

As with Google, I became interested in Uber in 2013 for several reasons. They are controversial in London and many other cities, where they undercut pre-existing transport companies and unions, and using a purely data-driven approach to transport logistics. Besides their labour practices, whereby drivers are technically self-employed (yet ‘rides’ are near-completely controlled by the company), the company also use interesting language to describe their operations. Their co-founder, Travis Kalanick, uses metaphors of fluidity similar to those found within Parametricist discourse to describe their ideal operation:

Our philosophy is to always have an available ride to someone who wants it. Our mission, we like to say, is transportation as reliable as running water, everywhere for everyone.[35]

At the time of my moving to Paris, several articles had been published in mainstream press regarding Uber’s next, ‘audacious vision’:[36] the perpetual trip.[37] This expands the fluid mode of movement that Uber envision for their drivers and passengers even further: all are subject to continuous movement, with drivers picking up and dropping off passengers travelling in similar directions on an ad-hoc basis, with the goal of near-continuous movement and multiple occupation of the car by passengers.[38] I became intrigued by the potential *sensation* of being an Uber driver on a perpetual trip – eternally moving, fed ad-hoc directions via a remote, human-less interface.[39] In his presentation discussing the company’s operations in 2015, founder Travis Kalanick spent much time discussing the employment opportunities his company had created, as well as the ease with which riders could use the app, and the partnerships they were forging (and hoping to forge) with local governments, but very little time discussing the day-to-day experiences of being a driver.[40] The perpetual trip struck me as a strange new form of labour, a continually-updated journey to nowhere in particular, with a continually-changing series of passengers in the drivers’ vehicle. I wanted to explore this concept metaphorically in a design project.

In order to examine the world of these forms of emerging web-technology further (and their gradual transgression into the built environment), I decided to work in the media of the technologies themselves. I began learning Python, the language in which the original Google web-crawler was built.[41] I also wanted to work with relational databases, which are the back-bone of many web services. I was also intrigued by the programming language Max, largely used by musicians and visual content creators, which offers a visual node-based mode of programming; I had seen it used by several media artists, and its diagrammatic mode of programming reminded me of the aesthetics of building electronic circuits or patches for synthesisers.[42] This investigation led to the creation of two projects. The first, *86400*, looks at interfacing with Google via one of their APIs and attempting to represent a specific vision of how Google Images sees time visually. The second, *24fps Psycho*, is a first-attempt at creating software that creates metaphors for the Uber perpetual trip. Both projects aim to create films that are impossible to watch in their entirety.

## 86400

In 2010, Christian Marclay premiered a film called *The Clock*.[43] 24 hours in length, it consists entirely of excerpts from films and television programmes which features a depiction of the time on-screen, usually on a clock-face (but sometimes spoken). When exhibited, the film plays in real time, so that at any one moment the time on-screen is the real time. Being a 24-hour long montage, the audience are free to construct their own narratives and rationale connecting the films; it plays like a string-of-consciousness, the only consistent connection between the myriad segments being the representation of the time. The concept of the film resonated with me; the method of construction is similar to some of the Oulipo’s poetic and storytelling methods.

Google’s Image Search, a service which enables users to search for images, was first released in 2001.[44] A web-crawler which enables users to search for images online, the early versions of the service created a large database of images found online, and categorised them according to the content of the web-page on which they were found (e.g. a caption below the image).[45] Google Image Search now allows for users to search by image – instead of typing a search term in the search bar, users can drag an image from their computer. In 2011, the artist Sebastian Schmieg began experimenting with this function of the search engine, and created the first of an ongoing series of films whereby he conducts a recursive image search: uploading an image as a search, downloading the first returned image, using this as the next search – and so on. The first film in the series, *Search by Image, Recursively* is a 12-frame-per-second video consisting of 2951 images, initiated through the upload of a transparent 400x225 pixel PNG-format image.[46] The film shows a series of seemingly-related images, working through images of galaxies, cities by night, screenshots of computer games, films, graphs, catalogue product photos, diagrams, and more. At one point a stylised ‘meme’ image is on-screen for several seconds, as multiple iterations with differing text and dimensions flash onscreen for a fraction of a second each. The film simultaneously shows the diversity and multiplicity of images found on the internet. It acts as a snapshot of a time, when the unseen inferences about images caused Google Images to equate any two images to each other (performing the same search at a later date may lead to a different series of images). In a similar way to Marclay’s *The Clock*, I was impressed by the implicit relationship between disparate sources the audience was forced to question.

On day in early 2015, whilst teaching myself to programme in the Python language in the Bartlett studio, I decided to search for the current time on Google Images, in the form of a 24-hour clock (e.g. ***12:15:32***). The result was a series of almost random images. I repeated the process for several more times, loosely following the clock as it changed in real-time (although unable to perform the search at the required speed of once per second!). The images that were returned occasionally bore a direct relationship to time, but very few featured, say, a clock, or a timestamp. I enjoyed trying to work out what the relationship between each one and the time really was. I decided to make a film which would feature the image for the current time, in the ***HH:MM:SS*** format, for all 86,400 seconds in the day – but instead of searching manually, I would automate a script to search for me.[47]

I wrote a basic Python script which would interact with the Google Images API, the programming interface that enables developers to interact with the Google Images service without the standard interface. The API was technically deprecated, meaning that it would be disabled within the near future, but was still functioning.[48] There are 86,400 seconds in any day – which meant that I had a target of that number of images to return. The first task was the establishment of a data structure to hold the results of searches in a database which would make them useable later.[49] I established a database with two tables: *searches*, and *images*, hosted on a remote server (which meant that I could enable multiple remote computers to work on the searching simultaneously). Each search would be logged as an item in the searches database, along with its success, the IP address the search was logged from, a timestamp, and a few more items of data. If a search was successful, the images it returned would be logged in the *images* table, along with information that the API provided, including their original context, various associated URLs, the IP address used for the search, an image description, and the image rights (ranging from public domain to copyrighted images). Each search would return up to four images, which were all logged in the *images* table. The first time a search term was used, it would be for public domain images; if this search was unsuccessful, it would search for two types of Creative Commons images, and finally for all images, including copyrighted images.[50]

I created a relational MySQL database with two tables, *searches* and *images*. The *searches* table would log all searches, successful and unsuccessful, whilst the *images* table would store all information on any images from the searches. The Google Images API allowed for searching with multiple criteria, including the rights-levels of returned images. I decided that it would be best if initial images were in the public domain; failing this, images that had various Creative Commons rights were better than potentially copyrighted images. Each time a search for a particular time returned no results, the next search for that time would be done at a less restrictive copyright level. Each second in the day corresponded to the number of seconds it was after ***00:00:00*** (so ***00:00:00*** was 0, ***00:00:01*** was 1, ***00:01:00*** was 60, ***01:00:00*** was 3600, and so on). Each loop of the programme operated as illustrated in Figure 3-33.

I was limited to a certain number of images per hour, appearing to come from each IP address. The programme would pause for a period if the API returned the error code associated with too many searches having been conducted. Each search also utilised a basic random IP address, so that the searches appeared to be coming from all over the globe. I ran the search programme overnight whilst working in London, Paris, and Chicago intermittently throughout 2015. It logged over 500,000 searches, and nearly 80,000 unique images in the first of its four best-image databases[51]. Towards the end of this image-scraping process, the Google Image Search API became increasingly unreliable, and eventually, it stopped working. Given the continual re-indexing of images, connections and assets that Google performs, and the inability to re-perform the same search again, the series of images that this programme recorded can be considered a snapshot of a specific aspect of Google’s indexing of images, at a specific time in history.

The final stage in the creation of the film was the assembling of the images into a film. I wrote a script which methodically downloaded all of the images in the first register (the number one search result) for every second whose image had been logged. In order not to get stuck on any one image, it downloaded multiple images simultaneously. Successful downloads were logged to the images table; after several unsuccessful attempts, an image would be marked as not available, and skipped later.[52] Once saved locally, another script copied images to another folder and resized them to ensure that they fitted within a 1920x1080 pixel frame, and thus would fit into a standard HD widescreen video size (images below that size were not changed). Finally, I generated all of the timestamps for images, from ***00:00:00*** to ***23:59:59*** as transparent PNG files in Processing. I then compiled the videos so that every image stayed on-screen for one second with the time displayed in a neutral sans-serif typeface over the top. The resulting film was 24 hours in length, and featured one image per second.

The resulting film was shown in its entirety, in real-time, for three days at the Do Disturb festival at the Palais de Tokyo from the 9th to the 11th of April 2016. It was displayed on a screen of approximately 5 x 3m, at the apex of the Palais de Tokyo’s main staircase – a location every visitor would pass. Unfortunately, during the festival, I was too busy working on the next project I will describe, *24fps Psycho*, to gauge much audience reaction, or even watch the whole film (indeed, I have still not watched the film in its entirety). The continuous change, a barrage of images, and the natural audience tendency to try to interpret the reasoning behind each image’s appearance, make viewing a strangely compelling, but also tiring experience. Once an image has passed, it is as if it is gone forever. The relentless one-image-per-second timing creates an ever-changing scene; it is a ‘blink-and-you’ll-miss-it’ experience. Whilst knowing that the images onscreen bear only superficial relations to each other, the audience cannot help but search for links between them. This, in a way, reflects the essential premise upon which Camus’ work is predicated (as summarised by Ronald Aronson), that ‘human beings inevitably seek to understand life's purpose [… but …] the natural world and the human enterprise remain silent about any such purpose.’[53]

In April 2017, I showed the work at the School of the Art Institute in Chicago. As well as the film itself, which again played in real time, I printed a series of posters which transformed the time onscreen into a regulated grid, so that each poster was equivalent to half an hour of time. The eight posters combined and displayed the hours of peak internet usage from ***19:00:00*** - ***22:59:59*** (also known as the internet ‘rush hour’).[54] I feel that the juxtaposition of the film, which portrays time as an overwhelming and relentless barrage of unpredictable images, and the posters, which present time as a ‘thing’ which can be rectilinearly ordered, abstracted and viewed from afar, created an interesting tension.

## 24fps Psycho

As a condition of the residency at the Palais de Tokyo, I was granted access to extensive use of the French National Audio-visual Archives, *Institut national de l'audiovisuel* (INA), including a dedicated research assistant and direct access to the technology department.[55] I was aware of the Palais de Tokyo’s partnership a few months before moving to Paris, and began devising a rough idea of a mechanism for a never-ending film, much like the perpetual trip that Uber was proposing before I arrived at the Palais de Tokyo.

Despite the well-ordered nature of the INA archives – the ease with which film clips could be searched, downloaded, and even edited in advance – I decided that I would not use the archive to create a film with traditional context or subject matter, but rather, to try to evoke the mental state I imagined for a driver on a perpetual trip with Uber. The drivers’ journey would likely take place in the town in which they lived; each journey would necessarily follow a logical spatial progression from one area to the next, yet the vehicle itself would be in a constant state of flux, as passengers were picked up and dropped off in any order. The driver, being only fed the information of the next collection or drop-off, would have little time to ascertain the context for each passengers’ individual journey. The city would thus become an ever-shifting series of decontextualized vignettes, a constant stream of small tasks in a continually moving vehicle. The perpetual trip reframes the driver as passenger on a journey with no end in sight, and a continual reconfiguration of bodies in each vehicle. My ambition was to recreate the sensation of this journey in filmic form, using scripted software. This was to form the prototypical software which became *24fps Psycho*, as well as the basis for an as-yet-unrealised project which further realises the idea.[56]

Part of the inspiration behind the project came from the Charles and Ray Eames film *Powers of Ten.*[57] The film, described as ‘A linear view of our universe from the human scale to the sea of galaxies, then directly down to the nucleus of a carbon atom’ is a meditation on the many scales at which one can view the universe.[58] The ‘video’ component of the film is a square frame, surrounded by simple infographics displaying the current scale in powers of ten (100, 10-1, 10-2, etc.). Starting with an aerial view of a man lying on a picnic blanket in a park in Chicago, the camera zooms out at a consistent rate, by a factor of ten times every ten seconds.[59] Thus, in the space of four minutes, the camera has shifted from being 100m (one metre) above the man, to 1024m away, with a viewpoint that has passed galaxies, stars, super nova flares, and more. The next instant the camera zooms back in to the man, and repeats the process, this time moving in rather than out, until the camera has reached a 10-14 metre zoom (0.0001 ångstroms), below the scale of atoms, which the narrator describes as the ‘limits of our understanding’.[60] The film is well-known to architects; in fact, it was written with architects in mind. Within his notes on the film, Charles Eames writes: ‘Particularly in the past fifty years the world has gradually been finding out something that architects have always known – that is, that *everything* is architecture.’[61]

Although best known in filmic form, my first encounter with the film was rather different. Aged six, and passing through a subway station in Mexico City, I was enthralled by large-scale prints on the wall, approximately one every ten metres. Key frames from the film had been laid out in the station so that the experience of the scalar zooming was a spatial one, and the concepts from the film presented in such clear language that a six-year-old could grasp, and remember them. The exhibition made a strong impression, and it was only much later in life that I realised that the images had, in fact, been taken from a film. When I did finally discover the film version of *Powers of Ten* as an adult, I began to wonder how film could be constructed as a spatial entity. I was struck by the way that traditional celluloid film projection relies on a linear, spatialised format where each frame, onscreen for 1/24 of a second, takes up the same amount of room on the spool, and is something that must be ‘moved through’ before the next frame can be seen. Each frame has fixed dimensions, irrespective of how much ‘information’ it contains – a blank screen requires as much celluloid and takes the same amount of time as the most intricate photograph. The film can only ever move in a linear way, forwards or backwards, much like Turing’s original concept for the Turing Machine.[62] The basic premise of film, that it relies on frames progressing at a rate above that of the human perception of motion, has remained unchanged since Eadward Muybridge’s experiments with photography in the 1880s.[63]

I wanted the project experiment and play with the spatial qualities that film contained. Often, when immersed in a film, I find myself reminded of other films and scenes – either by the composition, grading, themes, general ‘mood’, soundtrack, or any of a number of other signifiers. I started thinking about whether it would be possible to create a filmic version of hypertext, the principle envisioned by Vannevar Bush in 1945, which forms one of the foundations of the internet.[64] I wanted this project to play with the inherent spatiality of film, creating a virtual map on-screen that could be navigated via the playing of films, as if the viewer were passing through space.

To do this, I needed a criterion by which each film clip would relate to the next, a logic by which to stitch films together. On Uber’s perpetual trip, the logic of progression could only ever be spatial: a vehicle moves through a city on a journey planned by an algorithm on a two-dimensional map. Uber vehicles being subject to the use of road maps, cars can only choose from a limited number of options at each junction (e.g. turn left or right, or continue). Traditional film, as projected in cinemas for the past century, is an established and predictable medium: it usually consists of 24 frames being projected sequentially onto a screen per second (commonly known as frames per second, abbreviated to ‘fps’), whilst one side of a celluloid film strip contains the soundtrack.[65] Celluloid film has a consistent bit-rate of one regularly-sized frame every 24th of a second; a twenty-minute long blank film would occupy exactly the same amount of physical space as a twenty-minute segment from a Hollywood film.[66]

I decided to begin the project by attempting to find similarity between different frames in pre-existing film clips. *Similarity* is a vague term in computation: there are myriad methods which could be applied to rank images’ similarity to each other (this has long been the case: Marvin Minsky described ‘the problems of *visual* pattern-recognition’ as having ‘received much attention in recent years’ within the field of artificial intelligence in 1961).[67] Not having a formal background in machine learning, I decided to find an arbitrary method for finding *similarity* in order that I could begin working, and testing (with the intention of later improving my detection mechanisms); I settled with analysing the colour content of film frames, reducing the complexity of images to a simple 3x3 grid. By the time I arrived in Paris, I had built a rough prototype of a scripted programme which would analyse and log the colour content of film frames.[68]

My initial prototype analysis software, built in Processing, took short film clips, and logged, in real-time, a variety of calculated and measured values for each frame in a film to a Comma-Separated Value (CSV) file, including:[69]

* The red, green and blue (***RGB***) pixel values for nine points within the image (the central pixel for each rectangle if the screen were divided into a 3x3 grid)
* Averaged ***RGB*** values across the whole image
* Averaged ***RGB*** values across a 3x3 grid
* Averaged ***RGB*** values for the horizontal and vertical middle line of pixels

The basic premise of the software was as a first-stage in the development process: this would enable the creation of a database of pixel values for each frame in a film, which could then be used as a basis for a form of mathematical comparison of film frames for similarity. The software also enabled a graphic interface to preview films that were reduced to 3x3 grid of either averaged pixel values, or the centremost pixel within each of the 3x3 grid rectangles. I was surprised how recognisable film clips were when reduced to this simple grid; I used footage that I had shot of driving over a bridge in Iceland, as well as the famous shower scene from Alfred Hitchcock’s *Psycho* to demonstrate this principle.[70] I chose these scenes initially simply because I had them to hand whilst I was writing the programme; however, upon showing the demonstration software to an audience, I was struck by just how recognisable the film still was. I also realised that in using a black-and-white film, the level of computation my simple programme would have to perform would be one-third of that of a colour film.

I started to download films from the INA and Prelinger Archives.[71] INA’s research department had granted me access to a collection of their 1940s-1960s newsreels. I particularly liked the aesthetic of the Prelinger Archives: American films, often home movies, public television broadcasts, or corporate films.[72] I used a Python script with the *ffmpeg* library to split every Prelinger film into its constituent frames, a new version of my Processing script – this time rebuilt in Python, using the *Pillow* image-processing library – to create a database of the colours within each image. To test how closely my system managed to organise similarity, I started to use my databases with Max, and the source film *Psycho*, to replace each frame in the original film with a ‘similar’ frame from the Prelinger archives.

At this stage, I had a meeting Fabien Danesi, a curator at the Palais de Tokyo, who had seen my presentation at the Tokyo Arts Club. I showed him the updated software, and described the ambition I had for the project. He told me about Douglas Gordon’s 1993 installation *24 Hour Psycho*, an artwork which served as the setting for, and had been described at length, in the novel *Point Omega*.[73] In *24 Hour Psycho*, Gordon had slowed the film *Psycho* down to the extent that it took 24 hours to play the entire film (meaning that the film plays at approximately two frames per second); DeLillio’s description of the film, woven throughout the novel, is as a series of images whose meanings have been transformed; every minor inflection made by an actor can be examined in excruciating detail.

At this time, working in the gallery’s studio every day, I was acutely aware of the location of the Palais de Tokyo in Paris. It is housed in one of the few remaining buildings in Paris from the 1937 World Exposition. For years the building was empty, serving various (mostly storage) purposes until it re-opened in 2003. Its exterior is a mirror image of the Musée d'Art Moderne de la Ville de Paris, which is housed on the other side of a multi-level courtyard featuring a large colonnade and a pond. During the conversation with Fabien, we had watched an excerpt of a BBC Documentary about Douglas Gordon made in the 1990s, which featured an interview with the artist on the colonnade, and the installation of work in the museum opposite us.[74] Gordon had, in fact, installed *24 Hour Psycho* in the Musée d'Art Moderne in the year of its creation.[75]

By this time, it had become apparent that the computational work required to translate the notion of the perpetual trip into film in the manner I wished within the period of my artist residency; it would require significant investment in machine learning skills. The data operation to choose the most appropriate match to that currently onscreen, from a potential pool of millions of images, 24 times a second, is complex, and was in hindsight beyond my skills at the time. However, I was keen to develop and show *a version* of the project, and had received positive feedback after demonstrating the prototype software in November. Fabien proposed that my version of the frame-replacement software could be shown in the Do Disturb festival. I decided that using *Psycho* as a base film would work; in the tests I had worked on in the studio, large portions of the film remained legible, both after the original images were reduced to a 3x3 grid of greys, and then after my image-replacement algorithm had been used.

I worked on *24fps Psycho* in between multiple other projects (*86400*, *Network / Intersect*, and *Scriptych*), in multiple countries. Most of the coding took place during the month-long stay in Korea, whilst editing and setting up *Network / Intersect* for installation at the Seoul Museum of Art (see chapter 4). The installation date for *Network / Intersect* was the 30th March 2016, and the opening was on the 5th April. It required editing until the last minute. I flew back to Paris the morning after the opening, and worked on *24fps Psycho* for its performances on the 9th to the 11th April. I use the term ‘performance’ here because the process behind the film was a performance; the computation all took place in near real-time, and each screening was different.

The setup of the performances was as follows. The performances took place in the Palais de Tokyo’s Salle 37, an art deco cinema room dating back to the gallery’s construction. Three screens occupied the room; on the central screen, the film *Psycho* was projected onto the central screen. After the title sequence, the image became ‘pixelated’ into smaller and smaller resolutions, until after four seconds, the screen simply showed a 3x3 grid with the average colours from the nine equal areas onscreen. The resulting colours were then used to query the database I had collated of the frames from all of the Prelinger Archive films. The image that was most similar to these averages was then displayed, in black-and-white on the two screens to either side of the main screen.

The first screening, however, was a disaster. The cinema projection booth had been refurbished multiple times, and was wildly impractical; where most projection booths have a means of viewing the screen they are projecting onto, this area had at some point been bricked up; viewing the screens could only be achieved by climbing onto the desk in the booth. My allocated screening times were between other performances and film screenings, and there was a very short setup time. Because the processing was happening live (and could change each time it was screened), the performance relied on the use of a high-powered iMac that the Pavillon studio owned. However, the rigging company who had been brought in to install audio-visual equipment had not brought the appropriate adaptors (despite having had a comprehensive tech setup runt-though the day before), so at the last minute, instead of checking each part of my set-up methodically, I spent the entire time trying to locate an adaptor, then reconfiguring the specialist software I had to use to interface with the projectors. At this time, the technicians all disappeared. The screening restarted several times due to a string of technical errors. At one point, as it became clear that there was an issue with the projection interface, I had to write a patch *during* the performance.[76] Part of the nature of work that involves experimental computation involves accepting a degree of technical error; however, I have never had such a catalogue of issues with a single project. The sensation of such a failure is crushing.

By the time of the next screening, however, I had been able to robustly rebuild almost the entire project to be more resilient in case of an error such as projector failure. Being subject to what felt like every possible failure made the second performance far better. Since the software had been extensively rebuilt, it was also my first chance to see the film the entire way through (I had worked on selected sections before), and I became a member of the audience in the screening room. The imagery, although not continually updating at 24 frames per second (due to memory lags) did have a beguiling effect similar to *86400*. Although no image existed onscreen for long enough to perceive in its entirety, different frames from the same films featured onscreen repeatedly; one motif repeated was a Richard Nixon press conference, and many distinctively 1950s-60s elements of American life appeared onscreen. Initially overwhelming to watch, the barrage of continually changing images, faster than comprehension would allow, became a steady stream of noise; the difference between individual images became a constant, removing the perception of difference.

### Project learnings

This chapter presented two projects which both exclusively used computer scripting and archival content to create new films. An important part of the way that I work is to continually experiment with new media and materials, and it is inevitable that sometimes these experiments do not work in the way that I would like. This was the case with 24fps Psycho. However, I did learn a lot from the project.

One of the problems with the project was the conflation of ideas which caused the focus of the work to shift. What started as a piece of test footage (the film *Psycho*) became the core focus of the work; rather than being a project trying to create an endless film, creating a metaphor for the experience of a perpetually travelling driver, it became software that overlaid new content onto the top of an existing film. The formal quality of the film did partially hint at the absurd. At the screenings of *24fps Psycho*, much of the content of the original film was included: the distinctive soundtrack, with its score by Bernard Herrmann, as well as the colour content, albeit in pixelated form. When confronted with these elements, as well as the new images being projected alongside, the audience attempted to find meaning in the entire assemblage. Inevitably, the experience was incomprehensible; the stream of imagery was relentless and unrelated to the film itself (besides the visual similarity of 1950s/1960s American films). The experience was ultimately meaningless – which is a partial absurd success.

The film also highlighted the Batesonian ideas of noise and difference. Initially, confronted with the baffling, continuous reel of images, experiencing the film was tiresome. However, after a few moments the content of the imagery ceased to be tiring; my mind had realised that the imagery was all noise, rather than information. I was surprised to find that *86400* is actually more challenging to watch, as its framerate of one image per second is just long enough to make connections between one image and another, whereas the images in *24fps Psycho* begin to merge into one another very quickly.

One of the major compromises in *24fps Psycho* was the quality of the computational processes themselves. It became apparent early on that the computational techniques required to create a similarity-seeking computational script which would be recognisable to a person, rather than a machine, were too advanced for the level of programming knowledge I had at the time. I have since learnt a number of technical skills which would have made the project far more computationally viable. The continuous technical errors that struck the first performance were crushing; however, this is also a reflection of the fragility of working in a purely computational medium. Whilst creating work of this nature is enjoyable, there is a lack of tangibility which feels restrictive with purely digital projects; there is no object or thing to point to once the performance is done. The platform-dependence of working with computer scripts is also a shortcoming of the medium: the files used to create the piece will likely not function in a few years’ time.

I do not feel as though I fulfilled the original brief I set myself with this project, of exploring the sensation of being a perpetual trip driver. As experimentation is part of my working practice, so is a lack of ‘closure’, particularly when I do not feel an idea has been resolved. The framework of *24fps Psycho*, and the skills that I have learnt from the project, will inevitably find their way into new works in the future.

## Chapter conclusion

This chapter has introduced and discussed a pair of projects which use computational scripting to curate pre-existing visual work, in image and video form, into a pair of newly synthesised films; one film presents a new image every second for twenty-four hours, whilst the other presents a new image every twenty-fourth of a second for nearly two hours. I call this mode of practice ‘computational curation’, whereby a computational script is used to filter and sort from an array of pre-existing sources in an archive.[77] In this way, these projects represent a departure from the others in described in this thesis: they are almost entirely the result of a digital mode of production. The implications of this creation method poses questions about the films’ ability to meet my own assessment criteria.

### 86400

Of the two projects in this chapter, *86400* most accurately communicates the core ideas the project set out to convey; it is a compelling, continuous film which experiments with notions of form and difference. The form of the film is deliberately as simple as it could possibly be: one image appears on-screen per second, along with a numerical depiction of the time that particular image represents, continuously for an entire day. My logic for not showing the mechanism (i.e. the script and performance of the machine) was that the ubiquity of image-searching means that an audience member could quite readily work out how the system works; the specifics of the search mechanism, API, and the particular scripts used are not of huge importance.

I have observed audience members reacting in one of two ways when watching the film: some are initially compelled by the ever-changing images, and seek to make connections between them, and may remain watching the film for a long period of time; others find the constantly-changing imagery overwhelming, and are quickly repulsed. In this respect, the simplicity of the film’s form is deceptive. An image remaining on-screen for one second is long enough for a person to observe it, but not necessarily fully process their observation. The inability to pause the film creates an overall feeling that the images’ existence is fleeting, and once the image has changed, it has gone forever. This is, of course, untrue (the same film plays every day) – but the audience, who cannot control the films’ playback, cannot change the speed at which the images are presented. In this respect, I consider the communication that the film represents, and its honesty to form, successful.

Less success in this area can be found in the prints created for the SAIC exhibition. These are visually interesting – as any huge array of images might be – but do not communicate enough new information to warrant further exhibition. One of the successes of the film is the fleeting, ephemeral nature of the images on-screen; when these images are placed onto a poster, which by its nature is unchanging and not rooted in time, any ephemerality that the film might convey is made redundant. In this respect, I consider the posters within *86400*’s exhibition in Chicago a failure.

*86400* represents the first solely computerised script project within this thesis. The project has explored computational scripting, a process which involves many machinic principles. The means by which the source images were gathered, collated, and organised by Google in the first instance is machinic; the use of myriad servers and lines of code, each performing series of small actions, in the creation of the Images search engine, represents the operation of a machinic entity. My own use of multiple scripts, for the searching, downloading, sorting, and compiling of a film, which via scripted means, made itself, is also machinic. The *86400* film hints at this machinic nature, without explaining it explicitly.

The film is, however, absurd. The concept of making a 24-hour film is inherently absurda; this is far beyond the attention span of any person. A 24-hour film in which the images onscreen do not convey a narrative story is more absurda still. Whilst the theme Marclay’s *The Clock* – clocks – ensured that there was a form of visual or thematic continuity to the film, *86400* is linked only by the timestamp of other metadata which cause the image to show up at any particular time. Images vary wildly in their form, the means by which they were generated, their composition, format, and content. At least one section (at around 22:00hrs) contains humour: different images of the same man giving a presentation are interspersed among other images; I have witnessed the mere repetition of this motif bringing laughter to an audience, the original content and meaning of the presentation being meaningless in the context of the film. There is also a humour of the absurda+b type as audiences attempt to find connections between the images: through the sheer barrage of images, they struggle to remember what they have seen (absurda), yet still try to find connections and meaning between the images and the order they appear in (absurdb). This tendency hints back to the source of this chapter: Bateson’s ‘Form, Substance and Difference’. Lacking a coherent means of interpreting a constant stream of images, the audience start to interpret the commonalities between images – an activity which itself relies on the interpretation of differences. If, as Bateson argues, information is the ‘*difference which makes a difference*’, this film conveys no information.[78] The work is inherently meaningless, yet causes an audience to search for meaning. In this respect, it is a success of the absurdb.

### 24fps Psycho

Whilst *24fps Psycho* employed a similar method of production – an entirely computer-scripted process – according to my own assessment criteria, it is not a success. The main reason for this, besides my inability to gain the technical control of the project I would have liked, is its failure to accurately communicate the ideas I wished to convey, namely the spatialisation of film. However, the failure of the project represents an opportunity to learn, and it is important to reflect and assess the ways that this failure might be avoided in the future.

The form of the project is one area where the project is successful: the film does reflect the process and techniques used to create it. The use of Max software, which itself created a large diagrammatic mode of processing images and film in a computationally-scripted manner, was satisfying. However, this diagrammatic mode of practice did not alleviate the shortcomings of processing that the software was performing; the computation within the project was not advanced enough to replace each frame within the source film with one that looked similar. In terms of Batesonian similarity, this represented a major failure which could only be remedied via a more thorough researching and development, along with rigorous testing, of the computational processing of each image. The notions of *similarity* and *difference* in images are intuitive for humans, but remain a complex issue to tackle via computer.

The film also failed in its formalisation of its intent in its final form. The intention of spatialising film was obscured by my shortcomings in computational analysis of images; as previously mentioned, the ability to invest more time in computational theory and practice at an early stage in this process would have improved the project significantly. However, despite not achieving the formalisation of form I would have liked, the film was highly watchable (when screening at the Palais de Tokyo through the *Do Not Disturb* festival, it gained a small repeat audience). The effect of the film, flickering wildly between images from a wide variety of sources, did in a small way reflect arguments of Bateson’s ‘Form, Substance and Difference’. The sensation of watching the film was not as jarring as I had initially expected; much like the sensation of watching *86400* (albeit in much faster form), the continuously changing images resulted in the audience looking for similarity, rather than registering difference in the images. This, however, was not the representation of the Uber perpetual trip that I had aimed to create. The film was a resounding failure in its inability to spatialise film.

It is important here to acknowledge that such failures are a part of experimental practice. What did not work in this project can be built upon in the future in order to create a more successful outcome. Future iterations of this project might consider a more advanced mechanism of image analysis; potential mechanisms include vector-analysis of images (in a process similar to that seen in language with *Scriptych*).[79] Hypothetically, a vector-space-analysis of frames within multiple films could create a large, multi-dimensional map of the relationships between similar frames; a more effective means of replaying films might be to release virtual ‘agents’ to wander around the multi-dimensional vector-space in the manner of an Uber driver on a perpetual trip.[80] This method, however, would require a significant investment in learning advanced image processing techniques, and access to a large archive of film. I am hopeful that such an opportunity presents itself in the future.

This chapter has presented two computationally-curated projects exploring computational scripting, with mixed results. The final chapter of this thesis will apply a different mode of scripting, whereby the designer is the person to follow a set of scripted instructions, in the development of a novel methodology entitled reflexive scripted design.

[1] The Palais de Tokyo Pavillon production team consisted of Ange Leccia (Pavillon founder and director), Fabien Danesi (programme director), Chloe Fricout (coordinator and production manager), Justine Hermant (production support), Justine Emard (technical support), Marilou Thiébault (intern), Caterina Zevola (production support).

[2] All of these events, and many more, really occurred. The continual change creates an atmosphere which feels as though anything could happen at any moment.

[3] Palais de Tokyo, ‘Do Disturb. Festival Non-Stop: Performance, Danse, Cirque, Design...’, Palais de Tokyo EN, 13 June 2016, <http://www.palaisdetokyo.com/en/event/do-disturb-0>. The inaugural festival was in 2015.

[4] Curated by Vittoria Matarrese.

[5] My partner had recently started working at the University of Chicago; the Palais de Tokyo’s Pavillon programme included a month spent in Seoul Museum of Art’s Nanji residence, where much of the work for *24fps Psycho*, and the post-production work for *Network / Intersect*, the focus of chapter 4 of this thesis, took place.

[6] Ofcom, ‘The Communications Market Report: United Kingdom’, Ofcom, 30 September 2016, <https://www.ofcom.org.uk/research-and-data/cmr/cmr15/uk>; Ofcom, ‘The Communications Market Report’ (Ofcom, 6 August 2015), 6. 48% of smartphone users rate themselves 7/10 or higher in describing how ‘hooked’ they are to their phones (rising to 61% for 16-24 year olds).

[7] Ofcom, ‘The Communications Market Report’, 6 August 2015, 6.

[8] B.R., ‘Barcelona Hits Airbnb with a Hefty Fine’, The Economist, 25 November 2016, <http://www.economist.com/blogs/gulliver/2016/11/clampdown-catalonia>.

[9] Sam Knight, ‘How Uber Conquered London’, *The Guardian*, 27 April 2016, sec. Technology, <https://www.theguardian.com/technology/2016/apr/27/how-uber-conquered-london>.

[10] See, for example, the Court of Justice of the European Union’s ruling on the ‘Right to be Forgotten’, a law enabling European citizens to remove personal information from internet search results Court of Justice of the European Union, ‘Judgment in Case C-131/12 Google Spain SL, Google Inc. v Agencia Española de Protección de Datos, Mario Costeja González’, Press Release (Luxembourg: Court of Justice of the European Union, 13 May 2014); European Commission, ‘Factsheet on the “Right to Be Forgotten” ruling’ (European Commission, 8 July 2014), <http://ec.europa.eu/justice/data-protection/files/factsheets/factsheet\_data\_protection\_en.pdf>.; Swiss data laws Anita Greil and Katharina Bart, ‘Swiss Court to Rule on Google Street View’, *Wall Street Journal*, 24 February 2011, sec. Tech, <http://www.wsj.com/articles/SB10001424052748703408604576163770758984178>.

[11] This is the case with multiple countries where a non-Latin alphabet is used; China’s WeChat service, for example, enables far higher functionality than the equivalent European or American apps. Charles Arthur, ‘WeChat: Want an App That Lets You Do Everything at Once?’, *The Guardian*, 15 February 2016, sec. Technology, <https://www.theguardian.com/technology/2016/feb/15/multifunction-apps-charles-arthur>.

[12] Google, Inc., *Google Maps*, version 4.30.54, iOS (Google, Inc., 2017); Citymapper Ltd., *Citymapper*, version 6.15, iOS (London: Citymapper Ltd, 2017); Uber, *Uber*, version 3.243.3, iOS (Google, Inc., 2017); WhatsApp Inc., *WhatsApp*, version 2.17.21, iOS (WhatsApp Inc., 2017); Google, Inc., *Gmail*, version 5.0.17049, iOS (Google, Inc., 2017); Apple, Inc., *iOS 10*, version 10.3.2, iOS (Apple, Inc., 2017); Skype Communications S.a.r.l, *Skype*, version 6.35, iOS (Skype Communications S.a.r.l, 2017). Note that iMessage and FaceTime are part of iOS 10.

[13] For example, the other major search engines (including Lycos, Ask Jeeves, Yahoo and America Online) and relied on human-ranked search results via directory-style searches. The first web-crawler was Matthew Gray’s *World Wide Web Wanderer* in 1993. Aaron Wall, ‘History of Search Engines: From 1945 to Google Today’, Search Engine History, accessed 7 May 2017, <http://www.searchenginehistory.com/>.

[14] Google received 46 million UK visitors in March 2015; the population of the UK was estimated to have been 65 million in June of the same year. Ofcom, ‘The Communications Market Report’, 30 September 2016, 16; Emily Shrosbree, ‘Population Estimates for UK, England and Wales, Scotland and Northern Ireland: Mid- 2015’, Statistical Bulletin (Office for National Statistics, 23 June 2016), 2, <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2015>.

[15] See, among numerous other reports: Kamal Ahmed, ‘Starbucks, Google and Amazon Grilled over Tax Avoidance’, *BBC News*, 12 November 2012, sec. Business, <http://www.bbc.com/news/business-20288077>; Sam Schechner and Stephen Fidler, ‘Google Strikes Deal With U.K. Tax Authority’, *Wall Street Journal*, 23 January 2016, sec. Tech, <http://www.wsj.com/articles/google-in-talks-to-settle-european-tax-disputes-1453484192>; Sam Schechner, ‘Google’s Tax Setup Faces French Challenge’, *Wall Street Journal*, 8 October 2014, sec. Tech, <http://www.wsj.com/articles/googles-tax-setup-faces-french-challenge-1412790355>.

[16] I searched the US Securities and Exchange Commission’s EDGAR Company filings for all of the available 10-K annual summary reports, and paid particular attention to section 21, which lists all subsidiary companies. Google Inc., ‘10-K Form #0001193125-05-065298’, 30 March 2005, <https://www.sec.gov/Archives/edgar/data/1288776/000119312505065298/dex2101.htm>; Google Inc., ‘10-K Form #0001193125-06-056598’, 16 March 2006, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-06-056598.txt>; Google Inc., ‘10-K Form #0001193125-07-044494’, 1 March 2007, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-07-044494.txt>; Google Inc., ‘10-K Form #0001193125-08-032690’, 15 February 2008, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-08-032690.txt>; Google Inc., ‘10-K Form #0001193125-09-029448’, 13 February 2009, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-09-029448.txt>; Google Inc., ‘10-K Form #0001193125-10-030774’, 12 January 2010, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-10-030774.txt>; Google Inc., ‘10-K Form #0001193125-11-032930’, 11 February 2011, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-11-032930.txt>; Google Inc., ‘10-K Form #0001193125-12-174477’, 23 April 2012, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-12-174477.txt>; Google Inc., ‘10-K Form #0001193125-13-028362’, 29 January 2013, <https://www.sec.gov/Archives/edgar/data/1288776/0001193125-13-028362.txt>; Google Inc., ‘10-K Form #0001288776-14-000020’, 11 February 2014, <https://www.sec.gov/Archives/edgar/data/1288776/0001288776-14-000020.txt>.

[17] Predictably, the tax and company directors all lived within 30 minutes’ drive of the Google Headquarters in Mountain View, California.

[18] Business Tax Team, ‘Tax Strategy Group 2014: Corporation Tax Policy’, Corporation Tax Policy (Dublin, Ireland: Department of Finance, 2014), 7, <http://www.finance.gov.ie/sites/default/files/TSG%201311.pdf>. The Treasury report describes the exact setup that Google employed: A ‘US Parent’ company (e.g. ‘X Incorporated’) owns an ‘Irish Registered Non-Resident Company’ (e.g. ‘X Ireland Holdings), which in turn owns a ‘Substantive Irish Co[mpany] registered and tax resident in Ireland’ (e.g. ‘X Ireland Ltd.’). There is then a complex arrangement over ownership of goods and services, and royalty payments – see Ibid.

[19] The restructuring was announced via Larry Page, ‘Alphabet’, Alphabet, 10 August 2015, <https://abc.xyz/>.

[20] Neal E. Boudette, ‘Building a Road Map for the Self-Driving Car’, *The New York Times*, 2 March 2017, <https://www.nytimes.com/2017/03/02/automobiles/wheels/self-driving-cars-gps-maps.html>; Conor Dougherty, ‘Hoping Google’s Lab Is a Rainmaker’, *The New York Times*, 15 February 2015, <https://www.nytimes.com/2015/02/16/business/google-aims-for-sky-but-investors-start-to-clamor-for-profits.html>; Stephen Heyman, ‘Google Books: A Complex and Controversial Experiment’, *The New York Times*, 28 October 2015, <https://www.nytimes.com/2015/10/29/arts/international/google-books-a-complex-and-controversial-experiment.html>; Conor Dougherty, ‘Two Cities With Blazing Internet Speed Search for a Killer App’, *The New York Times*, 5 September 2014, <https://www.nytimes.com/2014/09/06/technology/two-cities-with-blazing-internet-speed-search-for-a-killer-app.html>.

[21] Google’s self-driving car research has been transferred to a company called Waymo, owned by Google’s parent company Alphabet. Darrell Etherington and Lora Kolodny, ‘Google’s Self-Driving Car Unit Becomes Waymo’, *TechCrunch* (blog), accessed 7 May 2017, <http://social.techcrunch.com/2016/12/13/googles-self-driving-car-unit-spins-out-as-waymo/>.

[22] ‘“Phantom Auto” to Be Operated Here: Driver-Less Car to Be Demonstrated About City Streets Next Saturday – Controlled Entirely by Radio.’, *The Free Lance-Star*, 18 June 1932; Michael Kidd, *Key to the Future* (General Motors; Dudley Pictures Corporation, 1956), <https://www.youtube.com/watch?v=F2iRDYnzwtk>.

[23] Early prototypes were built using golf buggies.

[24] LiDAR is a scanning technology that enables often sub-millimetre accurate 3D scans of an area based on the reflections of a laser across a spinning angled mirror. Ron Amadeo, ‘Google’s Waymo Invests in LIDAR Technology, Cuts Costs by 90 Percent’, Ars Technica, 10 January 2017, <https://arstechnica.com/cars/2017/01/googles-waymo-invests-in-lidar-technology-cuts-costs-by-90-percent/>. There are also numerous other technologies that contribute to the car.

[25] Erico Guizzo, ‘How Google’s Self-Driving Car Works’, IEEE Spectrum: Technology, Engineering, and Science News, 18 October 2011, <http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works>.

[26] Gregory Bateson, ‘Form, Substance, and Difference’, in *Steps to an Ecology of Mind*, 13. printing. (Ballantine, 1985).

[27] Ibid., 460. Original emphasis.

[28] Ibid.

[29] Alfred Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics*, Fifth edition, second printing (Brooklyn, N.Y., USA: International Non-Aristotelian Library, Institute of General Semantics, 2000), 58.

Bateson invokes Alfred Korzybski’s dictum *the map is not the territory*, an argument that there is a distinction between the world as it exists and the human perception of it due to the limitations of sensory perception (Gregory Bateson, ‘Form, Substance and Difference’, in *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology* (Jason Aronson Inc, 1987), 455.). Korbyski originally stated ‘A map is not the territory it represents, but, if correct, it has a similar structure to the territory, which accounts for its usefulness.’ Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics*, 58.

This is an idea that is echoed multiple times in the work of Jorge Luis Borges, perhaps most famously in the short fictional story *On Exactitude in Science*, in which a 1:1 scale map of an empire was created atop the empire itself. Later generations discovered ‘that vast Map was Useless’, and left it to ruin in the West of the empire. Jorge Luis Borges, ‘On the Exactitude of Science’, in *Collected Fictions*, trans. Andrew Hurley (New York: Penguin, 1998), 325.

[30] For example, an obstacle which has fallen onto the road, or a change in street signage.

[31] Travis Kalanick, ‘Uber and Europe: Partnering to Enable City Transformation’ (Digital-Life-Design (DLD), Munich, Germany, 18 January 2015), <https://www.youtube.com/watch?v=iayagHygV0Q>.

[32] The company uses a tool the Guardian titles ‘Heaven – the Uber-eye view of all the cars active in the city’ to monitor the location of all of its active drivers. (Knight, ‘How Uber Conquered London’.) Uber themselves call this the ‘God View’ (see Voytek, ‘Mapping San Francisco, New York, and the World with Uber’, *Uber Global* (blog), 16 May 2011, <https://newsroom.uber.com/uberdata-mapping-san-francisco-new-york-and-the-world/>; Erick Schonfeld, ‘Uber CEO On His “Official” NYC Launch: “Congestion Is A Bitch” (Video And Heatmaps)’, *TechCrunch* (blog), 4 May 2011, <http://social.techcrunch.com/2011/05/04/uber-screenshots-video/>.)

[33] In addition to the continuous tracking of users’ location whilst using the app, the Uber terms and conditions for UK-based customers state:

However, by providing User Content to Uber, you grant Uber a worldwide, perpetual, irrevocable, transferable, royalty-free license, with the right to sublicense, to use, copy, modify, create derivative works of, distribute, publicly display, publicly perform, and otherwise exploit in any manner such User Content in all formats and distribution channels now known or hereafter devised (including in connection with the Services and Uber’s business and on third-party sites and services), without further notice to or consent from you, and without the requirement of payment to you or any other person or entity.

Uber, ‘Legal: Terms and Conditions (GB)’, Company website, Uber, 23 August 2016, <https://www.uber.com/legal/terms/gb/>.

[34] Knight, ‘How Uber Conquered London’; Voytek, ‘Mapping San Francisco, New York, and the World with Uber’. In the latest version of the app, a user cannot opt-in to sharing their location only when the app is in use; they must either *always* or *never* enable location services.

[35] Kalanick, ‘Uber and Europe: Partnering to Enable City Transformation’. Note that Kalanick has since resigned as CEO of the company amidst a ‘shareholder revolt’ in reaction to the ethics and working culture of its business practice. Mike Isaac, ‘Uber Founder Travis Kalanick Resigns as C.E.O.’, *The New York Times*, 21 June 2017, sec. Technology, <https://www.nytimes.com/2017/06/21/technology/uber-ceo-travis-kalanick.html>.

[36] Uber Newsroom, ‘Uber’s New BHAG: uberPOOL’, Corporate blog, Uber Global, 2 February 2015, <https://newsroom.uber.com/ubers-new-bhag-uberpool/>.

[37] Knight, ‘How Uber Conquered London’. This is also mentioned on Uber’s blog (Uber Newsroom, ‘5-Year Anniversary Remarks from Uber CEO Travis Kalanick’, Corporate blog, *Uber Global* (blog), 3 June 2015, <https://newsroom.uber.com/5-years-travis-kalanick/>.) as well as in Kalanick’s keynote speech Kalanick, ‘Uber and Europe: Partnering to Enable City Transformation’.

[38] For more on the Perpetual Trip concept, see Kalanick, ‘Uber and Europe: Partnering to Enable City Transformation’. The idea of this kind of fluidity is aligned with neoliberal market ideals; Spencer discusses (one of the originators of neoliberal thought) Michael Polanyi’s discussion of fluids as a basis for organisational structures (Douglas Spencer, *The Architecture of Neoliberalism: How Contemporary Architecture Became an Instrument of Control and Compliance* (Bloomsbury Publishing, 2016), 28–29.), whilst for Schumacher fluidity is a central tenet of his organisational and market ideals:

We might think of liquids in motion, structured by radiating waves, laminal flows and spiralling eddies. Swarms have also served as paradigmatic analogues for the field concept: swarms of buildings that drift across the landscape. There are no platonic, discrete figures or zones with sharp outlines. Within fields only regional field qualities matter: biases, drifts, gradients, and perhaps conspicuous singularities such as radiating centres. Deformation no longer spells the breakdown of order, but the inscription of information. Orientation in a complex, differentiated field affords navigation along vectors of transformation. The contemporary condition of arriving in a metropolis for the first time, without prior hotel arrangements and without a map, might instigate this kind of field-navigation. Imagine there are no more landmarks to hold on to, no axes to follow, no more boundaries to cross.

Patrik Schumacher, ‘Parametricism: A New Global Style’, in *Digital Cities AD*, ed. Prof Neil Leach, 4th ed., vol. 79, Architectural Design 4 (Wiley, 2009), 14. Schumacher also copies whole sections of this quote verbatim into Patrik Schumacher, *The Autopoiesis of Architecture. Vol. 1: A New Framework for Architecture* (Chichester: Wiley, 2011), 421–23.

[39] The theme is similar to the lack of control displayed in the Godot Machine of chapter 1. Note that Nathan Moore also discusses the idea of the continual movement of bodies as a mode of examining power and control (and invokes Gregory Bateson) in ‘Diagramming Control’. Nathan Moore, ‘Diagramming Control’, in *Relational Architectural Ecologies: Architecture, Nature and Subjectivity*, ed. Peg Rawes, 1st ed. (Abingdon, Oxon: Routledge, 2013), 58.

[40] Kalanick, ‘Uber and Europe: Partnering to Enable City Transformation’.

[41] Sergey Brin and Lawrence Page, ‘The Anatomy of a Large-Scale Hypertextual Web Search Engine’, *Computer Networks and ISDN Systems*, Proceedings of the Seventh International World Wide Web Conference, 30, no. 1–7 (April 1998): 113, <https://doi.org/10.1016/S0169-7552(98)00110-X>.

[42] Cycling ’74 and IRCAM, *Max 7*, version 7.3.1, Apple Macintosh (Cycling ’74 / IRCAM, 2016).

[43] Christian Marclay, *The Clock*, 15 October 2010, Film, installation, 15 October 2010.

[44] Andrew Zipern, ‘News Watch: A Quick Way to Search For Images on the Web’, *The New York Times*, 12 July 2001, sec. Technology, <http://www.nytimes.com/2001/07/12/technology/news-watch-a-quick-way-to-search-for-images-on-the-web.html>.

[45] Google now analyse images using other methods, such as vector space analysis, now demonstrated in their Cloud Platform Vision API. ‘Vision API - Image Content Analysis’, Google Cloud Platform, 2 December 2015, <https://cloud.google.com/vision/>.

[46] Sebastian Schmieg, *Search by Image, Recursively, Transparent PNG, #1*, 9 December 2011, 12fps video, script, 9 December 2011, <https://vimeo.com/34949864>.

[47] It was only later that I realised that the use of a 24-hour clock, in use across Europe and much of the world, is not commonly used in the United States outside of military contexts.

[48] This is one of the perils of working with API-based services: at any point the service provider could decide to turn the service off. The shut-down of the Google Images API appears to have been part of the much larger corporate restructuring that happened in 2011, when multiple services and APIs, including *Google Labs*, *Google Buzz* and *Google Talk*, were disabled.

[49] Note the Google Image Search API documentation states: ‘The Google Image Search API must be used for user-generated searches. Automated or batched queries of any kind are strictly prohibited.’ Google, ‘JSON Developer’s Guide | Google Image Search API (Deprecated)’, Google Developers, 28 May 2015, <https://developers.google.com/image-search/v1/jsondevguide>. This project sets out to explicitly critique the ethics of large technology corporations such as Google and Uber, whose Terms of Service set up a deliberately asymmetrical relationship between the corporation and the end-user (see ‘Technology and the Absurd’ within this thesis’ Introduction). Under normal circumstances, breaching a corporation’s Terms of Service may flout university ethical guidelines; however, UCL’s Research Ethics Committee explicitly states that artistic or literary criticism ‘are not considered to be “research” and would be exempt’ from the standard research ethics guidelines. UCL Ethics Committee, ‘Exemptions’, UCL Research Ethics Committee, 15 March 2016, <https://ethics.grad.ucl.ac.uk/exemptions.php>.

[50] This resulted in a large number of public-domain images being found; largely from image public archives (e.g. NASA, Flickr’s *The Commons*, etc).

[51] The image search returns up to four ‘top hit’ images. These are returned as an array of four images, numbered from 0-3. The resultant film was constructed of images from the first result (register 0).

[52] This happened with quite a few images. Images often become unavailable online as servers change ownership, websites shut down, etc.

[53] Ronald Aronson, ‘Albert Camus’, ed. Edward N. Zalta, *The Stanford Encyclopedia of Philosophy* (Metaphysics Research Lab, Stanford University, 2017), 3, <https://plato.stanford.edu/archives/sum2017/entries/camus/>.

[54] Tom Lawrence, ‘Evening Internet “Rush-Hour” Affects Broadband Users’, *The Independent*, 16 November 2011, sec. Technology, <http://www.independent.co.uk/life-style/gadgets-and-tech/news/evening-internet-rush-hour-affects-broadband-users-6262838.html>.

[55] I also worked with INA’s Groupe de Recherches Musicales (GRM) during the production of *Scriptych* (see chapter 2).

[56] The human-driven perpetual trip is the beginning of Uber’s longer-term plans involving driverless cars. Such vehicles are already being tested with real passsengers in Pittsburgh and San Francisco. Anthony Levandowski, ‘San Francisco, Your Self-Driving Uber Is Arriving Now’, *Uber Global* (blog), 14 December 2016, <https://newsroom.uber.com/san-francisco-your-self-driving-uber-is-arriving-now/>.

[57] The Eameses made two versions of *Powers of Ten*, nearly ten years apart. Both feature the same idea, and near-identical content. The first, *A Rough Sketch for a Proposed Film Dealing with Powers of Ten*, was made in 1968, whilst a second, longer film made in 1977 is the one commonly referred to as *Powers of Ten*. Charles Eames and Ray Eames, *A Rough Sketch for a Proposed Film Dealing with the Powers of Ten and the Relative Size of Things in the Universe*, Film, 1968; Charles Eames and Ray Eames, *Powers of Ten*, Film, 1977. Both are cited in Charles Eames and Ray Eames, *An Eames Anthology: Articles, Film Scripts, Interviews, Letters, Notes, and Speeches*, ed. Daniel Ostroff (New Haven, CT: Yale University Press, 2015), 297.

[58] Eames and Eames, *An Eames Anthology*, 297.

[59] The scene was actually photographed in Los Angeles, where the Eames studio was located. However, the scene was transplanted to Miami in the 1968 sketch film, and Chicago in the more famous 1977 film. James Hughes, ‘The Power of Powers of Ten’, *Slate*, 4 December 2012, <http://www.slate.com/articles/arts/culturebox/2012/12/powers\_of\_ten\_how\_charles\_and\_ray\_eames\_experimental\_film\_changed\_the\_way.html>. This was possible due to the way in which the still photographs and artworks were put together. See Figure 3-31.

[60] Eames and Eames, *Powers of Ten*, 1977.

[61] Eames and Eames, *An Eames Anthology*, 383. Original emphasis.

[62] A. M. Turing, ‘On Computable Numbers, with an Application to the Entscheidungsproblem’, *Proceedings of the London Mathematical Society* 42, no. 2 (1936): 230–65.

[63] I first became aware of the principle of film being a succession of images thanks to a visit to the Museum of the Moving Image in New York, aged 10, and have been fascinated with the medium ever since.

[64] The hypertext idea has long been associated with Vannevar Bush’s article ‘As We May Think’. Bush envisioned a machine called a Memex, a ‘mechanised private file and library’ where people could browse their own catalogue of materials, which would link in relevant places to other related articles. Vannevar Bush, ‘As We May Think’, *The Atlantic*, 1945, <http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/?single\_page=true>.

[65] Some film-makers have experimented with different frame-rates; most notably Peter Jackson with his recent interpretation of *The Hobbit*, which was shot at 48fps. Peter Jackson, *The Hobbit: An Unexpected Journey*, Adventure, Fantasy, 2012.

[66] The recent advent of digital film and its associated compression has all but eliminated the consistent bit-rate. For the sake of reducing file sizes, modern digital film formats such as *h.264* or *.avi* often only encode a keyframe as a complete image, and *changes* from one frame to the next, rather than a series of individual frames. This means that unlike their analogue equivalents, where every frame occupies the same amount of space, compressed digital films rarely have a consistent *bitrate*. Whilst it is possible to encode films as a stream of images, the conventions of lossy image compression formats, such as JPEG, mean that each image itself has a different file size.

Within digital cinema photography, many of the professional cameras, manufactured by companies such as RED and BlackMagic, offer the option to shoot film as a series of uncompressed RAW images; this gives film-makers greater flexibility to make edits in post-production, and is thus roughly a digital equivalent of shooting on celluloid.

[67] Marvin Minsky, ‘Steps toward Artificial Intelligence’, *Proceedings of the IRE* 49, no. 1 (January 1961): 11, <https://doi.org/10.1109/JRPROC.1961.287775>.

[68] This was presented to an audience at the launch of the Pavillon residency programme at the Palais de Tokyo’s *Tokyo Arts Club* evening on 25th November 2015.

[69] CSV files are a lightweight means to store arrays of information, akin to a spreadsheet. They can be converted to numerous data types, including databases and spreadsheets. Data is stored in plain text format, with each value separated by a comma and a new line per entry.

Processing Foundation, *Processing 2.2.1*, version 2.2.1, Mac OS X (Processing Foundation, 2014), <http://www.processing.org>.

[70] Alfred Hitchcock, *Psycho*, 1960.

[71] I had previously used footage from the Prelinger archives in the development of *Nybble*: see chapter 2. I used a basic Python CURL script to list, then download all of the available Prelinger files from the <https://archive.org> website in an identical format.

[72] The corporate videos included *Computer and the Mind of Man*, as used in the Nybble dancer-recruitment video. Richard Moore, *Computer And The Mind Of Man: Logic By Machine* (KQED-TV, National Educational Television, 1962), <https://archive.org/details/Logic\_by\_Machine>.

[73] Douglas Gordon, *24 Hour Psycho*, 1993, Film, installation, 1993, <http://www.mediaartnet.org/works/24-hour-psycho/>; Don DeLillo, *Point Omega: A Novel* (Pan Macmillan, 2010).

[74] The entire premise of the documentary is that Gordon himself is hard to track down. It is shot in a style rarely found in art documentaries today – brash, self-deprecating, irreverent and insincere – the hallmarks of the *Young British Artists*. Ewan Morrison, ‘24 Hour Psycho’, *Ex-S* (Scotland: BBC Scotland, 1996), <https://www.youtube.com/watch?v=9V0PTNgsQDY>.

[75] Douglas Gordon and Klaus Peter Biesenbach, *Douglas Gordon: Timeline* (The Museum of Modern Art, 2006), 292.

[76] I am indebted to Amy Butt and David Roberts for their support and clear minds during this chaotic screening.

[77] I use the term *archive* consciously here: although the images scraped via *86400* do not exist in a physical archive, Google does keep low-resolution cached versions of the images on its servers. In this instance, I argue that the search queries which returned the specific images represent the probing of an archive of images from the navigable internet at the time that Google; *86400*, the result of a specific set of nearly half a million search queries, represents a snapshot of the Google Images archive from late-2015.

[78] Bateson, ‘Form, Substance, and Difference’, 460. Original emphasis.

[79] See, for example, Emerging Technology from the arXiv, ‘How Google “Translates” Pictures into Words Using Vector Space Mathematics’, MIT Technology Review, 1 December 2014, <https://www.technologyreview.com/s/532886/how-google-translates-pictures-into-words-using-vector-space-mathematics/>.

[80] This method would have the added ability to continually add more films – which would essentially represent more territory – on a continual basis, much like the method by which Uber itself expands aggressively into new areas. For criticism of this, see Knight, ‘How Uber Conquered London’.

Reflexive Scripted Design *Network / Intersect* =========================

In January 2014 I went to see a play by the immersive theatre group Punchdrunk. Entitled *The Drowned Man: A Hollywood Fable*, the performance took place in a large 5-storey building, formerly a Royal Mail sorting office, next to London Paddington station.[1] Each member of the audience was given an identical white mask to wear, and during the performance was free to roam the set of a ‘town’ which had been constructed inside the warehouse to mimic the outskirts of early 1960s Hollywood. The audience could walk in and out of houses, pick objects up, read letters, look in drawers, and follow the (unmasked) performers around as their characters went about their fictional lives.

The performers' scripts led them in a highly choreographed journey around the entire building, from one floor to another, from the David Lynch-styled nightclub and the Foley studio in the basement to the shops, bar and cinema on another, to another's film sets, or the top floors' desert and chapel. The audience would individually choose a character to follow, witness their interaction with another character – for example, a fight – then choose which character they wanted to follow next as the two ran off in opposite directions. Or, they could follow nobody, and just explore the world that Punchdrunk had created. The whole time, a spatialised soundtrack played throughout the set, different in each area, featuring fragments and sections of songs and film scores. This served several functions: to create a cinematic atmosphere, to 'narrate' and provide soundtrack to scenes within the play, and to give the performers subtle audio cues. The play featured little spoken dialogue from its actors, instead relying on movement, gesture, and physical interactions.

Wearing a mask, which limited my peripheral vision, whilst exploring a highly detailed world, and witnessing interactions between actors, yet not being able to interact – even being anonymised by a mask myself – felt somewhere between watching a film and playing a sophisticated video game. After the two and a half hours of the performance, I had picked up fragments of several storylines, but had experienced something that was at once beguiling, intriguing, alienating and immensely enjoyable. In short, I felt punch-drunk. I saw the production several times in order to decode its mechanics.

The play was in fact highly choreographed. It featured multiple intertwining narratives, and around 30 actors, mostly with dance or physical theatre backgrounds, going about their lives in 1960s Hollywood. The play had a looping structure, with each 'scene' being approximately 5 minutes long, and the characters running their entire ‘loop’ multiple times per performance. The storylines for the characters included young actors trying to break into the movie business, exploitative studio executives, spurned lovers, a starlet’s demotion to a non sex-symbol role, and at least one murder (hence the shows’ title). Although there was a high number of characters physically inhabiting the set, there were many more hinted at through the design of the set itself. Each character had a set of spaces that they ‘belonged to’, which were laid out and filled with artefacts which reflected their personalities. This was highly exaggerated, and taken to absurda levels in some cases; the vein starlet's dressing room featured about twenty mirrors all angled to look at her; comically large piles of chicken-wire cages filled one characters' office; a caravan was filled with angst-ridden handwritten letters and actors' headshots; the security guard's office was filled with a huge number of orchids and plants.

The thing I found striking about the play was the manner by which the design of the space reflected the perspectives of its characters. It seemed to reflect Bateson’s assertion that ‘human beings operate more easily in a universe where some of their psychological characteristics are externalised.’[2] Had I not even seen the play, the space itself would have been able to hint at a number of the storylines that would take place inside it. I found myself determined to carry out a project in which the design of a characters' environment to reflect their own beliefs and motivations would play a major role.[3]

Italo Calvino expressed a similar idea in the chapter of his book *If on a winter's night a traveler...* entitled ‘In a network of lines that intersect’.[4] The entire book is an experiment in form; every second chapter is an unrelated ‘first chapter’ from a different genre of book, based in a different culture, and written in the first-person perspective by a character whose internal state of mind is reflected in their environment. ‘In a network of lines that intersect’ is told from the perspective of a businessman who sees the financial and business world as a large optical device. Using metaphors about mirrors and reflections, the character describes his shady and somewhat paranoid methods of financial deception:

They [other businessmen] don't know that I have built my financial empire on the very principle of kaleidoscopes and catoptric instruments, multiplying, as if in a play of mirrors, companies without capital, enlarging credit, making disastrous deficits vanish in the dead corners of illusory perspectives. My secret, the secret of my uninterrupted financial victories in a period that has seen market crashes and bankruptcies, has always been this: that I never thought of money, business, profits, but only of the angles of refraction established among shining surfaces variously inclined.[5]

Calvino, like Punchdrunk, creates a world for his character to inhabit that reflects his internal mind-set and motivations. This particular story culminates in the character becoming lost in his own hall of mirrors, his identity merging with that of those was trying to deceive; the lens through which he saw the world became his own downfall.

As discussed in earlier chapters, Calvino was well known for his experiments in form, both before and during his time as an Oulipian. The extreme constraints he placed on the form of his work in *If on a winters night a traveler…* spanned from the style of writing and entire world-view shifting completely every other chapter, to the overall structure of the book, which follows a rule of thematic inversion: the last chapter was an inversion of the first, and so on. These ideas of constrained, ‘scripted’ processes (following a ruleset in order to create works) were another element I wanted to explore as a creative tool within a project, following the trajectory of projects presented in this thesis that all use the idea of the ‘script’ (computer scripting / scripted performance / scripted design process) in one or more ways. This chapter presents the final project, and the prototypical instance of a process I call ‘reflexive scripted design.’

Part of the inspiration for the reflexive scripted design process came from a workshop I attended in Punchdrunk’s studios.[6] Run by designers Hebe George and Maita Jobbe Duval, who had both worked on The Drowned Man, and held on the set itself, the workshop explored design process that Punchdrunk had used in the creation of the play. One of the main things I took away was their approach to writing their performance scripts. Punchdrunk's plays are reactive to the empty buildings they are set in; the directors of the company spend time alone in a potential building before any of rest of the company see it working out what it could potentially contain. They claim not to have pre-set ideas when they 'acquire' a new property, but rather use a creative process based on intuition to guide their work.

Each play is a synthesis of three elements: two 'primary texts' and a place and time. In the case of *The Drowned Man*, the primary texts were Georg Büchner’s unfinished play *Woyzeck* and Nathaniel West's *The Day of the Locust*, whilst the place and time was early 1960s Hollywood and the surrounding areas.[7] The synthesis of three elements creates something novel, and doesn't force the writers to lean too heavily on any one element. Once I had learnt of this technique, it seemed that it was a mode of scripting a process much in line with my research interests. I had long wanted to work on a project which would similarly create a set of worlds that reflected the internal state of characters, yet also serve as criticism of larger sociological or technical ‘machines’. Calvino’s businessman was a compelling character whose world offered promise: key to the next stage of the project would be to find other abstracted world-views.

Soon after reading Calvino’s novel, I became interested in the similar, but different form of abstracted world-view emerging forms of Russian propaganda which were being reported in British and American press.[8] A pair of articles in the New York Times and the Guardian in 2015 present an interesting image of state-sponsored Russian propaganda in the 21st Century. In the New York Times article ‘The Agency’, investigative journalist Adrien Chen examines a propaganda agency whose aim is to create uncertainty on the internet, using social media, blogs, and online videos.[9] Workers at the St. Petersburg-based Internet Research Agency (IReA) create and curate false avatars who inhabit online space. Many of these avatars run blogs, comment on news articles, and display a high level of interaction with each other, frequently commenting on each other’s blog posts, mentioning each other in tweets, and so on – creating the illusion that these avatars belong to a natural, organic community. In addition, they create false accounts of events that never happened. In the story's opening anecdote, the avatars create a social media frenzy around a fictitious chemical fire in a small town in Louisiana, using websites such as Twitter to ‘report’ on the situation in real-time, contact real local officials, and act as if the event had really happened. Other fabricated events Chen described include a racially motivated shooting, and an Ebola outbreak at Atlanta airport. The Ebola outbreak is particularly notable for the level of detail in its supporting media:

A YouTube video showed a team of hazmat-suited medical workers transporting a victim from the airport. Beyoncé’s recent single “7/11” played in the background, an apparent attempt to establish the video’s contemporaneity. A truck in the parking lot sported the logo of the Hartsfield-Jackson Atlanta International Airport.[10]

This, Chen argues, is not normal propaganda. The motives behind this new mode of false information are intriguing, and something that British-Russian journalist Peter Pomerantsev investigates further in the Guardian article ‘Inside the Kremlin’s Hall of Mirrors’.[11] One aspect of the contemporary Russian propaganda efforts, Pomerantsev explains, is to sew stories of falsehoods in every possible media outlet, from the internet to the state-sponsored Russia Today TV channel (known as RT). The initial aim is to create a distrust in the media. However, Pomerantsev relates the overall effort back to a Russian field operations manual called *Information-Psychological War Operations: A Short Encyclopaedia and Reference Guide*, which he quotes:

“There are two possible approaches to information war,” the encyclopaedia states. The first approach “recognises the primacy of objects in the real world” and attempts to spin them in a favourable or unfavourable direction. The “more strategic” approach, it continues, “puts information before objects”. In other words, the encyclopaedia seems to be saying that reality can be reinvented.[12]

This is a powerful image: the idea that by spreading mistruths, the fabric of reality can be undermined.[13] I began to think about the workers that Chen describes at the IReA: what do they think about the work they carry out, and how does it feel to be sewing untruths for a living? In the article, Chen describes the daily routine of the workers via a former worker he interviews; he witnesses the staff exit and enter their workplace end masse at the beginning and end of their 12-hour shifts. Knowing anything beyond the immediate task to hand, I thought, would imply that either the workers are highly cynical, or that they adopt a similarly abstract worldview to the character in the Italo Calvino story.

These issues of control, and how they affect personal freedoms, bring me to a pair of related theoretical writings: Felix Guttari’s ‘Postscript on the Societies of Control’ and Nathan Moore’s ‘Diagramming Control’.[14] Moore’s chapter builds on the central argument of ‘Postscript on the Societies of Control’ – a work that proposes that Western society has moved beyond the Foucauldian idea of ‘disciplinary societies’ (epitomised by the diagram of the Panopticon), and towards ‘societies of control’ where power is increasingly abstracted and norms are ever-shifting.[15] Moore has an interesting perspective on this argument: he is a lawyer who is interested in the concept of control, yet also has an interest in the built environment.[16] His chapter aims to create spatial metaphors that enable the reader to create diagrams of control systems, so that a layer of abstraction is removed and they may be discussed in a spatial plane.

In the summer of 2015, the photographer Max Colson and myself were invited to run a workshop by the Royal Institute of British Architects (RIBA) and UCL Urban Lab. The workshop was entitled *Virtual Control*, and was timed and themed to accompany an exhibition of the same title Colson was showing at RIBA (which also featured one of my art pieces).[17] We took a group comprising approximately 12 members of the public and RIBA members on a guided walk from Stratford Underground Station in London, through the Westfield East Shopping centre and to the recently-opened Queen Elizabeth Olympic Park. Colson and I wanted to encourage these members of the public to engage with these newly constructed ‘public-private partnerships’ and investigate the implicit rules and associated behaviours that the spaces generated through a series of structured conversations – essentially, to question to what extent Guttari's ‘Postscript on the Control Society’ had been embodied in these new built forms.[18] One of the attendees was Moore; the conversations that we had on the day, and the email correspondence that followed, was of great interest to me. We discussed how the Westfield Shopping Centre in its architectural and interior design was a dense informational system which (whether it had been designed this way or otherwise) existed for the purpose of conveying meaningless messages. It presents the visitor with a seemingly endless array of novelty, creating continual confusion and causing its visitors to lose their grip on the meaning of their environment – and thus, causing them to buy more goods.[19] The metaphor about Westfield was similar to that found in the articles on Russian propaganda, and a similar sleight-of-hand technique to that used by the character in the Italo Calvino story.

The ideas I had been exploring would find a concise application once I began my residency at the Palais de Tokyo. In November 2015, the Palais de Tokyo’s curator Fabien Danesi and Seoul Museum of Art’s (SeMA) Gahee Park told the 6 artists in the programme about a group show they would be curating at SeMA. They wanted us to each create a new work that in some way tied in with their exhibition title Urban Legends, and if possible, made some reference to Korea. The budget allocated was €3000 per artist, and the exhibition would open in April 2016. As part of the programme, the artists would also spend a month in Seoul in advance of the show.

## Network / Intersect

Due to the constraints of the exhibition format, its timescale, and budget, as well as my personal interest in the medium, I decided that the best option would be to make a film. My time would be split between this and several other projects (*86400*, *24fps Psycho*, and *Scriptych*). From the date we were given the brief, there were around 4 months until the journey to Korea; one month in Seoul; then the exhibition. Based on the time constraints, and the inevitable difficulty of producing an ambitious work in a new country where I was unable to speak the language, I decided that all filming would have to take place in Paris.

The limited budget meant that sets had to be produced cheaply, or filming would take place in public places where no permits or permission had to be sought. The budget would also limit the available crew; I could afford to pay a limited number of actors, but also had the assistance of staff at the Pavillon: Justine Emard, a practising artist and photographer, and Justine Hermant and Chloe Fricout, who would both assist with production.

### Rules

I chose to adapt the method I had learnt from Punchdrunk to determine the content: the subject matter would be inspired by the stories of Russian internet propaganda and Italo Calvino's *In a network of lines that intersect*; the place and time would be a contemporary Seoul. However, the practical constraints of not being in Seoul made shooting there within the time-frame impossible. In addition to the adapted Punchdrunk technique, I created a basic ruleset which I would use to make decisions throughout the project, about every aspect of the production, from its inception to the film editing.

The rules were:

1. The form of the film must reflect its content
2. Techniques of the Russian Internet Research Agency must be used where possible
3. The film must be set in Seoul
4. All filming must take place in Paris

Some of these were chosen for thematic reasons: introducing creative constraints to form and content, much like the Oulipian rules; some of the rules were for practical reasons (but also posed creative constraints). All the rules were decided following careful research, and a reflection of my own attitudes towards the subjects. Thus, I call this process of rule-creation ‘reflexive scripted design.’ The term ‘reflexive’ is used as an adjective in two ways. Firstly, like Oulipian works, it focuses attention on the process and production of work, so that the rules themselves become part of the defining fabric of the project.[20] Secondly, it acknowledges the role of the author in the creation of work which responds to subjects; the author becomes innately aware that the arbitrary rules created early on may have effects on the form and content of the work later, and thus the perception of the subject matter.[21] ‘Scripted’ in this instance refers to the rules which are created. In using this term, I consciously embrace its myriad meanings and inherent contradictions, giving a degree of freedom to the author: like the director of a play, they can choose the level of leniency they give themselves to interpret their own rules. The rules should be created as a result of research into the subjects, places, and potentially characters to be integrated into the work, and in some way ‘site’ the project (as the Paris-Seoul relation did in this project).

### Form

The project described in this chapter serves as the prototype for this design process. Once the rules had been established, the most important thing to establish was the form the film would take. Being a film synthesising two inter-related themes, I decided to display the film on 2 screens side-by-side, with the idea that two films would be synchronised to show similar aesthetic content whilst discussing contrasting but complementary subject matters.[22] The film would focus on two characters: one inspired by Calvino's businessman, the other a worker in a propaganda agency responsible for a network of avatars. Central to the propaganda agency worker's job is the adopting of multiple personas and viewpoints in their 12-hour days.[23] In order to carry out this task, I decided that my character would have to adopt a mode of thinking similar to the one Pomerantsev describes; to believe that reality is an illusion, and that their work is meritorious in its role in pointing this out. The mode of exploring both characters would be through showing their routines and the environments they inhabited, both of which would reflect the internal states of the characters.

The characters would also balance each other visually; one sees themselves as a master of their own destiny and is the director of a network of companies, whilst the other is low-ranking within a chaotic, and ever-moving organisation.[24] I named the characters ***M*** and ***W***, letters whose capitals are the inverse of one another. ***M*** – based on the Calvino character – would appear in the centre of the screen where possible, with low-angle cameras to imply their dominant position. Their environment would be luxurious, executive: travelling by chauffeur-driven car, meeting in marble-lined buildings and boardrooms full of dark wooden furniture. ***W*** would travel by public transport and work in an increasingly messy cubicle in a generic office building. The visual inspiration for ***W*** was largely inspired by the films of Kaufman; an atmosphere of shoddiness and chaos.[25] Like most Kaufman films, many Theatre of the Absurd plays, and the Calvino story, the films would also be entropic. The central motif of both storylines would be the disintegration of the characters' sense of self caused by the abstracted lenses through which they see the world.

Since the central motif of Calvino's story is that of the mirror (the businessman has built his empire on the idea of mirrors), the films would also mirror each other – one playing forwards, whilst the other played backwards. Once they came to their end, or beginning, the direction of both films would reverse, so that the film that had previously been playing backwards would play forwards, and the previously forwards film would play backwards.[26] However, this came with a challenge: in the pair of films, each one’s chaotic end would have to segue into the others’ ordered beginning.

These chaotic endings would differ for both characters, based on their world-views and their particular line of work, but both would revolve around issues of identity and their sense of self. ***W***, whose character transforms into myriad personalities per day in the confines of the office for the purposes of living virtual lives online, would find these invented characters invading his non-work life; to borrow terminology from Deleuze and Guattari (via Manuel de Landa), the *virtualities* he created online would merge into his *actuality*, blurring the line between his lived reality and the fictions he creates.[27] The film would show ***W***’s daily routine becoming slowly more confused and absurd, culminating in him repeating lines of fiction to narrate his lived experience; simultaneously, he would be seen wearing distinctive costume from his characters in daily life, visually symbolising this transition. ***M***, on the other hand, explains his business dealings in terms of mirrors and lenses, as if his whole business empire were a large machine for the creation and manipulation of images. During the film, he extends this metaphor to describe a technique he uses to ensure clients empathise and identify with him:

***I imagine myself behind a one-way mirror, so that when they look at me, they see themselves: their moves and mannerisms, their hopes & dreams. The whole time my true motivations remain hidden – even from myself.***

Much like the character in Calvino’s story becomes trapped in his own hall of mirrors, ***M*** becomes victim to his techniques of hiding his emotions and motivations. He develops an inability to distinguish between his own mirror image and other people, his speech merging with that of his clients in a confused, parabolic mess. The film should convey the impression that ***M*** is somewhere between mirrored self-misidentification and a Fregoli disorder.[28] The two storylines feature similar forms of self-identity crisis, but resolve in different ways.

This would also mean that both films would have to be filmed with a mind to their appearance both forwards and backwards simultaneously. It took several attempts to devise a means to diagram the shots of both films in a way that ensured they could share thematic elements and transitions in both directions simultaneously. The eventual result had two main elements: a timing system, and a diagram system.

### Timing

The overall film length was to be 512 seconds; this meant each film would be 256 seconds long. I chose this time increment for two reasons. Firstly, ***W*** works primarily on computers. Computer memory works on a base-2 system;[29] ***256*** and ***512*** are numbers synonymous with computing. Secondly, both numbers are divisible in the base-2 system; therefore, the film could be divided into 1, 2, 4, 8, 16, 32 or 64 second chunks. I settled on 4 seconds after doing a few screen tests. 2 seconds is too short; 8 seconds is too long. This does not mean that all shots must be four seconds, but rather a multiple of four seconds.

### Diagram

I developed a diagram system to plan shots within the films. This consisted of two landscape pieces of paper, of equal length, which had measurements printed across the bottom from one side to each other – one line to represent each four seconds of the film (256 seconds total). The paper also had an arrow pointing left to right to signal its direction. Transitions would have to occur at 4-second markers. Read left-to-right, the storyboard acted like a film timeline. Turning the other storyboard upside-down and placing its timeline in line with the other film ensured that what was happening on one storyboard at a certain time could be synchronised with the storyboard on the other screen as well. Time could be effectively segmented into usable shot-lists.

My initial storyboards divided the timelines into equal-sized ‘chunks’, portraying one day in the life of each character (so the films would, for example, both feature 4 64-second ‘sections’, each one representing a day in the characters’ life). However, playing through storyboard simulations in film-editing software with script read-throughs showed that these felt like artificial constraints on natural story-telling. If each ‘day’ onscreen was the same length as the others, it would be hard to draw attention to any particular element as the focus of a story). The 4-second shot rule (or multiple thereof) was, however, kept in place; this enabled and enforced a modular filming style whereby each shot had a minimum of 4 seconds on-screen. When working with actors, they would be given directions for the next 4-20 seconds immediately before filming, echoing the modular way in which I envisioned W's character working in the propaganda agency (‘picking up’ and ‘putting down’ multiple personas per day).

### Workflow

The descriptions of editing and audio techniques above reflect one crucial part of the design process: workflow. A major part of film-making is the discipline and planning one puts into one’s workflow: having a framework in place to shoot, gather footage, review, rate, collate and edit a film. In the case of this project, whereby the form of the project and its outcome was being determined in advance by a scripted design process, this was even more important. The operations to shoot two films simultaneously, both of which must be played both forwards and backwards, are complex. Another crucial limitation was the film's budget: I could only afford to pay the actors for a small number of shooting days (4 per actor) and there was only one day where both actors would be in the same place at the same time. The logistics of the editing operation were worked out in advance of any shooting, and multiple attempts to edit and export ‘dummy’ footage were tested to improve the system.

One of the main editing restrictions was the capabilities of editing software on my computer.[30] Although my computer has relatively high specifications for film editing, the challenge of editing 2 high definition films in opposing directions was one with intrinsic practical issues; rendering previews of reversed film is still something that takes time. The following workflow was devised for film exports.

The final film consists of two 1920x1080 films, side by side.[31] However, the films were edited individually, then exported as assets which were then imported into a third, master timeline. This timeline simply positioned a film file called ***w\_latest.mov*** on the left, and ***m\_latest.mov*** on the right. Because the films were pre-compressed (and could be exported at low resolution as they were simply to check timing of shots in editing), they could be reversed on the timeline easily. When it came to mastering the films, I simply had to export high resolution versions of ***W*** and ***M*** as ***w\_latest.mov*** and ***m\_latest.mov***, then export the master film (which would collate these two films) at high resolution. The structure of the film, with the 4-second ‘chunks’, proved to create a highly restrictive editing technique. This meant that there are a few sections of the film where the pacing is not as it may have been had I been able to work outside of the confines of the scripted design process, but these limitations do reflect the working methodology of Calvino and the Oulipo.

In order to plan shots, and be able to work confidently and efficiently when actually filming, I created diagrams detailing the optical angles and focus lengths of every camera I had access to. I also shot test footage in every location that I would later use. This would enable me to plan shots more effectively for shooting.

### Internet Research Agency Techniques

Besides the technical aspects of film-making, a major component of this project was the use of techniques inspired by the IReA. Chen reports that the last known address of the IReA was in a nondescript office building in St Petersburg, yet their workers, assumed to be near-exclusively Russian, make videos and write blogs that purport to be from America. Chen’s example of a video supposedly shot in Atlanta airport gains legitimacy through the positioning of a truck in the video with Atlanta Airport decals (see Figure 4-39). Rules 2, 3 and 4 of the project stated that the film must use IReA techniques, and be shot in Paris but set in Seoul. By shooting in Paris-as-Seoul, I was also fulfilling the IReA technique: in the same way that it could be assumed that most of the IReA workers had not visited the USA, I had at that time not visited Korea. Therefore, like the IReA workers, I would have to use the tools of the internet – Google Street View, Flickr, Google Translate, and more – to learn what my version of Seoul should be.

One step towards creating a fake Seoul was to find the people to inhabit it: the actors to play ***W*** and ***M***. I had, for the first time, budget to pay actors, so set about placing adverts written in Korean and English in the artist residences where I lived, on Facebook and the internet. Through a network of contacts, I managed to gain enough applicants to hold auditions, and chose to cast two actors: Hokyoung Kim, a Korean actor visiting Paris and looking for work, and Patrick Ng, a Hong-Kong-Dutch actor.[32]

The easiest film to shoot in a fake Korea would be ***M***, an executive who would be seen riding in chauffeur-driven cars and in luxury offices. Interiors of offices would be filmed in the Palais de Tokyo; in sets I would construct in the Pavillon studio, and on the marble staircase of the 1937 building. One shot in particular – of ***M*** descending a staircase – echoes the Russian Constructivist photographer Aleksandr Rodchenko's *The Stairs*.[33]

Much of ***M***’s routine involves travel in the back of a car. This meant that I had to have several shots of 4-20 seconds’ length of ***M*** in a car. The camera would be positioned low down, between the two front seats, facing up at ***M***, who would be seated in the centre of the rear seat. The budget of the film would not allow for executive car hire, so I used Uber Executive (a taxi service providing executive cars) for a journey from the Palais de Tokyo to Pont Louis-Philippe bridge. I spent time in advance searching for a journey that would feature tunnels similar to those I had seen on Google Street View of Seoul; this journey ensured that the driver would take the express road by the river that was also away from the distinctly Parisian buildings we would pass (the low camera angle would also mask our true location). This journey would also take us to the bridge where the intersection shot could be filmed (the actor playing ***W***, plus the two assistants followed us in a second Uber Executive taxi, which we would use to shoot the transition shot, around 25 minutes later).[34]

Unlike ***M***, ***W***’s character is a low-level employee, ill-compensated for their work, travelling by crowded public transport to a shoddy, generic office with a temporary for a gruelling 12-hour shift.[35] The buildings he inhabits would be generic, slightly run-down; I also wanted to include a Kaufman-esque office that would deteriorate in reflection of the characters' identity breakdown. The shots of ***W*** travelling to work would be shot on the Paris Metro system, but with masks similar to the ones the IReA used on their ‘Atlanta Airport’ truck to disguise it. The Parisian Metro is particularly visually distinctive: many trains have doors which require manual opening, the network contains strongly French design influences throughout, and several of the stations are ‘themed’.[36] It fascinated me as a public space: it is often extremely busy, and many areas are covered with graffiti. It is not uncommon to encounter performances whilst travelling, both in ‘sanctioned’ areas where musicians busk in stations, or in carriages, where both individuals and groups of musicians frequently enter carriages and play loud music for a few minutes. I chose to film on Line 1, whose relatively modern trains (and their doors) are automated, and whose interiors featured long illuminated panels onto which fake Korean subway maps could be attached.[37]

I designed four sets of maps, which originally were intended to feature in four scenes of the film (however, in later editing this was reduced to one map). The station names, written in Korean, were in fact partial sentences taken from Moore’s ‘Diagramming Control’, and translated into Korean using Google Translate. All of the shots on the Paris Metro would be taken with a short-focus lens, and feature a close-up of the ‘Korean’ Metro map, followed by a pan to ***W***'s character arriving in a station, then following him as he leaves the train and turns right to walk down the platform. Whilst filming, we would then both run to get back onto the train, re-entering in a loop so that we could film the next scene at the next station without losing the map.

Another part of the Parisian Metro to feature heavily in the film was Châtalet des Halles station. When I had first moved to Paris, I had taken note of the station’s travellator.[38] It was as notable for its length (around 300 metres) as well as its unusual form; a horizontal section with a high ceiling is contrasted halfway along with a curved incline and a low ceiling. During the time I was resident in Paris, Châtalet was also being refurbished, and the travellator had a series of exposed beams above it: the unnaturally steady movement of a camera on the travellator combined with the exposed building innards would make a perfect texture for a film about a person who is experiencing a sense of detachment from their surroundings. The same short-focus lens was used as for the Metro train shots, and green, municipal-style posters were stuck to the side of the travellator every 10 metres or so that said ‘Remember: You're in Korea’. I liked this idea because it was so absurda; I have never seen a poster to remind an audience which country they're in.[39] In the film, ***W***'s character looks at the poster at exactly the moment his voiceover dialogue says, ‘***How can we trust anything when solidity itself is an illusion?***’ The posters can also be seen in the corridor of ***W***'s office building as he enters every morning.

The travellator served the modular filming method well; we would film ***W***’s character in one costume travelling both ways on the escalator, and upon return to the original end (where our assistant was waiting with the equipment bag) ***W*** would change into another costume, and we would loop again. Our other assistant waited at the other end of the escalator to look out for officials. We shot every variant of ***W***’s multi-costumed character in both directions on the escalator.

### Transition shots

I needed to devise a means for the characters to pass on the chaotic ending of their story to the gentler beginnings of the other story. The beginning of ***W***'s story would focus on an atom spinning, and ***W***’s justification for their work: that ‘***there is so little matter in the universe, it may as well not exist***’ (and therefore that reality is but an illusion, and a little more untruth is no different). I found this ‘fact’ through an IReA-derived process: Googling terms such as ‘nature of reality’ or ‘amount of matter in the universe’ until I found websites (of questionable quality) that presented me with information that suited the characters’ motivation. The model ‘atom’ used in ***W***’s film was a wine cork placed onto the end of an electric drill's screwdriver head. The drill used had a built-in LED light which activated when the drill operated; thus, the drill itself provided both the atoms’ spinning and illumination. This scene would be the counterpoint to ***M***’s identity breakdown, which would present ***M*** repeating a palindromic series of lines as if a spinning kaleidoscope (an effect generated in post-production).

The other ‘transitional’ scene would take advantage of the physical positioning of the screens within the film; using two identical cameras placed on a special rig, I would film the characters’ paths crossing in a city. The moment would be an intersection of two paths, as in the title of Calvino's chapter. At the height of ***W***’s breakdown of identity, ***M*** would pass in a car, pause as if at traffic lights; ***M*** and ***W*** would look at each other, and ***M***’s car would continue. This would establish a power relationship between the two characters: ***M***’s travel by executive car would contrast the busy, confused journey by metro we had just witnessed ***W*** taking, thus establishing ***M*** as a person who is in control. At the same time on-screen an audio cue would direct attention to the other screen: the stereo track, which during ***W***’s film playing forward would be entirely on the left (where ***W***’s film is) would transfer to the right (where ***M***’s film is). The shot would require technical logistics and another diagram.

A site was chosen on a bridge in Paris for the live-action transition – Pont Louis Philippe.[40] By this time, I had lived near to this bridge, at the Cité Internationale des Arts artist studios for 3 months, and had observed the bridge and its footfall near-daily. The one-way bridge is uniquely placed in Paris, as it is adjacent to another, far busier bi-directional bridge (Pont Marie), yet itself has very small vehicular throughput. The high number of one-way streets in Paris were a consistent consideration for film-making. This particular layout, and the relatively quiet nature of the location, meant that between takes the driver could do a loop of the nearby streets to ‘reset’ the shot each time (see Figure 4-45), as well as ensuring that the actor playing ***W*** could safely stand in the middle of the road (supervised by assistant Justine Hermant) between shots.

The shot was planned via a diagram; the basic premise was that two identical Blackmagic Pocket cameras would be placed next to each other on a rig, so that the right edge of the left camera’s frame would line up with the left edge of the right camera, thus creating an extremely wide-angle shot (the 32:9 ratio with 3880x1080 pixels). ***W*** and ***M*** would be framed on their relative sides of the screen, save for the time when ***W*** crosses the screen into ***M***’s shot. ***W*** leaving his own screen was a deliberate choice; I wanted the audience to have a visual cue as to which screen they should divert their attention to. Figure 4-47 shows the actions that had to be performed for this to take place; shooting two films at once, one would have to be reversed. ***W***’s film was the only logical solution, as this shot comes at the end of his film, as part of his confused state (so the rest of the world working the other way round from him makes sense) and ***M***, being composed and in control at the beginning of his film, would have to be moving forwards. The solution was to film ***W***’s end-scene backwards, and ***M***’s introduction scene forwards, both at the same time. Therefore ***W*** would walk backwards from right to left of the screen as ***M***’s car approached, then pause and look at ***M***, then walk backwards off-camera to the left as ***M***’s car drove away to the right of the screen. The audience would see the entire scene backwards the first time around, so that ***W*** walks up to a car that is reversing up the street, looks at ***M***, and then crosses the road as ***M*** reverses out of view, then as both films change direction, ***W*** would be walking backwards whilst ***M*** moves forwards.[41]

This day of shooting took a deal of logistical planning: it was the only day that both actors could schedule to work together. I met with ***M*** and ***W***, and assistants Justine Hermant (JH) and Justine Emard (JE) at the Palais de Tokyo in the morning. I explained the logistics of each shot that we had to get that day, and we used the Pavillon studio and an unoccupied exhibition space to practise the shots. We then split into two groups: ***M*** and I would take an Uber Executive through Paris on the route that enabled us to film his in-car shots. ***M***, JH and JE would follow in another Uber Executive 25 minutes later, and we would all rendezvous at the bridge, where we would shoot the transition scene. ***M*** would then leave, and ***W***, the assistants and myself would go to the Cité Internationale des Arts to shoot all of ***W***’s corridor scenes.

### Audio

A crucial technique in the signalling of screen the audience should focus on (besides the obvious film direction) would be the audio track. Having two films playing side-by-side in the opposite direction to each other, I wanted a method to ensure the audience knew where to look. Using stereo sound, the audio of the film that is playing forwards is selected to come from that side of the screen, so that when ***W***’s film is playing forwards – on the left screen – the audio is active in the left channel and silent in the right, and vice versa for ***M***. The transitional scenes, where one storyline transitions into the other, and the direction of both films changes, would feature a cross-fade to signal this change. In the video shown in Korea, subtitles would also act as a visual cue.

Audio also became a crucial part of the editing process. I always find editing a film sequence to audio far easier than editing without. This film was edited on non-linear editing software Premiere Pro.[42] In the software, it is possible to place visual markers, say, every 4 seconds, which can be used to trim clips as needed. But this does not always aid the pace of film-editing; so I decided to use a click-track equivalent. Using the programming language Processing and sound library Minim, I generated two sine-wave notes (C5 and G5) of 0.5 seconds’ length.[43] These were imported into the timelines of the two films, ***M*** and ***W***, in my Premiere Pro timeline so that every second a note would play – a G every fourth second, and a C every other second. This meant that I was able to remain conscious of pacing and timing of shots whilst editing. As every cut would fall on a G, it became easy to work out how long shots I was editing would last, and whether they were suitable. It is remarkably hard to edit shots to a particular length without such a click-track. In the final edits of the films, I decided to keep the click-tracks in; their consistency led to a distinctive aesthetic, similar to that found in *Nybble*, and helped signal the audio cue from one screen to another, and their pacing gave a sense of order. It also proved to be an interesting artefact of the process that had led to the films; an instance of the form being shaped by the content.

### Visualising break-down

During ***W***’s film, the audience witness him creating false stories similar to those that Chen describes: mundane mistruths about small towns in the American countryside. I wanted the towns to sound distinctly American and plausible, so downloaded a dataset of small towns in the United States from the US Government's Open Data site.[44] In my trips to the United States over the past few years, I had been struck by the distinctive way in which Americans say town names in normal conversation – the town name is usually closely followed by the state it is in (for example, ‘Oklahoma City, Oklahoma’, ‘Chicago, Illinois’, or ‘Slaughter, Louisiana’). This seemed like the sort of detail that the IReA would have picked up on. ***W***’s dialogue when describing fictional events would be like a news ticker:

***Swink, Oklahoma. The senator's wife still missing. Temecula, California. A plane crash...***

However, the town names become more confused:

***Agora Hills, California. A strange man in a trench coat. Agnosia Hills, California…***

Agora Hills is immediately followed by Agnosia Hills. Agnosia is a mental symptom whereby the subject fails to recognise or identify objects, often associated with conditions where patients lose their grasp on reality (e.g. Alzheimer’s).[45] ***W***’s statements become more confused and mundane as the film goes on, eventually culminating in the statement:

***Seoul, South Korea. A businessman in a car.***

This signals something he is actually seeing: therefore, the false worlds he creates and the one he lives in are merging. ***W*** falls victim to his own trap, believing the untruths he spreads whilst add another layer to his uncertain reality.

The short, succinct style for these lines had several influences. One was my memory of news-ticker headlines from old radio programmes when I was a child. Another was Dora Garcia’s book *All the Stories*, which is a compendium of short stories with many sources, each told in a few sentences;[46] another still was the opening to Bob Dylan's Theme *Time Radio Hour* programme, which ran from 2006-2009. At the beginning of each episode, a female voice declared a series of short statements in a consistent format:

It’s night time in the big city. A truck driver runs a red light. A strange quiet man practices tai chi in a park. It’s Theme Time Radio Hour with your host Bob Dylan.[47]

The statements were short and intriguing, with just enough detail to paint an intriguing picture of a scene.

Another signifier of the chaos in W’s life is his office cubicle: it becomes messier as he becomes more confused. All of the scenes featuring W at his desk were in fact shot with a forced perspective – and angled table – against a rear-projection screen.[48] This was the same rear-projection set also used for ***M***’s office scenes. ***W***’s office cubicle was a model built of polystyrene board, built and animated with Justine Emard. With a fixed-position camera, we shot video of the scene becoming messier over time; the carpet gets patchy and stained, post-it notes, documents and maps get stuck onto the wall, and the floor becomes covered in messy paper and rubbish.

The office’s exterior also changes over time. The shots of ***W*** walking down the corridor were shot at the *Cité Internationale des Arts*, and feature the same ‘Remember: You're in Korea’ posters as the travellator scenes on the metro. The company ***W*** works for is called Ray Inversion (a reference to ***M***’s character). Each time ***M*** enters the door, the sign is increasingly distorted (reflecting the ever-changing, temporary offices Chen describes and ***W***’s mental state):[49] first, the sign is shabbily taped to the door; then taped upside down; then, multiple signs are taped haphazardly on top of each other. The external world again reflects ***W***’s current state of mind.

Like ***W***’s office, ***M***’s board-room was also a model with a forced perspective. However, the process was slightly different for ***M***: first, footage of ***M*** (and myself, as the ‘client’) was shot on the same set as ***W***’s cubicle (the rear projection screen). The image projected behind ***M*** is a blue wallpaper pattern that was ‘mirrored’ in Photoshop to create a line of symmetry. We shot all of ***M***’s scenes, including the scenes featuring me as ***M***, and recorded the dialogue live on-set, rather than in post-production. These scenes were then edited for visual clarity (increasing contrast, eliminating unwanted background, etc.) and the footage transferred to an 27" iMac with high-resolution monitor. The iMac itself was placed into a forced-perspective model of ***M***'s boardroom, and each scene re-shot from multiple angles, so that it appeared that ***M*** was inhabiting a miniature model.

The paperwork that ***M*** is seen looking at in his office are stylised re-drawings of diagrams taken from an e-book copy of Newton’s *Opticks*.[50] These were printed on top of discarded corporate spreadsheets, salvaged from a bin in Paris. The table under the paper gains the superimposition of Prelinger Archive footage of a giant telescope, further highlighting the visual metaphor.[51] This optical metaphor also spread into the buildings that ***M*** inhabits: these were simple models constructed from elements of Flickr images of downtown Seoul (a technique inspired by the IReA). The images were mirrored to echo the central motif of ***M***'s story; this image was then put onto a high-resolution TV screen which was placed behind cardboard cut-outs of mirrored buildings taken from other images of buildings in downtown Seoul. These buildings also featured the logo of an eye – designed to be one of ***M***’s company logos. The design of this logo was based around Ptolemy’s idea that vision occurs via the eye casting out beams of light;[52] the logic being that the protagonist in Calvino’s story begins by paraphrasing Plotnius, and therefore would be likely to have also read early treatise on vision by other Greek philosophers.[53] I did design logos for companies that would serve as a basic visual history of optical theories throughout philosophy, but cut the detail before shooting as it was a concept too complex to explain via the script.

### Performance reflecting propagandist techniques

The mode of performance for the actors was designed to reflect the IReA techniques. As the IReA workers are given the minimum information required to carry out each task – often resulting in them sending confused, contradictory messages – the actors in this film were deliberately given minimal instructions in order to act in each scene (with the exception of the bridge-transition scene).[54] This was a mode of answering the research question, extending scripting to the process of producing a film, and often led to absurd scenarios.

For the break-down of ***M***’s character, I wanted to evoke a feeling of lack of meaning to the words the actor was speaking. This would create a sense of confusion, similar to the confusion the character ***M*** was supposed to be feeling at that time (I had thought of his mental state as being like Fregoli delusion, whereby facial recognition and the boundaries between self and others are warped).[55] In order to evoke this state, the actor would be directed to repeat the palindromic script, which also featured numerous optical references (‘shift the focus’), until it lost all meaning, getting faster and louder each time. Since I played the ‘other’ that ***M*** merges with, I also underwent this process. After about 2 minutes, I entered a trance-like state of repetition, and the script I had written was unrecognisable. However, this is one area of the film that I do not feel is successful; it is a repeated palindrome within a repeating palindromic film, but the audio recording was low quality.

Similarly, whilst shooting ***W*** as his multitude of characters, a ‘modular’ approach was taken. This involved a rotating array of rear-projected backgrounds (the disintegrating office scenes), a repeated set of instructions, and a series of costume changes. The idea was to get footage of every permutation of ***W***’s character, against every possible background, behaving in one of four manners (staring vacantly at the camera, typing, typing manically and ‘freestyle’), so that this footage could be interspersed later on in the editing process. Shooting these scenes took around 4 hours, during which time the actor repeated the same behaviours hundreds of times. It became a strange, ritualistic performance, and, like shooting ***M***’s character, during shooting the ritual overtook any sense of meaning.

## Chapter conclusion

The final chapter of this thesis has defined a novel ‘scripted’ design methodology, and presented the prototypical instance of this method in the production of the film *Network / Intersect*. The methodology, entitled reflexive scripted design, synthesises techniques of the Oulipo (constrained, rule-based writing) with site-specific playwriting methodology of the Punchdrunk theatre company, into a new technique which is both a generative creative tool, and critically engaged. Reflexive scripted design is differentiated from the majority of other contemporary ‘scripted’ design processes (such as parametric design, for whom constraints are usually spatial or material) precisely because of the enforced post-research period of reflection, and processing of contextual information in the generation of rules which determine the creative output.[56] The purpose of this reflection period is to ensure that the content of the subject matter, and the designer’s own understanding of that subject matter, is reflected in the form of the design resolution (hence the term ‘reflexive’).

In the introduction I discussed the criteria by which I assess a projects’ success: the extent to which the processes and techniques used to create the project are expressed, or the *honesty* of its form; the ability of a project to communicate its core ideas effectively; and the use of absurda+b themes and techniques (including humour and hinting at the Camusian, existential absurd). Whilst the project and methodology discussed in this chapter are not without flaws – many of which will be discussed later – they represent the most successful of the projects in this thesis according to my own assessment criteria.

With respect to the last criterion (the absurd), the process of reflexive scripted design, and the film that I created using it, is consciously and conspicuously an absurda performance. The process requires the designer to create rules, (in themselves absurda), which are then *performed into* their work. The constraints placed on *Network / Intersect* were patently ridiculous, and led to equally absurda outcomes (for example: disguising Paris as Seoul; working actors into a frenzy with repeated, iteratively different takes; using a limited palette of techniques and technologies taken from Russian propagandists). The absurdb also forms a central theme to the film: ***W***’s character expresses opinions about the meaningless and inconsequentiality of their own actions, the impossibility of truth, and the meaninglessness of existence as a whole; ***M***’s character expresses an absurd understanding of the meaninglessness of capital, yet simultaneously a desire to control it. Like many Theatre of the Absurd plays, both of the stories in *Network / Intersect* are entropic; they also depict a breakdown in communication, albeit one within the characters’ minds. The ability of the project to convey the absurdb is perhaps aided by the projects’ rooting in fiction (as opposed to the computational process or live choreography of the projects in chapters 1-3).

This prototypical reflexive scripted design project is also successful in the communication of its core ideas. The subjects of the film (the Italo Calvino story and Russian propaganda) are both at the forefront of its narrative, as well as reflected in the techniques used to create the film and its final form. In this respect, the film fulfils the *form* and *communication* criteria laid out in the introduction more successfully than any of the other projects. This is again perhaps an affordance of the project being a fictional film; the director of a film has total control of what is included in every frame (the *mis-en-scène*), and the techniques used to create the imagery. Unlike any of the other projects I have created via computer scripting or choreography, audiences are so used to the medium of film that the technology becomes almost invisible, allowing them to focus on the subject and content rather than the details of the medium itself. *Network / Intersect*, in being a dual-screen alternatively-reversing film, consciously plays with the expectations of an audience that a film will be a mono-directional experience depicting one story at a time, thus using a standard format to confound an audiences’ expectations.

The success of the methodology according to my own criteria does not mean, however, that the project was a total success. As with any project, there are numerous changes that I would make to its execution if I were to carry out the same task again. Most of these are related to the production of the film *Network / Intersect* itself, rather than the reflexive scripted design process. One of the shortcomings is the editing of the film: the process used to edit the film was cumbersome, and offered very little room for changes to pacing of the stories (as editing one film necessarily edited the other). The editing process of a film is where it comes to life; the first cut of the *Ant Ballet* documentation film was approximately double the length of the final cut, as iteratively I was able to go through footage and cut each scene down to the bare minimum required to communicate an idea.[57] However, the editing process within Network / Intersect was highly restrictive, although not in ways that were creatively constructive. One limitation was my inability to render a double-sized video which utilised clips playing in two directions simultaneously with any speed; often a minor change to a scene in one of the films would require fifteen minutes or more to render a low-resolution preview; what’s more, the computer could not be used for anything else whilst this rendering was taking place. This production ‘bottleneck’ made for an extremely frustrating editing process whereby it was easy to lose track of progress, and lists of changes had to be made in batches, often blindly so as to avoid hours of delays in preview-renders. I tested numerous ways to overcome this problem, but none were truly effective; the final film was edited in two halves, with M and W’s respective stories both edited in isolation in their natural direction, and a complex system of notes and diagrams to work out where cuts would go. I spent far more time editing one of the stories (***W***) than I did the other (***M***), with the consequence that I am not satisfied with the pacing or final resolution of ***M***’s story.

There are two ways in which I would avoid this production bottleneck if I were to produce the same type of film again. One would be via a refined editing and rendering workflow, and the other would be via better advanced storyboarding and script treatment. I believe that the latter would have been the most effective in this particular scenario: technical issues such as rendering times might be improved via simple technical means, but this failure was one of story logic, and ironically, scripting.

### Storyboarding and script treatments

When large film studios produce films, it is common practice for writers, directors, producers, and actors to hold a ‘table-read’ of film scripts in advance of the film’s production. This serves several purposes: the directors and writers are able to observe how the film will be seen by an audience, and identify if there are issues with characterisation, story logic, and so on, so that changes to the script can be made in time for the film’s shooting. Actors are also able to establish and develop the direction their characters will take, and the principal cast and crew are able to meet and discuss their roles. This was something that did not happen during the production of *Network / Intersect*; the actors were deliberately only given portioned instructions relevant to their current task-in-hand, so as to mirror the IReA techniques.

Another technique common in Hollywood is the production of a studio film is the production of an animated storyboard. Often created by specialist storyboard artists, these animated series of illustrations depict a shot-by-shot preview of the anticipated final film, so that the visual pacing, camera angles, special effects, and so on, can be planned in advance. In the production of *Network / Intersect*, I did not do script read-throughs; I did create storyboards, but these were discarded when it was realised that the depiction of multiple repeating days on-screen was inappropriate for the pacing of the film. Part of the reason I did not do this properly was due to a tight timeline within which the film had to be produced; part of the reason was because I was working alone, and did not feel the need to communicate, or sell, the concept of the film to a third party during the production process. This was naivety on my behalf: fundamentally, films have to communicate ideas to people who have not yet seen them! When making fiction films in the future, I will be sure to invest a lot more time into these crucial early planning stages of read-throughs and animated storyboards, soliciting opinions from third parties as to whether the logic, pacing, and stories are captivating and make sense. I am reminded of the old workshop adage: *measure twice, cut once*; an early investment in an animated storyboard, complete with an audio voiceover reading the script, would have been a useful reference document, and might also have made the fussy workflow that editing such a film necessitated.

### Limitations

The major limitation of this chapter is the testing of reflective scripted design on only one case study. It is hard at present to delineate issues with the methodology itself, and the prototypical film it was used to create. Whilst this limitation is frustrating in the context of a doctoral thesis, it does lend scope for future practice: I am excited by the prospect of using reflexive scripted design again in the future in order to ask critical questions of the technique: *Is its use restricted to narrative media such as film or theatre? How might other forms of creative practice be integrated into the process? And for whom might this process be useful?* These are all questions I will attempt to discuss in the final chapter of this thesis: the conclusion.

[1] Felix Barrett and Maxine Doyle, *The Drowned Man: A Hollywood Fable*, Play (Temple Studios, 31 London St, London W2 1DJ, United Kingdom: Punchdrunk and the National Theatre, 2013).

[2] Gregory Bateson, ‘A Theory of Play and Fantasy’, in *Steps to an Ecology of Mind*, 13. printing. (Ballantine, 1985), 193.

[3] Among other things, I also admired the highly rigid structure the play had used to choreograph people to move through a space; despite seeing the play multiple times, I had not noticed the consistent increments of time.

[4] Italo Calvino, ‘In a Network of Lines That Intersect’, in *If on a Winter’s Night a Traveler*, trans. William Weaver, Array (New York: Harcourt Brace Jovanovich, 1981), 157–64. Note that in main body of this thesis, both the book and chapter titles will appear in line with their presentation throughout the book itself, with only the first letter capitalised, whereas references use title case.

[5] Ibid., 158.

[6] Hebe George and Maito Jobbe Duval, ‘Punchdrunk Design Masterclass’ (Temple Studios, 31 London St, London W2 1DJ, United Kingdom, 16 June 2014).

[7] 1813-1837 Büchner Georg, *Woyzeck*, ed. Nicholas Rudall, Plays for Performance (Chicago: Ivan R. Dee, 2002); Nathanael West, *The Day of the Locust* (New York: The New Classics, 1950); George and Duval, ‘Punchdrunk Design Masterclass’.

[8] Note that research for this project began in 2015, and was completed in April 2016, before the major political events of that year unfolded, and the term ‘fake news’ gained popularity.

[9] Adrian Chen, ‘The Agency’, *The New York Times*, 2 June 2015, <http://www.nytimes.com/2015/06/07/magazine/the-agency.html>.

[10] Ibid.

[11] Peter Pomerantsev, ‘Inside the Kremlin’s Hall of Mirrors’, *The Guardian*, 9 April 2015, Online edition, sec. The Long Read, <https://www.theguardian.com/news/2015/apr/09/kremlin-hall-of-mirrors-military-information-psychology>.

[12] Quoting *Information-Psychological War Operations: A Short Encyclopaedia and Reference Guide*, Ibid.

[13] This phenomenon has received significant news coverage in light of allegations following recent political events in the US, UK, and France. See, for example, Farhad Manjoo, ‘As Internet Seizes News, Grip on the Truth Loosens’, *New York Times*, 3 November 2016, National edition, sec. Business; Carole Cadwalladr, ‘The Great British Brexit Robbery: How Our Democracy Was Hijacked’, *The Observer*, 7 May 2017, sec. Technology, <https://www.theguardian.com/technology/2017/may/07/the-great-british-brexit-robbery-hijacked-democracy>., among others.

[14] Gilles Deleuze, ‘Postscript on the Societies of Control’, *October* 59 (1992): 3–7; Nathan Moore, ‘Diagramming Control’, in *Relational Architectural Ecologies: Architecture, Nature and Subjectivity*, ed. Peg Rawes, 1st ed. (Abingdon, Oxon: Routledge, 2013), 56–70.

[15] Deleuze, ‘Postscript on the Societies of Control’, 4.

[16] Moore holds an MA in Architectural History from the Bartlett.

[17] Max Colson and Ollie Palmer, ‘Exploring Virtual Control Workshop’ (Stratford Station, Westfield Shopping Centre and Queen Elizabeth Olympic Park, 18 August 2015).

[18] Anna Minton, *Ground Control: Fear and Happiness in the Twenty-First Century City*, 1st ed. (London: Penguin Books, 2012), 44. Minton writes extensively about ‘private-public partnerships’, describing them as ‘pseudo-private space’. Ibid.

[19] Nathan Moore to Ollie Palmer and Max Colson, ‘Westfield and Olympic Park’, 21 August 2015; Ollie Palmer to Nathan Moore and Max Colson, ‘Re: Westfield and Olympic Park’, 21 August 2015.

[20] ‘Reflexive, Adj. and N.’, *OED Online* (Oxford University Press), fig. 2d, accessed 8 May 2017, <http://www.oed.com/view/Entry/160948>.

[21] Ibid., fig. 2c.

[22] This led to the film's dimensions being 3880 x 1080, or a 32:9 ratio.

[23] Chen, ‘The Agency’.

[24] Chen discusses the 12-hour days, the seemingly temporary nature of the offices, and the routine of the workers in detail.

[25] In *Eternal Sunshine for the Spotless Mind*, the revolutionary new technology which enables selective wiping of memories has been adopted by a doctor who runs a chaotic office akin to a low-budget plastic surgery in suburban America. Michel Gondry, *Eternal Sunshine of the Spotless Mind*, 2004.

[26] The idea of a dual-screen film that plays forwards and backwards has previously been used by Michel Gondry in the music video for Cibo Matto’s *Sugar Water*. The music video features a split screen showing the two members of the band, with the left half of the screen playing forwards and right backwards, and horizontally mirrored. Half way through the video it becomes apparent that the entire film was in fact shot on one camera; the focus of the left screen changes from singer 1 to singer 2; which of course means that in the mirrored video, singer 2 is replaced by singer 1. The video is technically highly sophisticated in its form, and ability to synchronise the actions of characters at nearly all times. It contains a number of interesting filmmaking techniques. Michel Gondry, *Sugar Water*, Music video (Warner Music, 1996).

[27] See Manuel De Landa, *Intensive Science and Virtual Philosophy* (New York: Continuum, 2002), 33. De Landa quotes Gilles Deleuze and Paul Patton, *Difference and repetition* (London; New York: Continuum, 2001), 208–9. “The virtual is fully real in so far as it is virtual”

[28] Max Coltheart, ‘Delusional Belief’, *Australian Journal of Psychology* 57, no. 2 (August 2005): 72, <https://doi.org/10.1080/00049530500125082>.

[29] Computers use a base-2 system because information is stored in binary ‘bits’ (1 or 0).

[30] My personal laptop was the most practical computer to use, since I could use it anywhere, and it would be guaranteed to journey to Korea with me during the final phase of the project. I imagine that in the future, much film editing software will rely on cloud-based solutions, and rendering relatively simple footage such as mine will be far faster. However, this film was made in 2016 on a 15” MacBook Pro using Adobe Premiere Pro CC and Adobe Media Encoder CC to edit.

[31] 1920x1080 is a standard shooting format that can be found on most commercial cameras, smartphones, DSLRs, etc.

[32] I advertised and cast gender-blind for both roles; however, from the applicants, the two actors best suited to the roles were both male.

[33] Alexander Rodchenko, *The Stairs*, 1929, Photograph, gelatin silver print, 3.18 cm x 9.53 cm, 1929, <https://www.sfmoma.org/artwork/2000.87>.

[34] Pont Louis Philippe was also very close to the Cité internationale des Arts, where my live-work studio was located.

[35] Chen discusses these long schedules, and describes the routine of the workers' entry and exit to their building.

[36] The station at Musee de Arts and Metiers, for example, is themed after Jules Vernes' Journey to the Centre of the Earth, with riveted copper throughout the platforms.

[37] Filming in a public place was part-inspired by an interview I had heard with Michel Gondry, in which he had described the impromptu filming of a scene in the film *Eternal Sunshine of the Spotless Mind* on the streets of New York City whilst the now-defunct Barnum and Bailey Circus paraded elephants through the city. Their scene made it into the final film. Gondry, *Eternal Sunshine of the Spotless Mind*.

During filming, the crew and myself encountered several metro employees, some of whom were curious as to what we were doing. When told that we were shooting a film, they did not ask to see any documentation, but told us this was fine provided we did not leave any litter, or obstruct the flow of people. It was only after the filming on the Parisian Metro had been completed, and the film shown in Korea, that I found out that the Metro prefers film crews to apply for permits to film in advance; if filming in a public place in the future, I would apply for such a permit.

[38] Châtalet les Halles was the first station I had to transfer at on arrival in Paris, encumbered by large bags full of equipment for studio production.

[39] The one exception to this might be signs which remind drivers which side of the road to use at British airports.

[40] This was also the end-location for ***M***’s driving shot.

[41] I had calculated the camera rig dimensions through my earlier measurements of camera angles. However, on the day of shooting, there was an error with one of the BlackMagic cameras, so I had to create a similar rig for two Canon cameras and a pair of tripods at the last minute; the mis-alignation can be seen in the final film.

[42] Adobe Systems Incorporated, *Premiere Pro*, version CC 2015.2, Mac OS X (Adobe Systems Incorporated, 2016).

One feature of my workflow that evolved, rather than being planned, was a result of the high internet speed I had access to whilst editing in Korea. The studio I worked from (at SeMA’s Nanji artist residency) had an internet connection with over 100 Megabyte per second upload speeds. When editing films, I usually ask someone else to review my timelines – in most instances, this is a colleague who is not involved directly with the project. In Nanji, I consulted Abi Palmer (see also *Nybble* in chapter 2); she was based in London. I was editing the film at night, exporting sections of film from Premiere Pro, uploading clips as private videos to YouTube, and sending her links to the videos. The process was highly efficient whilst editing the films individually – in a number of instances, I made edits we discussed whilst on the phone, and was able to show her the result in a number of seconds. However, this workflow was severely hampered by the speed at which dual-screen video can be rendered; rendering a 3880 x 1920 video where half of the screen is moving at reverse-speed is extremely slow. This will be discussed in the chapter conclusion.

[43] Processing Foundation, *Processing 2.2.1*, version 2.2.1, Mac OS X (Processing Foundation, 2014), <http://www.processing.org>.

[44] US Census Bureau Creating office name here, ‘Incorporations, Mergers, Consolidations and Disincorporations’ (United States Census Bureau), accessed 8 May 2017, <https://www.census.gov/geo/partnerships/bas/bas\_newannex.html>.

[45] The term ‘agnosia’ was coined by Freud, and possibly popularised by Oliver Sachs in *The Man Who Mistook His Wife For A Hat: And Other Clinical Tales* (Simon & Schuster, 1998). See also American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR)*, Fourth Edition, Text Revision (Washington, DC, USA: American Psychiatric Association, 2000), 152; Hillary R. Rodman, ‘Face Recognition’, in *The Mit Encyclopedia of Cognitive Science*, ed. Robert Andrew Wilson and Frank C. Keil (MIT Press, 2001), 309–11.

[46] García's stories appear to come from mutliple sources: original stories, guest contributions and synopses of popular works. Examples include: ‘A man designs a switch that will let him live or will make him die. He spends the rest of his life staring at the switch.’ and ‘In the year 2001, an expedition discovers a hostile alien brain who can turn thoughts into reality.’ (The latter quote obviously the synopsis of 2001: A Space Odyssey). Dora García and Book Works (Organization), *All the Stories* (London; Birmingham: Book Works; Eastside Projects, 2011). Note: the book has no page numbers.

[47] Bob Dylan, ‘Episode 6: Jail’, *Theme Time Radio Hour Archive* (XM Radio, 7 June 2006), <http://www.themetimeradio.com/episode-6-jail/>.

[48] I built the rear projection screen in the Pavillon studio on a budget of €40 from two Muji shower curtains taped together, placed in front of a projector. The filming had to occur after dark thanks to the low light output of the projector; the set was designed so that both ***M*** and W's characters would have matching desk positions, and made use of the earlier camera setup diagrams I had created.

[49] Chen, ‘The Agency’.

[50] Sir Isaac Newton, ‘Opticks: Or, A Treatise of the Reflections, Refractions, Inflections, and Colours of Light’ (Project Gutenberg, 23 August 1730), <http://www.gutenberg.org/ebooks/33504>.

[51] Aura Productions, *Journey Into Light*, 1973, <http://archive.org/details/6238\_Journey\_Into\_Light\_01\_29\_44\_29>.

[52] A. Mark Smith, ‘Ptolemy’s Theory of Visual Perception: An English Translation of the “Optics” with Introduction and Commentary’, *Transactions of the American Philosophical Society* 86, no. 2 (1996): 246, <https://doi.org/10.2307/3231951>.

[53] Calvino, ‘In a Network of Lines That Intersect’, 157.

[54] Chen, ‘The Agency’.

[55] See Max Coltheart, ‘Delusional Belief’, *Australian Journal of Psychology* 57, no. 2 (August 2005): 72–76, <doi:10.1080/00049530500125082>; William Hirstein, *Brain Fiction : Self-Deception and the Riddle of Confabulation.*, Philosophical Psychopathology (MIT Press, 2005), 116; Todd E. Feinberg et al., ‘Multiple Fregoli Delusions after Traumatic Brain Injury’, *Cortex* 35, no. 3 (1999): 373–87, <doi:http://dx.doi.org/10.1016/S0010-9452(08)70806-2>.

[56] This does not mean that generated rules cannot be spatial, but more that they are not limited to spatial parameters. One of the rules within the filming of *Network / Intersect* bounded the production to the city of Paris – a spatial constraint.

[57] The same was true of the *Nybble* film, which is in fact a composite of multiple performances.

# Conclusion

This thesis has discussed various definitions and interpretations of the notions of *script* through its four chapters, showing a progression of ideas through a series of design projects. The presentation of projects in this order displays a thematic development of work, in an order that loosely corresponds with the order in which the projects were developed. The design research has taken the form of installations, performances, software, and films, and has used various definitions of scripting, which range from behavioural scripting in animals (*Godot Machine* and *Ant Ballet*), to performative scripting (*Nybble*, *Scriptych*), to computer scripting (*Ant Ballet*, *Scriptych*, *86400*, *24fps Psycho*), and finally, a scripted design process (*Network / Intersect*).

Chapter 1 focused on behavioural scripting through two projects, the *Godot Machine* and *Ant Ballet*. The latter was a performative attempt to script the behaviour of ants via the use of synthetic pheromones. Using Bateson’s concept of psychological framing (which shares a number of concepts with both Schank and Abelson, and Tomkins’ script theories), the chapter discussed the framing of both of these projects in relation to the field of ‘sci-art’ in which they were initially presented. Furthermore, it argued that my practice is best defined as work that is informed, but not defined, by an engagement with other disciplines, including science; and that a methodology which is bound in rules about authenticity, rather than the communication of scientific principles, is largely influenced by the methodology of Stanley Kubrick. The project’s main mode of presentation to the public was via a series of short films, and models which simulated the effect of the *Ant Ballet* machine’s experiments in Barcelona.

Chapter 2 presented two projects which had computational scripting at their core, but which performed the actions of computers through dance. Both projects were shown at major cultural institutions: *Nybble*, performed at the V&A Museum, was a large diagram of the inner workings of a computing machine, with performers blindly following scripted instructions in front of a live audience; *Scriptych*, performed at the Opera Garnier, used performance scripts, computer scripts, and data from Hollywood film scripts to perform an interaction with a three-dimensional word-vector database. Both projects were performed in front of live audiences, but also exist in filmed documentation. The chapter focused on the experience of writing code, and the ways in which this affects my own thought processes.

Chapter 3 focused on computational scripting, using a pair of projects (*86400* and *24fps Psycho*) as a mode of critiquing specific contemporary technologies. These projects represent a mode of practice I call computational curation, whereby software is used to synthesise pre-existing content into a new form. The computationally-generated film *86400* employed a script to interact with the Google Image Search API, creating a database of hundreds of thousands of time-related images, which were compiled into a 24-hour-long film: the work was a diagram seeking to create an immersive critique of the endless onslaught of classification that is pervasive in digital culture, and in turn to highlight its meaninglessness. *24fps Psycho* used computational scripting, and a diagrammatic computer interface (Max) to create an ultimately unsuccessful film that was performed live in front of an audience. The chapter discussed the various reasons for this projects’ failures, and speculated that such a project will likely appear computationally naïve as future technologies develop which render the machine learning tasks attempted easy.

Chapter 4 presented my first explicit use of a novel scripted design process entitled reflexive scripted design, in which a designer creates a set of absurda rules based on research and reflection; the rules are then performed back into the work, with the aim of creating an absurda+b work whose form reflects its content. The novel process is derived from methodologies of the Punchdrunk theatre company and the Oulipo, and through ideas explored in this thesis. The process was used to create a short fiction film, *Network / Intersect*, in which two characters working in the production of internet propaganda and financial instruments lose the ability to delineate the abstract ideas which they use to justify their work and their lived realities. The chapter concluded that whilst the project in itself was successful, the methodology for reflexive scripted design has been explicitly tested only once; this conclusion will discuss the extent to which it can also be found explicitly and implicitly in all of my work.

The main argument of the thesis is that the notion of script is one that is both important, and underexplored, in contemporary design discourse. The word script is tied to early notions of writing as well as drawing, and is in regular use within theatrical and filmic productions, psychology and computer programming. Within architectural design, however, script is most commonly used in relation to computer scripts, and, by extension, parametric design. This thesis has argued that this narrow understanding of script belies a rich vein of concepts that exhibit potential for new design methodologies, such as reflexive scripted design, which I outlined and tested in chapter 4. This wider understanding of script allows for an architectural discourse that includes conversations about authorship, freedom, and creativity within design.

I have also presented the Camusian ‘absurdb’ as a mode of critique, arguing that the themes contained within the plays of the Theatre of the Absurd – originally written in Europe at the beginning of the Cold War – are in fact relevant to present-day uses of technology. The method used to implement this critique has been through the construction of projects which function as absurd diagrams, or absurd machines. The synthesis of these central themes – scripting, the absurdb, and diagrammatic practice – and the mode in which they have been explored (through active design research) represents a novel enquiry.

This conclusion will discuss the findings of the work described in the thesis, and the thesis itself, highlighting similarities and differences across projects, methodologies and media; the position of my work in relation to the fields in which I practice; the implications of the notions of scripting I have discussed in this thesis for design in general, and in particular, for the modes of film-making I have employed; the ways in which I carry out practice-led research; and the original contributions to knowledge that can be found in this thesis. It will also briefly discuss shortcomings of the research and future avenues of research, aiming to clearly situate my work within a wider field of design, and film.

### Public experiments

This thesis describes a series of projects in which the roles of research and practice are intertwined. The practical design work described in this thesis refuses to stick to any one medium; projects use computation, installation, performance, film, sound design, and more. As such, the categorisation of the work itself, and the role that this thesis plays in describing the work, is not straightforward. This conclusion attempts to describe the relationship between the theoretical content of this thesis, and the practice embodied in the work it describes, beginning by identifying the elements crucial to the production of my work.

In chapter 1 I introduced Born and Barry’s description of *epideixis*: the ‘public experiment’.[1] All of the work described in this thesis might be considered a form of epideixis; the work is both driven by, and drives, research, which is often performed for a public. The production of work in this way is a mode of thinking through making, a form of knowledge creation that could not be achieved (or engaged with by an audience) through isolated research or design work. This is consistent with arguments put forth in Brad Haseman’s 2006 paper, *A Manifesto for Performative Research*.[2] Haseman describes ‘performative research’ as a ‘multi-method’ mode of research which is ‘led by practice’. This contrasts a purely quantitative or qualitative method.[3] Haseman uses the term *performance* in two ways: work is *performed* both as an action (e.g. work is *carried out*), and also *performed* as an act in front of an audience.[4] All of the works in this thesis were publically shown, and several publically shown in multiple media.[5] *Ant Ballet*, for example, was shown as a documented performance and in multiple different iterations in exhibitions; *Scriptych* was performed in front of a live audience, and a film documenting the performance then shown to new audiences in film festivals. This public exhibition is crucial to my practice; my work represents my attempts to communicate ideas that I believe are important and interesting, and performance through exhibition is central to this communication. Born and Barry’s introduction of *epideixis*, whilst originally targeted towards sic-art projects, is an accurate description of my particular mode of scripted design practice.[6]

In the introduction, I discussed various meanings of the term script. When viewed through the lens of performative research, almost all of these can also be linked to the idea of performance. The root of *scribere* (to scratch) is a gestural movement, and thus an act that must be performed. The behavioural scripting described by Tomkins relies on the performance of *scripts* in order to create affect in humans; in Schank and Abelson’s version of script theory, people perform pre-set roles in scenes they can easily decipher through their common ordering. Computer scripts are performed by computers; reflexive scripted design is performed by a designer. In the projects described by this thesis are numerous performances: computers performed their scripts to an audience in *24fps Psycho*; ants’ reactions to synthetic pheromones unwittingly became a performance in *Ant Ballet*, as did the actions of myself as the projects’ protagonist*;* dancers performed as a computer and with a computer respectively in *Nybble* and *Scriptych*; and so on. There is an inherent connection between the script in its various manifestations, and the need for the script to be performed in some way. In this manner, my work, scripted, performed, and shown to a public, is both Born and Barry’s *epideixis*, as well as a manifestation of Haseman’s notion of *performative research*. This then poses a question: if the performance of design work is to be taken as a mode of research in itself, what then is the role of research in this thesis? How does the research, both in the description of work and methods employed in its creation, relate to the embedded knowledge that is contained in the work itself? And what are the original contributions to knowledge that this thesis claims?

### Reflections on writing

It is tempting when writing accounts of the creation of completed design work to apply a clear, linear narrative to its development. This is what I had been taught to do throughout my entire design education, and commercial work, until doctoral level: after employing a development process that inevitably takes dead-ends, encompasses multiple failures (often themselves the result of an ever-changing ‘design brief’ upon realisation that certain issues cannot be ‘solved’), the designer is to retrospectively apply a rational, concise, and logical account of the design process which presents the final design as inevitable. In my experience, this ‘problem-solving’ mode of design relies on the designer honing the scale of the ‘problem’ they are working with down to one which a technical solution might appear to solve. In the presentation of this thesis, I have consciously avoided such post-rationalisation of my own process, whilst also acknowledging that the premise upon which practice-led research begins is different. Haseman describes practice-led research as beginning not with ‘a problem’ but rather an ‘enthusiasm of practice […] practice-led researchers construct experimental starting points from which practice follows.’[7] One example of such a starting point, Haseman continues, is the availability of a new technology. In chapter 3 of this thesis, the description of APIs, and my understanding of the political ramifications of an increasingly API-focused technology community came via both reading contemporary technology criticism, and from experience testing possibilities of APIs following as own ‘experimental starting point’. My own ‘enthusiasm of practice’ (which might otherwise be informally known variously in different fields as ‘tinkering’, ‘hacking’, or ‘taking apart’) largely served as a starting point for most of the projects within this thesis; as such, the projects do not seek to ‘solve’ a ‘problem’, but rather create a series of objects, performances, films, and installations, which frame critical conversations around technology and the absurd. Often the starting points for the projects would have emerged as a result of an earlier endeavour to learn a new technology or process, although the tracing of such work to a root is sometimes a lengthy process.

One example of this comes in chapter 4 with the production of *Network / Intersect*. The article which inspired ***W***’s character, written by Adrien Chen in the *New York Times*, was initially sent to me by my friend Golo Henseke after I had talked to him about unpublished work I had carried out creating false identities and bots to manage them on Twitter;[8] this work in turn was influenced by presentations I had seen and a workshop I had attended on identity by the artist Heath Bunting.[9] In a similar vein, *86400* was the direct result of learning Python in an attempt to learn about the mechanisms of Google. Although most of the projects described in this thesis (*Scriptych*, *86400*, *24fps Psycho*, and *Network / Intersect*) were developed and exhibited during my residency at the Palais de Tokyo, each of the projects had, in some way, been developed through the research and design work (much of it unpublished) of the preceding few years. The way in which projects develop also relies heavily on formal and informal conversations with numerous people: academic advisors, colleagues, friends, students, and strangers. Where possible, I have attempted to cite as many of these influences, and credit as much of the informal group of people that surrounded each project as possible in the appendix of this thesis.[10]

As well as relying on conversations, the work produced also made use of numerous spaces, and different kinds of spaces, in its research and production. This thesis being produced in an architectural school, the relevance and influence of the spaces its work was created in cannot be underestimated. One of the most striking aspects of Tom Sachs’ practice, as described in the introduction, is the creative freedom evident through the establishment of the studio in which he works; Sachs’ films make it clear that his studio is set up in such a way that it enables productivity and creativity (for instance, in the requirement that all tools must be kept clean and ready for immediate use), is central to the way in which he works, and serves to create and reinforce a culture of practice within the studio. The nature of practice for a relatively unestablished, relatively non-commercial artist such as myself, working in cities such as London and Paris (where all forms of private space are expensive), does not afford such a privilege. I was incredibly fortunate to have been given access to a pair of studios whilst in Paris – one within the Palais de Tokyo itself, and one in the Cité des Arts Internationale (a dedicated artist live-work space) for the period of my residency. Both spaces were set up according to ever-changing needs: for a period, the Palais de Tokyo studio became a film set; at other times both studios had computers whirring away overnight as they ran scripts on thousands of images or film clips; at other times they were quiet places for reading, writing, contemplation, model-making, and so on.

As with the writing of code described in chapter 3, which requires a different mind-set to many other activities, the physical space required to write a thesis is different to the space required to develop design projects. The two activities may be largely intertwined, with various modes of research influencing each other throughout the process, but in this case, they largely occurred in spatial isolation from one another. The writing of this thesis has required a different kind of space: that of the quiet office or library, spatially distinct from the studios used to design, build, film, and test. This thesis has been written in numerous such spaces. I include this detail not because it is important to the narration of the thesis itself, but rather because one of the roles of the thesis itself is to identify elements which have enabled the work described within it to take place, with the hope that this knowledge might later be used to enable similar work or lines of enquiry to be pursued elsewhere.

Until this point, I have examined physical and theoretical context in which the work in this thesis has been produced, but now I will draw attention to its situation within a wider context. The work has been produced both through the design research PhD program and within the artist residency at a national institution; it has been exhibited at a zoo, national art and cultural institutions, at film festivals, and in universities; it has taken in the form of performances, scripts, machines, and installations. Whilst acknowledging to new research paradigms the work sits within, the multidisciplinary nature of the work itself renders traditional artistic categorisation futile; the projects are more united by subject matter and methodology than any singular use of a media. Here I attempt to extrapolate intrinsic properties of the work such the unifying genre may, however problematically, be applied.

In the introduction, and each chapters’ sub-conclusion, I discussed the assessment criteria by which I judge my own work: each projects' use of form, communication, and the absurd in their presentation of a subject. Of the key criteria could be described as *honesty*, which appears in the section on *form* (‘Is the form of this project honest? Does it express the processes and technologies used to create it? Does it formalise its intent in the expression of its form?’). This is consistent rule has manifested itself in all projects. In *Ant Ballet* for example my own internal rules demanded the project had to be *authentic*: that is, depicting the real behaviour of real ants, rather than any sort of simulation. This led to the projects’ main experiment being carried out thousands of miles away in Barcelona (at considerable expense, both in terms of finance and time), rather than the relative ease of the United Kingdom. In *Nybble*, this is manifested as dancers being given instructions via walkie-talkie in real time, in order that they might feel the sensations of being a human computer. In *Scriptych*, the two dancers from the Paris Opera had to spend weeks training to learn how to use devices to measure their movement in space; the two performances in front of a live audience were carried out using the experimental software, rather than a simulated version of this software, even though the potential risks of failure were high – all for the sakes of authenticity. In *Network / Intersect*, the absurda rules of the production meet the shooting of the film far more logistically complex and it might have been otherwise.

The requirement for honesty in this manner draws back to one of my key influences, Stanley Kubrick, whose factual rigour in the production of films such as *Dr. Strangelove* and *2001: A Space Odyssey* add to the joy I get from watching them, and serve to heighten the absurda+b affect the films create.[11] The use of a filmic analogy here is deliberate: it is taken the process of writing of this thesis to realise that film is at the core of what I do. Every project in this thesis has a strong filmic element, and thinking about film early on in each project shapes the form the projects take. Here I would like to discuss the significance of the filmic medium to my work.

### Film

I have been interested in film for as long as I can remember. As discussed in the technical notes to chapter 1 brackets (found in the appendix), I initially began making films at the Bartlett to document machines I was making. This was a natural progression of my interests: in my teens I had inherited my grandfather’s camera collection. I father worked in the photographic industry (and my first job was working in the warehouse of the company he worked for, in part dismantling and repairing industrial photographic equipment). I had access to photographic cameras, unlimited film, and unlimited processing – a luxury in the late 1990s and early 2000s, when the transition from analogue to digital film was barely underway. I spent my summers shooting photos on analogue cameras, and making short films using VHS and DVD cameras. This, combined with technical curiosity, said into a love of both film itself, and film-making. Years later, in joining the Bartlett, making short films seemed to be the most obvious way to document my machine making. Seeing into this practice, I started designing my projects with film in mind. I built simple devices to enable dynamic time lapses of the construction of machines and I was making or trips I was taking.[12] These in turn influenced decisions I would make about the machines themselves: what would be the most effective way of achieving something within my budget, and how would it appear on screen? Both the *Godot Machine* and *Ant Ballet* have clear examples of this in the light rings they utilise above the m utilise above the machines themselves: the lighting acts both as a means of illuminating the devices for video capture, as well as being an homage to the set design of Ken Adams in *Dr. Strangelove*.[13] The films themselves aimed to capture an authentic, working machine being designed, built, and tested.

Since then, all projects have taken their filmic outcome into account early on in the design process, as I am innately aware that any film will be a key outcome of my work itself. With *Scriptych*, for example, the technology used was deliberately hidden from the audiences’ view (the phones strapped to the dancers’ arms were sheathed in black material, and the computer system they were interfacing with was entirely hidden from public view); however, the framing of dancers in space – their position in the room – was based on how they would look on film. When choosing the exact site, they would dance in, I shot test film from every angle I could find in the main entrance atrium of the Opera Garnier, in order to make sure that they would be well-framed in a 16:9 widescreen filming format. I obtained special permission to film the performance with a live audience on the nights of the performance, rather than just film a rehearsal (itself a process requiring negotiations and legal contracts with the Opera for filming rights). The *authenticity* of the film, as a documentation of the event and the process, is not *coincidentally* aesthetically pleasing accident; it is intrinsic to the way in which the project was designed from its inception.

Similarly, in the most obvious example, *Network / Intersect* was a project framed around the creation of the film. The design elements included models of interiors and buildings was forced perspective, all designed to suit is 16:9 format. The angle is the both interior studio and external shots were calculated via 3D diagrams I made, taking measurements of every permutation of camera body and lens within the Palais de Tokyo inventory so that I would know in advance what will be in-shot when we were on location. These lens diagrams were also used to create the special rig for two Black Magic cameras in the Pont Luis Phillipe ***M*** / ***W*** cross-over shot. Much like in the making of *Scriptych*, I also shot test footage in every location that I knew filming might take place in Paris in the weeks leading up to the film’s shooting, both as a means of seeing how the locations would look on film, and in order to work out the mechanics of the film-making itself (how long a shot on an escalator might last, where the camera could move, and so on). The film was designed as much as an object might be, rather than being subject to chance and opportunity.

In my process, the knowledge that something will be or will appear in a film heavily affects its design. Early in most projects are with film in mind. An example of this would be the *Godot Machine* – itself an unfinished project – but one for which I build a 3D model of the machine on a set I designed, then built the set itself in an unused laboratory room within UCL, in order to plan for the eventual tracking shot for a film I wished to make about the machine if it were ever completed.[14] The design of machines (for example, the *Godot Machine*, *Ant Ballet* machine) and performances (e.g. *Nybble*, *Scriptych*) owes a lot to how those machines and performances will look on film.[15]

Another way in which film affects my work is in the creation of projects I categorise as ‘computational curation.’ *86400* and *24fps Psycho* are both projects which used computational technologies to create films through the reinterpretation of archival material (a Google Images search and the Prelinger Archives respectively).[16] In both of these cases, a mode of computational scripting is performed on thousands of images or film clips, reordering and re-presenting them in a new context. The development of computer software to perform these operations was reminiscent of the combinatorics methods discussed in Calvino’s *Cybernetics and Ghosts* (and attempted in his story the *Burning of the Abominable House*), in which a limited number of story-components are recombined in different orders, creating new connections and meanings between the constituent parts.[17] However, the ambitions of *24fps Psycho* went beyond this linear recombination and had intentions of spatializing film, Breaking films down into their constituent components – a series of frames – and finding ways to connect different frames in a virtual space. Although I feel the project to have been ultimately unsuccessful in its current guise, I look forward to developing more refined and computationally capable iterations of this project in the future. I see this work in the vein of Douglas Gordon’s *24 Hour Psycho* and Anthony McCall’s series of ‘solid light’ installations (the most famous of which being *Line Describing a Cone*).[18] Both of these films use the concepts of difference between frames to create and inhabitable space through film projection; Gordon’s 1993 work expanded the film *Psycho* to the extent where the otherwise invisible movement between frames became the works’ focus-point, removing the original meaning from the work, whereas McCall’s work used light and dark areas within a celluloid (and later digital) projection to create moving cones of light for an audience to move through. Both our investigations into the ‘material’ of film, challenging assumptions about the medium itself. this particular line of research, although used to create projects which are formally quite different from my other projects, in fact I derived from a similar starting point of curiosity about the technical make-up of film itself (see chapter 3).

I predict that the role of computational curation will become more prevalent in everyday life in coming years; already, social media, online shopping, and video platforms use aggregated data to recommend content, products, and video based on inferences made through individuals past behaviour and actions online. Emergent technologies hint at the possibility of generating audio and visual content based on textual inputs;[19] a future where films can be generated using combinatorial techniques, with corresponding synthetic visuals and audio, does not seem wildly impractical.

Thinking through making, and specifically, thinking through making films, is not a practice free from restrictions: film is largely codified medium, and thinking about the appearance of every element of a project through two-dimensional rectilinear format that film currently implies may appear to place severe constraints on my work, and the way in which I think about it. However, I would argue that this is in fact fitting for this thesis, as one of its key themes is an emphasis on arbitrary constraints through scripted processes, and the associated creative freedoms these provide. The limitations of thinking and working in a filmic manner are intrinsic to my work itself, by virtue of the way in which I think about work through film, and help to anchor an otherwise largely interdisciplinary practice to at least one form of media.

What then, is the role of this thesis in describing the work that I have produced? The thesis, although descriptive of the methods, influences and processes behind my work, is not a technical manual for recreating the work. Where code is mentioned, it is described, rather than given (this is in part due to the knowledge that any code written in this thesis might be obsolete within a short period of time); I have described the means, context, and reasoning by which projects have been developed, rather than any other mode of presentation. The thesis, then, might itself be interpreted as a script to a working methodology; much like a screenplay enables a director to interpret a story for stage or film, this script might enable other creative practitioners to adopt a process in the creation of their own work. As such, I expect that this thesis might be of interest to critical design practitioners, those interested in film, theatrical or performative production, or those more generally interested in the modes of knowledge production enabled by ‘performative research.’

### Reflections on practice

It is worth noting that none of these projects was developed in isolation from each other: most of the work was carried out in the same studio spaces, using the same computer, with often overlapping production timescales.[20] Yet each mode of scripting carried its own set of parameters, requiring different modes of engagement with subject matter, spaces within studios, and even other people. Practicing the various modes of scripting simultaneously often required jumping from one state of mind to another, in order to pursue contrasting logics and practices, for example, the shift from computational scripting to writing an actual film script. Sometimes I would need to find means to transfer from one mode of scripting to another; often this was in the form of a walk, a meal, or exercise. Some environments were far better suited to different modes of scripting: the isolated studio apartment where I lived in Paris was far better for writing computer code than the sociable studio in the Palais de Tokyo, yet the latter was far better for visual inspiration, creative thinking, and sharing ideas. Understanding the requirements of each mode of scripting informed the way in which work was produced. This is of particular importance today, as computational scripting becomes both and more popular, and more accessible, in architectural design.

The computational aspects of the works mentioned in chapters 2 and 3 required the adoption of a completely different creative mind-set to other parts of the projects. In the second chapter, I have outlined the way in which I attempted to think through the logic of computational code and create instructions, which would effectively generate the desired performance from a computer. Much of this code-writing made use of external libraries (as described by Ousterhout), which meant that lower-level functions could be achieved with rudimentary knowledge of the underlying principles.[21] The machine-learning scripts used to train the word-vectors in *Scriptych*, for example, were based on a library called Gensim by Radim Řehůřek, which enabled the parsing of large corpora of words to create word-vectors for every word which appeared in a collection of Hollywood film scripts, themselves having been downloaded via automated scripts and processed by Cristian Danescu-Niculescu-Mizil at Cornell University.[22] Gensim is open-source, and is maintained by Řehůřek and myriad other volunteers; it was programmed in Python, itself an open-source programming framework with thousands of contributors, and it makes extensive use of Tomas Mikolov et al’s Word2vec process.[23] The interface that enabled dancers’ moves to retrieve these words was built in Max, a visual scripting language, but also made extensive use of libraries which enabled it to communicate with the sensors via Open Sound Control, as well as an instance of Gensim running in Python, and the ‘say’ functions within Mac OS X’s built-in command line interface. I could continue to cite various libraries, snippets of code, dependencies, interfaces, and languages for each project (including several more for *Scriptych*), but this thesis is about design research, not computer science. In short, using computer scripting languages enables the integration of myriad external libraries which extend the core functionality of a language, making repetitive or difficult tasks easier, or simply speeding up the production process (as described by Ousterhout).[24]

Although many of the libraries for languages such as Python are open-source, and freely distributed, there is a cost to the ease with which they can be used. This is borne in both ignorance over functionality, whereby the end user does not have to know what the computer is really doing when a certain instance is called, and the risk of creating software that is overly dependent on external libraries. Many libraries are in fact reliant on other, lower-level libraries for their core functionality; a library such as *pyMovie* is actually a fancy wrapper for *ffmpeg*, for example. Simultaneously, the high level of dependency that operates within these languages can act as an Achilles' heel: the deprecation of Google's Image Search API during the execution of *86400*'s image-gathering procedure highlighted how the lack of support for one particular library, API, or even language can have a major impact on the reliability of an artwork. Even the software which ran *Scriptych*, developed only last year, requires a very specific software and hardware setup, and is at risk of not working simply through routine software updates on the smartphones or laptop it runs on (the computer used to produce the work, and this thesis, has auto-updated its operating system tens of times since then). This is partly due to the low-budget nature of such software development: experimental projects such as this one are a form of electronic *bricolage*, relying on off-the-shelf hardware and software patched together via untested means. Whilst other artefacts (such as films, buildings, costumes, and books) are all at risk of various forms of degradation, none quite match the fragility of this type of computer-based work of art.[25] Attempts to rectify these vulnerabilities and archive software tend to focus on the concept of a virtual machine, a software emulation of specific hardware and operating systems, a necessity which generally prohibits physical archiving and interaction.[26] The remedy to such issues might be a step towards more robust, lower-level programming on my behalf– but this takes considerable time and effort to learn, and, as I will explain shortly, such practice comes at a cost.

Writing computer code, in my experience, requires a different mode of engagement to other modes of design practice. Whereas physical design, with pencil and paper, can be completed in a loud studio (perhaps with music playing), in a conversational manner, the writing of code of any complexity often requires its author to engage in intense concentration as they iteratively build layers of complexity into an extremely abstract system. In my experience, this is also intensely antisocial, and my physical studio requirements differ if I am building a model for a film, or writing a programme, which interfaces with an online service. Often I have found myself the only person in any given place working on a code-based project (as was the case in Opera Garnier with *Scriptych*, or whilst working in Nanji in Seoul on *24fps Psycho*). This creates a different atmosphere to the traditional design studio, a place which relies on a high level of interaction between its inhabitants in order to enable the cross-pollination of ideas. Where I have found traditional design logic is best explored through testing it with other people – both as design ideas are formed and often fleshed out in a convivial manner, and asking the opinion of colleagues (or anyone else) – often my code is written in isolation, and the support communities exist purely online, in the form of websites, wikis, and forums.

Much of my non-code design practice contains references to other work (for example, the repeated references to Stanley Kubrick’s films in the *Godot Machine* and *Ant Ballet*, or to Beckett in *Nybble*), or a moment of humour (for example, the posters reminding the viewer they are ‘in Korea’ in *Network / Intersect*). I try to maintain this ethos whilst writing code, embedding humour or references into the very functionality of the project.[27] I am aware that in most cases this will never be seen: the work I produce is generally too embedded in artistic practice to be of interest to many programmers, and that sort of detail is too technical to be of interest to most of my peers in the design, art, or architecture worlds.[28]

Computer programmers and scripters alike often refer to a state of working they call ‘flow’ – a total immersion in work whereby everything outside of the task in hand becomes unimportant and abstract.[29] I have experienced this state whilst working on numerous design projects, but never to the same extent as whilst working with computer scripting. There is something about working on extremely technical issues, which requires a thought process quite different from normal, everyday logic. This causes me to lose myself in my work, which I find immensely enjoyable.[30] Similarly, the highly technical nature of computer scripting has a draw for a particular *type* of person within the field of architecture. As Peg Rawes notes, although there is a near-even ratio of female to male students within US/UK architecture schools, code-based architectural design (such as Parametricism) is: ‘more commonly populated by male students who are instructed through intensive workshops which focus on repetition and emulation.’[31] Whilst this is problematic within the world of architecture, it is perhaps manifest most explicitly in the remarkably male-dominated workplaces of Silicon Valley. As recent news reports have shown, there is increasing discontent with the aggressive corporate culture perpetuated within Silicon Valley technology companies (in particular Uber).[32] Chapter 3 of this thesis discussed one instance where the idealised, quasi-mathematical model of continual movement has been translated into a daily reality for a swathe of Uber’s drivers, who are now the test-subjects in what the company is calling the *Perpetual Trip*.[33] Much of the aggressive nature of the technology industry is arguably perpetuated by the mythology surrounding the Valley’s start-up scene: the image of young (usually male) entrepreneurs frantically building circuit boards, writing code, and using venture capital to create the “next big thing” in a garage is synonymous with Silicon Valley’s corporate technological culture.[34]

The notion of a mythological origin story is not only found in Silicon Valley technologists. As was mentioned in the introduction, Rawes has argued that the ‘hot house’ methods in which Parametricism is taught within universities, small teams, and ‘labs’ has generated a discourse around the style that relinquishes designer agency and equates computation-based design with ‘natural’ processes.[35] Rawes claims that latter is reinforced by mythologised connections between code and highly selective slices of genetic theory (such as D’Arcy Wentworth Thompson’s *On Growth and Form*) drawing parallels between Parametricism and organic, nonhuman processes.[36] As a result, this ‘uncritical belief in computational emergence’ Rawes argues, ‘reduces diverse organic life to a self-same matter’.[37] This argument has parallels with Korzybski’s map-territory relation (as invoked by Bateson), discussed in chapter 1:[38] claiming that an organic system can be explained through a mathematical model (as is the case with many of the morphological arguments in *On Growth* *and Form*) is akin to producing a map of a territory; it necessarily requires a process of reduction and exclusion. Using that same map, or parametric model, to then plan territory renders the territory itself subject to the same process of reduction and exclusion. In the case of Parametricism, human behaviour and desires are often reduced to a simple agent-based model, which reduces human desire to the status of movement through space.[39] Rawes proposes a renewed interest in Spinoza’s notion of geometric and ecological ratios as a means of ensuring human wellbeing and environmental responsibility; I will shortly discuss how I believe Tomkins’ notion of psychological scripting may also offer a means of a more humane mode of architectural practice. Computational scripting does not have to exist in isolation, or as a non-critical discipline within architectural design. The projects presented in this thesis show the ability to use computational scripting to pose critical questions about contemporary technology, as also demonstrated by artists such as James Bridle, Kasia Molga, Heath Bunting, and institutions such as Het Nieuwe Instituut in the Netherlands.

### Contribution to knowledge

Perhaps the most salient question of a theses’ conclusion is what the author sees as their original contribution to knowledge. Besides the performed research of the design work itself, this thesis contains three original contributions to knowledge. This first is both technical and absurda: the novel interface mechanism described in *Scriptych* (chapter 2). This original system allows the retrieval of data, and the creation of highly specific three-dimensional vectors, via sequences of movements. The rotational angles of an arm in three axes are converted to vectors via a ‘move’, and moves can be strung together, enabling a nine-fold increase in the accuracy of a vector with each additional move. The method of data retrieval is thus performative in the way it encourages a person to interact with the system; it effectively spatially embeds the user within a database, requiring the user to learn how to *think* *within*, rather than simply use, the system. It requires a space around the person that is free from obstacles, and places absurdly high expectations on both the memory, and accuracy of movement of the user. It is not a system designed for real-world use, but rather, in the spirit of this thesis, an absurd, performative mechanism which places its user into a machine.

The second, and arguably main, contribution to knowledge, is reflexive scripted design, as described in chapter 4. This is a novel methodology which was initially tested with the development of the film *Network / Intersect*. It is also somewhat absurda, and relies on a designer to engage with multiple modes of research in order to gain a deep knowledge of a subject area, then use that knowledge to design a set of rules (also known as a script). This script is then performed back into a work that thy produce, with each decision that is made in the production of that work being run via the script. The process is made explicit in chapter 4, but in reality, elements of this process have been used implicitly in every other project in this thesis. In the introduction, I introduced some assessment criteria by which I assess my own work; this is itself a primitive, implicit ruleset (or script).

This script can first be seen in more detail in *Ant Ballet*; before producing the machinery, costumes, and paraphernalia that made their way into the experimental performance and film, I engaged in a lengthy process of research, producing only tentative designs. The rules I followed about *authenticity* (i.e. that I was only interested in documenting real results) placed severe restrictions on the physical locations that the experiments could be carried out within; the legal restriction on importing ants to the UK, and the resulting absurda journey to the forests surrounding Barcelona became an intrinsic part of the work, as the design research transformed into performance. This was aided by my tendency to film much of the process, and the resulting ‘documentary’ film became as central to the project’s description as the technology behind the work itself.[40] The project by following my own self-imposed rules, became an absurd performance. Reflexive scripted design combines two or more literary sources, a location, and a scripted ruleset; *Ant Ballet* might then be seen to be a work derived from synthesis of contemporary scientific literature regarding ants and network systems, Stanley Kubrick’s *Dr. Strangelove*, in the context of a journey to a forest near Barcelona.

Since *Ant Ballet*, each project has implicitly used elements of the reflexive scripted design, placing rules on a projects’ development based on a period of research into multiple influences, the synthesis of these influences into a ruleset, and the locating of the resultant design work in a time and place. *Nybble* gave dancers rules based on the experiences of Italo Calvino, Alan Turing, and banks of ‘human computers’ of the past; this was synthesised with the mechanical workings of contemporary computers (in particular the parsing of ASCII characters to a screen) in the context of the V&A courtyard. *Scriptych* synthesised contemporary computing theory, in the form of vector space embedding of language, with constrained writing techniques inspired by the Oulipo, in the context of Opera Garnier. Dancers had to follow rules, as did the projects’ creators, Simon Valastro and I: the project aspired to authenticity, and as such, we placed extreme constraints on the way in which it was carried out. *86400* and *24fps Psycho* are minor anomalies in this trend – but both projects made extensive use of scripting in their creation. *Network / Intersect* was the first project to use reflexive scripted design explicitly, codifying the methodology that had already been a part of my methodology since the early 2010s.

In this context, I propose the reflexive scripted design methodology as this thesis’ main contribution to knowledge: designed intuitively through the process of design projects over the past few years, it represents exactly the kind of knowledge creation Haseman advocates in his ‘Manifesto for Performative Research’.[41]

This thesis’ third contribution to knowledge is the use of the particular synthesis of scripting and the absurd that I have used to critically question technology. I hope that this has served to open up the use of the term ‘script’ within design as both a creatively generative, and critical tool.[42]

### Notes on practice: opportunities for future research

This study has examined several key areas related to script, the absurd, diagrams and performance from the perspective of a designer and artist working in performative architectural design and film-making. This is, by virtue of the research methodology, a limiting practice. No one person can reasonably expect to tackle all issues that they might wish to. Whilst this thesis has provided accounts of my own research-based methodology, there are several areas, which I have not yet been able to explore which I believe may yield fruitful research in the future.

The first is the relationship between psychological scripting, affect, and architecture, with the theories of Silvan Tomkins of particular interest. To what extent can architecture influence the way in which Tomkinsian scripts form, develop and are enacted; and what could this tell us about how to improve design for human inhabitation, and how might this play out in film? Whilst ‘behavioural scripting’ is a term already in use within parametricist discourse, it generally refers to programming highly reductive ‘agents’ in a virtual environment to simulate their movement (rather than emotions), most commonly whilst in a crowd. A study into Tomkinsian psychological scripting and affect may yield interesting methods for designing better, more humane environments, which are enjoyable to inhabit.[43] One possible case study (which I mentioned briefly in the footnotes to the introduction chapter) could be *Hogeweyk* in the Netherlands, a care community for dementia sufferers (designed by Dementia Village Architects: Frank van Dillen and Michael Bol).[44] The community is designed to have the appearance of a generic town, with amenities such as shop, theatre, pub, and public square, with residents carrying out apparently normal lives within the town. It is, in effect, a safe place, offering residents a good deal more autonomy than residents than a traditional care home. One of the significant problems that dementia suffers commonly face is the confrontation with the realisation that they are being looked after, and mistrust that occurs when, for example, staff who they do not recognise have to coerce them into taking medication. *Hogeweyk* operates to a different principle: staff do not wear uniforms, but rather clothes that imply they are just ordinary citizens in the town; the residents are able to go about their lives in a manner whereby they can continue what might be described as *scripted* behaviour, buying groceries at the shop, visiting the pub or restaurant, all the while being cared for by the staff (who find themselves playing generic ‘roles’). The carers do not contradict the reality the residents project onto their situation unless explicitly asked; thus, the residents are able to be cared for in a way that minimises conflict, and associated stress and mistrust.[45]

The second area for future research is the viability of the reflexive scripted design process, both for its current intended media of fictional film and theatre, as well as for other modes of design. So far, I have made one film using this practice, but its robust viability is unproved in any medium beyond this. How might reflexive scripted design be applied to other modes of practice, such as design of the built environment or graphics? Is it only suitable for work that deals with fiction? These, and more questions, are as yet unanswered.

The final area of research that I believe to be interesting is precisely the one I intend to work on next: better defining the relationship between the psychological script, human agency, and various models of freedom. As explained in this thesis’ introduction, human agency, and the extent to which behaviour can be codified and predicted, is one of the central questions of large-scale surveillance systems – themselves often operated by ‘agencies’ of the state. These immense prediction systems, also the product of myriad machine learning computer scripts, rely on inferences about human behaviour based on the ‘logic of resemblance.’[46] The systems are constructed on the assumption that with enough data, patterns of threatening or subversive behaviour will reveal themselves through a similarity to previous instances of such behaviour – i.e. that such behaviour is, itself, somehow subject to a script. The relationship between this mode of behavioural analysis with the intention of prediction, as well as the often-opaque mechanisms through which it often operates, and the concepts of psychological scripting advocated by Tomkins / Schank and Abelson, is largely unexplored. What’s more, the evolving nature of the predictive systems, and the way in which they codify and predict human behaviour contain potential implications for the three types of freedom – personal, sovereign, and civic freedom – identified by historical sociologist Orlando Patterson.[47] This is a subject area which I have hinted at but not explicitly explored, throughout this thesis, one in which I believe the topic of the absurdb may once again prove to be a useful ally.

[1] Georgina Born and Andrew Barry, ‘Art-Science’, *Journal of Cultural Economy* 3, no. 1 (2010): 116, <https://doi.org/10.1080/17530351003617610>.

[2] Brad Haseman, ‘A Manifesto for Performative Research’, *Media International Australia Incorporating Culture and Policy* 118, no. 1 (1 February 2006): 98–106, <https://doi.org/10.1177/1329878X0611800113>.

[3] Ibid., 103.

[4] Ibid., 102.

[5] With the exception of the *Godot Machine*, which was not exhibited.

[6] Born and Barry’s description of *epideixis* bears several similarities to Haseman’s performative research, although is more explicit about the function of the public.

[7] Haseman, ‘A Manifesto for Performative Research’, 100.

[8] Adrian Chen, ‘The Agency’, *The New York Times*, 2 June 2015, <http://www.nytimes.com/2015/06/07/magazine/the-agency.html>.

[9] Heath Bunting and WaiWai, ‘Search Routines: Stories of Databases’ (D21 Gallery, Leipzig, 23 October 2014), <http://rhizome.org/community/14616/>.

[10] The mode of citing influences in academic research is notably different from the way that teams are credited in commercial design practice. If performative research is to develop further as a discourse in academia, this is an area which needs to be addressed.

[11] Stanley Kubrick, *Dr. Strangelove (Or How I Learned to Stop Worrying and Love the Bomb)*, 1964; Stanley Kubrick, *2001: A Space Odyssey* (Metro Goldwyn-Meyer, 1968).

[12] My favourite low-tech trick was to place a time-lapse camera on a rotating egg-timer into a busy studio where a large object was being build, resulting in a dynamically rotating, frenetic time-lapse.

[13] The use of white LEDs over other available light was due to the fact they would not interfere with video like Tungsten, fluorescent tubes, or halogen lights might.

[14] The film was planned to begin with the machine from afar, in a darkened room, lit only by the light of its ‘halo’ light; in one long, unbroken dolly-controlled shot it would pan all the way to an extreme close-up of them at walking on the machines’ surface. The construction of the set also involved construction of a dolly-device.

[15] This is probably further shaped by my background in graphics and product design, in which I developed a love of graphic forms and grid structures of Josef Müller-Brockman, Massimo Vignelli, and Dieter Rams (whose machine interface designs strongly influenced the design of the *Godot Machine* computer). Most of the three-dimensional devices I make are, in fact, designed as a series of two-dimensional planes; machines make repeated use of laser- or water-cut sheet metals, which are then folded into three-dimensional forms.

[16] I use the term ‘archival’ for Google images, as the search engines’ repository and database of images is continuously updated; the searches that I performed in the creation of *86400* represent a snapshot of Google Images as an archive at that particular moment in its history.

[17] Italo Calvino, ‘Cybernetics and Ghosts’, in *The Literature Machine: Essays*, trans. Patrick Creagh (London: Secker and Warburg, 1987), 3–27; Italo Calvino, ‘The Burning of the Abominable House’, in *Numbers in the Dark and Other Stories*, ed. Esther Calvino, trans. Tim Parks, Array (New York: Pantheon Books, 1995), 156–69.

[18] Douglas Gordon, *24 Hour Psycho*, 1993, Film, installation, 1993, <http://www.mediaartnet.org/works/24-hour-psycho/>; Anthony McCall, ‘Line Describing a Cone and Related Films’, *October* 103 (Winter 2003): 42–62.

[19] Technologies currently being developed in this field include ‘Generative Adversarial Text to Image Synthesis’, Reed et al’s software which can produce believable synthetic images from text descriptions; Adobe’s *VoCo*, Google DeepMind’s *WaveNet*, and *Lyrebird.ai*, which all enable synthesis of realistic natural language in humans voice based on pre-existing samples of a particular person talking (essentially allowing users to recreate anyone’s voice). Note that the aforementioned technologies are not yet convincing enough to replace real images and audio, but with heavy investments in machine learning, artificial intelligence and associated technologies from most major technology companies, they are likely to improve over time. Scott Reed et al., ‘Generative Adversarial Text to Image Synthesis’, *arXiv Preprint arXiv:1605.05396*, 2016, <http://www.jmlr.org/proceedings/papers/v48/reed16.pdf>; Adobe Conversations Team, ‘Let’s Get Experimental: Behind the Adobe MAX Sneaks’, *Latest Company News & Updates | Adobe Conversations Blog* (blog), 4 November 2016, <https://blogs.adobe.com/conversations/2016/11/lets-get-experimental-behind-the-adobe-max-sneaks.html>; Aaron van den Oord et al., ‘WaveNet: A Generative Model for Raw Audio’, *arXiv:1609.03499 [Cs]*, 12 September 2016, <http://arxiv.org/abs/1609.03499>; ‘Lyrebird - Create a Digital Copy of Voice’, accessed 13 October 2017, <https://lyrebird.ai/>.

[20] For example, much of the Max and Python computer scripting for *24fps Psycho* was carried out in the same studio in Seoul as the post-production of Network / Intersect, often whilst the rendering of *Network / Intersect*’s high-definition video was taking place.

[21] John K Ousterhout, ‘Scripting: Higher Level Programming for the 21st Century’, *Computer* 31, no. 3 (1998): 23–30.

[22] Gensim: Radim Řehůřek and Petr Sojka, ‘Software Framework for Topic Modelling with Large Corpora’, in *Proceedings of the LREC 2010 Workshop on New Challenges for NLP Frameworks* (Valletta, Malta: ELRA, 2010), 45–50. Cornell Movie Dialogs Corpus: Cristian Danescu-Niculescu-Mizil and Lillian Lee, ‘Chameleons in Imagined Conversations: A New Approach to Understanding Coordination of Linguistic Style in Dialogs.’, in *Proceedings of the Workshop on Cognitive Modeling and Computational Linguistics, ACL 2011*, 2011. Available from <https://www.cs.cornell.edu/~cristian/Cornell\_Movie-Dialogs\_Corpus.html>.

[23] Tomas Mikolov et al., ‘Efficient Estimation of Word Representations in Vector Space’, *arXiv:1301.3781 [Cs]*, 16 January 2013, <http://arxiv.org/abs/1301.3781>.

[24] Ousterhout, ‘Scripting: Higher Level Programming for the 21st Century’.

[25] Whilst in France, I visited the regional contemporary art collection of Frac des Pays De La Loire which houses some of the French national art collection; the preservation team told me of the difficulty in maintaining computer-based works.

[26] See, for example the Internet Archive Software Library, or Rhizome’s notable effort to archive and recreate net art from the 1980s to the present day. Internet Archive, ‘Software Library’, 18 June 2014, <https://archive.org/details/softwarelibrary>; ‘Rhizome Net Art Anthology’, Archive, Rhizome Net Art Anthology, 27 October 2016, <http://anthology.rhizome.org/>.

Virtual machines are also now a core concept to services such as Docker, Amazon Elastic Web Compute, and Google Compute Engine, all of which now offer ‘cloud-based’ computing services which distribute computation to large-scale distributed computer servers. An interesting history of this form of computing can be found in Tung Hui-Hu’s book A Prehistory of the Cloud. Tung-Hui Hu, *A Prehistory of the Cloud*, First (Cambridge, MA: MIT Press, 2015).

[27] Many of the libraries and communities which exist around the Python language contain in-jokes and references to pop culture: the language itself is named after Monty Python’s Flying Circus; one of the popular libraries to work out time changes is named *DeLorean* after the time-travelling car in the *Back to the Future* movie franchise.

[28] There are numerous online communities where programmers are able to discuss work: Stack Overflow, GitHub, as well as the many forums, wikis, conversation boards and websites which support various platforms and programming languages.

[29] The term ‘flow’ was coined by psychologist Mihaly Csikszentmihalyi, following research into the creative process with Jacob W. Getzels in the 1960s. Csikszentmihalyi was ‘struck by the fact that when work on a painting was going well, the artist persisted single-mindedly, disregarding hunger, fatigue, and discomfort—yet rapidly lost interest in the artistic creation once it had been completed.’ Such a description could be applied to the state of mind I find myself in whilst programming. Jeanne Nakamura and Mihaly Csikszentmihalyi, ‘The Concept of Flow’, in *Flow and the Foundations of Positive Psychology* (Springer, 2014), 89.

[30] Often this necessitates a period of decompression once I am finished (e.g. a walk) in order to return to any level of conviviality.

[31] Peg Rawes, ‘Spinoza’s Geometric and Ecological Ratios’, in *The Politics of Parametricism: Digital Technologies in Architecture*, ed. Matthew Poole and Manuel Shvartzberg (London and New York: Bloomsbury Academic, 2015), 216.

[32] Mike Isaac, ‘Inside Uber’s Aggressive, Unrestrained Workplace Culture’, *The New York Times*, 22 February 2017, <https://www.nytimes.com/2017/02/22/technology/uber-workplace-culture.html>; Farhad Manjoo, ‘Uber Case Could Be a Watershed for Women in Tech’, *The New York Times*, 1 March 2017, <https://www.nytimes.com/2017/03/01/technology/uber-case-could-be-a-watershed-for-women-in-tech.html>. The blog *Model View Culture* offers regular feminist critique of Silicon Valley culture; see Feminist Technology Collective, ‘Model View Culture | A Magazine about Technology, Culture and Diversity.’, *Model View Culture* (blog), accessed 3 May 2017, <https://modelviewculture.com/>.

[33] Sam Knight, ‘How Uber Conquered London’, *The Guardian*, 27 April 2016, sec. Technology, <https://www.theguardian.com/technology/2016/apr/27/how-uber-conquered-london>.

The notion of fluidity in itself is similar to those expressed by Schumacher in his parametricist manifesto *Parametricism:* *A New Global Style for Architecture and Urban Design*. Patrik Schumacher, ‘Parametricism: A New Global Style for Architecture and Urban Design’, in *The Digital Turn in Architecture 1992-2012*, ed. Mario Carpo, AD Reader. (Chichester: Wiley, 2013), 243.

[34] Stanford University’s website cites the Silicon Valley garage start-up myth as originating in 1939 with the founding of Hewlett-Packard in a: ‘Palo Alto garage. That garage would later be dubbed “the Birthplace of Silicon Valley.”’. Stanford Office of University Communications, ‘Stanford University History Part 3 of 5 - The Rise of Silicon Valley’, 18 August 2008, <http://www.stanford.edu/about/history/history\_ch3>. The “garage” (or “dorm-room”) start-up myth is found in numerous large technology companies’ publicity, from Hewlett-Packard to Google (whose ‘About us’ webpage has a section entitled ‘From the garage to the Googleplex’) to Apple (the garage where the company was reportedly founded was featured as a filming location in the 2015 film *Steve Jobs*), and Facebook (whose start-up myth was cemented in the Oscar-winning 2010 film *The Social Network*). Google, Inc., ‘From the Garage to the GooglePlex’, 1 May 2017, <https://www.google.com/intl/en/about/our-story/>; Danny Boyle, *Steve Jobs*, 2015; David Fincher, *The Social Network*, 2010.

Today, ‘incubator’ companies such as *Y Combinator* aim to emulate the conditions that have led to the creation of large-scale technology companies through pairing venture capitalists with hot-house style provision of space and resources. Facebook’s first start-up incubator project in Paris, revealed early this year, extends this myth futher in its name; called the ‘Startup Garage’, it will house 80 desks for a ‘6-month program [f]or data-driven start-ups’ with direct access to Facebook engineers and resources. Jennifer 8 Lee, ‘Running a Hatchery for Replicant Hackers’, *The New York Times*, 21 February 2006, Online edition, <http://www.nytimes.com/2006/02/21/business/businessspecial2/running-a-hatchery-for-replicant-hackers.html>; Nathaniel Rich, ‘Y Combinator, Silicon Valley’s Start-Up Machine’, *The New York Times*, 2 May 2013, Online edition, <http://www.nytimes.com/2013/05/05/magazine/y-combinator-silicon-valleys-start-up-machine.html>; Polina Marinova, ‘Facebook Is Launching Its First Official Startup Incubator’, *Fortune*, 17 January 2017, sec. Venture, <http://fortune.com/2017/01/17/startup-f-facebook-startup/>; Romain Dillet, ‘Facebook to Open Startup Garage at Station F in Paris’, *TechCrunch* (blog), 17 January 2017, <http://social.techcrunch.com/2017/01/17/facebook-to-open-startup-garage-at-station-f-in-paris/>; Facebook Inc, ‘Startup Garage at Station F - Posts’, 6 January 2017, <https://www.facebook.com/FbStationF/posts/1310680305672747>.

[35] Rawes, ‘Spinoza’s Geometric and Ecological Ratios’, 217.

[36] Rawes, ‘Spinoza’s Geometric and Ecological Ratios’; D’Arcy Wentworth Thompson, *On Growth and Form* (Cambridge: Cambridge University Press, 1917).

Douglas Spencer also discusses the influence of *On Growth and Form* on the work of influential parametric architect Greg Lynn, who uses Thompson’s concept of ‘flexible type’ organisms whose form is purely reactive to its environment as a model for architecture which is equally formed by its surroundings, and as part of Alejandro Zaera-Polo’s arguments about neoliberal market ideals. Douglas Spencer, *The Architecture of Neoliberalism: How Contemporary Architecture Became an Instrument of Control and Compliance* (Bloomsbury Publishing, 2016), 56,126.

[37] Rawes, ‘Spinoza’s Geometric and Ecological Ratios’, 218.

[38] Alfred Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics*, Fifth edition, second printing (Brooklyn, N.Y., USA: International Non-Aristotelian Library, Institute of General Semantics, 2000), 58; Gregory Bateson, ‘A Theory of Play and Fantasy’, in *Steps to an Ecology of Mind*, 13. printing. (Ballantine, 1985), 177–93.

This argument is exemplified in the Jorge Luis Borges short story *On Exactitude in Science*, in which an empire becomes so obsessed with cartography that it builds a 1:1 map of its territory; the map is useless, and ends up a tattered historical relic. Jorge Luis Borges, ‘On the Exactitude of Science’, in *Collected Fictions*, trans. Andrew Hurley (New York: Penguin, 1998), 325.

[39] See, for example, the way in which ‘behavioural scripting’ is discussed in Patrik Schumacher, ‘Advancing Social Functionality Via Agent-Based Parametric Semiology’, *Architectural Design* 86, no. 2 (2016): 112–13.

[40] The ‘documentary’ footage was first shown at FutureEverything festival in 2012. The presentation of the work as *performed* research was part of the projects’ success.

[41] Haseman, ‘A Manifesto for Performative Research’.

[42] There are, of course, shortcomings to this thesis, and my work in general. I am aware that, having spent the past seven years working largely towards the development of a reflexive scripted design methodology – one which is the result of both conscious effort and intuition – I am perhaps overly fond of the method.

[43] This might also be aided by the use of Schank-and-Ablesonian computer-scripted linguistic analysis.

[44] Dementia Village Advisors, ‘Dementia Village’, 13 June 2014, <http://dementiavillage.com/>.

[45] Sally Stewart, ‘Redesigning Domesticity: Creating Homes for the Elderly’, *Architectural Design* 84, no. 2 (2014): 80–87; Demos et al., ‘The Commission on Residential Care’ (Demos, 2014), 10, 18, 162, 167–69; Jeremy Story Carter, ‘Dementia Village Designed for Dignity’, Radio broadcast, *Blueprint for Living* (ABC RN, 3 October 2015), <http://www.abc.net.au/radionational/programs/blueprintforliving/designing-for-dementia/6805070>; Anne P. Glass, ‘Innovative Seniors Housing and Care Models: What We Can Learn from the Netherlands’, *Seniors Housing & Care Journal* 22, no. 1 (2014): 74–81.

[46] Claudia Aradau and Tobias Blanke, ‘Politics of Prediction: Security and the Time/Space of Governmentality in the Age of Big Data’, *European Journal of Social Theory*, 14 September 2016, <https://doi.org/10.1177/1368431016667623>.

[47] Orlando Patterson, *Freedom: Volume I: Freedom In The Making Of Western Culture*, Freedom (Basic Books, 1992); Orlando Patterson, ‘The Ancient and Medieval Origins of Modern Freedom’, in *The Problem of Evil: Slavery, Freedom, and the Ambiguities of American Reform*, ed. John Stouffer and Steven Mintz (Amherst and Boston: University of Massachusetts Press, 2007), 31–66.

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Technical development notes *Godot Machine and Ant Ballet* ==============================

I joined the Bartlett School of Architecture in 2009 to undertake a Master’s Degree in Architectural Design, as part of the Interactive Architecture Workshop led by Stephen Gage.[1] The Bartlett provided a fertile test bed for ideas and experiments, and it was here that I learnt to write computational code, as well as integrate advanced manufacturing techniques and prototypical electronics into my production process. Both of these practices had a significant effect on the way that I worked; the possibilities of designing and manufacturing 3D-printed and waterjet-cut components, the use of Arduino microcontrollers and electronic components, and a network of peers and tutors with expertise, led to a phase of intense experimentation in building mechanisms and robotic assemblages. At the same time as developing these practical skills, the conversations with tutors and peers served to develop a number of enlivening ideas, many of which have persisted and found their way into this thesis. The two projects, which formed the basis of my Master’s portfolio, established a mode of working which continues throughout the other projects in this thesis: namely, the use of diagrammatic techniques to explore, explain, and analogise. I continued to develop both projects during the first year of this doctoral research; however, it is the later re-framing of these projects which had the biggest impact on later work.

[1] See Stephen Gage, ‘The Bartlett Interactive Architecture Workshop’ (Maverick Machines: An Exhibition Inspired by the Work of Gordon Pask, July 2007). I was also taught by Richard Roberts and Ruairi Glynn. Prior to joining the Bartlett, I had a degree in Product Design, and a commercial background working in graphic design.

# *Godot Machine* technical development

For the purposes of clarity, I will separate the issues of developing the physical design of the *Godot Machine* from the issues of creating software to drive it. The basic premise of the software that drove the machine remained constant throughout: a feedback-and-correction system based on visual input from a camera about an ant’s position. However, the design of the object itself went through an iterative process that borrowed a numbering system from the world of software development. Starting at version ***v0.0***, each minor revision (for example, an undated actuator mechanism) would increment the design by ***v0.1***.[1] A major overhaul of the design (for example, a change to the structure itself) would result in a progression to the next integer, so that a major change to machine ***v0.4*** would result in machine ***v1.0***. This system was used to keep track of the many incremental changes and prototypical parts that were built and tested across a small number of underlying structures. The final machine that was built in this method was ***v3.2***.

The first model (***v0.0-0.1***) was a rapidly-made prototype based on some sketches. Its function was to explore the mechanics of driving a polystyrene ball of approximately 180mm in any direction, and it was made of off-cuts, spare parts and old continuous rotation servos that were in the studio. Both models (the first relying on steel rollers, and the second using paper cups to rotate the ball) were unsuccessful in rotating the ball along more than one plane simultaneously, and suffered from unpredictable ‘drag’ issues caused by friction by the inactive drive wheel. It was clear that a more advanced method was required to progress.

The second model, ***v1.0-1.2***, consisted of a concrete base of approximately 150 x 150 x 250mm, with four pressed steel arms of 1000mm length (850mm visible) emerging at an angle of around 25º from vertical, to be placed on a table or plinth. Each rod had a large surface-mount ball bearing bolted approximately two thirds of the way up, and at the extreme end, the actuating device. Resting atop the four ball bearings was a white polystyrene ball of 500mm diameter. I experimented variously with regular wheels (***v1.0***) and ‘omniwheels’[2] (***v1.1***) attached to continuous rotation servos, and finally with a ‘finger’ mechanism (***v1.2***): a pair of lightweight micro-servos, configured to pan and tilt a small metal rod which would push the ball to rotate it. My electronics skills at this stage were still crude, and the micro-servos were incredibly jittery and ineffective at actually rotating the ball (and far better at gouging it). When I presented the work at a first critique, rather than criticise my shoddy electronics and manufacture, the panel complimented the paranoid personality the machine appeared to have. I decided to try and keep a non-wheel-based rotation with the next iteration.

I then built a more precise experimental base for the machine using laser-cut aluminium (***v2.0***), also designed to be placed on a table or plinth.[3] Still using four ball bearings to support the 500mm ball, the chassis was designed with experimentation in mind. Each of the armatures which supported the rotation mechanisms had rows of pre-cut holes to accommodate fixing of new mechanisms at different angles. The first two mechanisms to be tested on the machine were categorically failures: laser-cut (***v2.0***) or 3D-printed (***v2.1***) ‘grippers’, powered by servos, would lift the ball from underneath and rotate it in one of four directions. The laser-cut components of ***v2.1*** were too heavy to work with the servos, and the 3D-printed components had too much friction to work reliably. ***v2.1*** marked the first use of 3D printing in my design work.[4] ***v2.2*** then used 3d-printed omniwheels to support the ball (designed to match the profile of the ball itself, unlike the omniwheels of ***v1.x***). However, the omniwheels did not offer enough grip on the 500mm polystyrene ball to actually rotate it. ***v2.3*** returned to the idea of ***v1.3***’s ‘fingers’, but this time with laser-cut acrylic and padded rubber end-caps. However, none of the mechanisms of ***v2.x*** worked effectively. It was at this stage that I realised designing an elegant mechanism to rotate a lightweight polystyrene ball accurately in multiple planes simultaneously was a real engineering challenge. There are multiple pure robotics projects for robots that balance atop balls, etc., but most of these are concerned with the robotics element and pay little heed to the idea of a featureless ball, which I deemed essential to the *Godot Machine*. If the ball’s surface contained features, then the ant on the ball would have ‘landmarks’ which it could use to navigate. I spent some time working on rendering polystyrene balls with plaster to create perfect surfaces, but in the end did not find a satisfactory or repeatable method which guaranteed uniform surface, or enabled me to actually transport the balls[5]. I decided that a rethink of the entire system was necessary.

This iteration also marked the first design of the ‘halo’ device, an illuminated ring of white LED lights surrounding a centrally-placed webcam which connects to the controlling computer (and thus the driving devices). ***v2.x***’s light ring was suspended above the ball from an independent support structure, much like an office desk lamp. The halo design itself served both practical and aesthetic functions: in the first instance, it provided an omnidirectional light that would illuminate the ball in order to regulate the light on the ant (much like a ring flash is often used for portrait photography). Secondly, it would confuse the ant: given that the machine was being designed in the UK, the most likely type of ant to be placed on the device would be *Lasius niger*, the common garden ant. This species is known to use an approximately equal, complementary combination of pheromone trails and visual landmarks to navigate,[6] however, the use of trail pheromones is largely used to signal when an ant has found food, an instance that would not be applicable to an ant on the *Godot Machine*. A consistent light, bright, circular light source above the ant, which appears to stay in the same place, would hopefully ‘de-anchor’ any visual cues for the ant. The third function of the light was a small homage to the light ring in *Dr. Strangelove*.[7]

***v3.x*** represented a major change in the machine, and my logic in designing it. Instead of separating the role of support (previously provided by ball-bearings) and actuation (the one factor I had changed so far), this version of the device rested the ball on three drive-shafts. Using three points of support instead of four – the minimum, and most stable number to support a sphere – the device was made of three pieces of identical laser-cut steel of 2mm thickness. The steel was then bent along pre-perforated lines and bolted together with M5 bolts. The pieces of bent steel overlapped each other like a camera’s aperture ring, and were in constant tension. Three stepper motors then mounted to the steel frame, and from these, brass rods would provide support to the ball. All experimentation on this model would then be with materials for the ball and the supporting rods. I bought balls with as many surface materials as possible from a nearby sports shop, and began to test these combinations. Since I had not designed the various balls, they did not factor into my numbering system.

This chassis proved far more successful as a test-bed. It was also far more efficient in terms of the amount of material it required: ***v2.x*** had five different types of aluminium parts, and ten individual aluminium pieces to fit together (excluding mechanisms), whereas ***v3.x*** only had three identical steel parts. Whilst it could be tested reliably on a table-top, the design could also be suspended from a ceiling, creating the illusion that the ant really was on top of her own world, a void in space. The stepper motors were easier to programme[8] than the various servo mechanisms that I had been working with. Instead of sequential loops to synchronise their movement, the steppers could be simply required a speed and a direction, and were highly accurate in their rotation. The size of the ball was reduced to between 180-250mm (depending on the type of ball being tested).

At the same time as building the ***v3.x*** chassis, I built a housing for the control system. This served both practical and aesthetic purposes. Due to the practicalities of building a machine without a fixed studio space in an architecture school, and the regular transportation of the device to and from critiques, the machine and associated electronic components were subject to constant movement and dislodging. This would often have an adverse effect on the wiring, which, in prototypical form, was not permanently soldered in place. Due to my inexperience with electronics, I also kept accidentally burning stepper motor driver boards. I decided to build a housing that would enable easy diagnosis of wiring errors or broken parts, and to replace burnt boards within a few minutes. I based the distributed layout of the components on the design of HAL’s, the computer control system in Stanley Kubrick’s *2001: A Space Odyssey*.[9] Towards the end of the film, there is a scene where HAL is switched off one component at a time. The individual circuits are laid out sequentially, so that the logic that they control can be easily seen. My panel design for the *Godot Machine* used a similar logic: it laid out, in diagrammatic form, the process within the microcontroller. A USB cable carries signal from a computer to an Arduino microcontroller at the top-right. This then sends signals to three EasyDriver 4.3 stepper motor drivers, which in turn are connected via long cables to the stepper motors themselves. Along the way are a series of LED indicator lights: one on the Arduino, and one on each stepper driver indicates that it is receiving power. A pair of LEDs on the Arduino signal what it is doing at that moment: a red light indicates that the Arduino is connected to the computer, but not doing anything (‘thinking’ mode) whilst a green light indicates that the Arduino is actively sending signal to the stepper motors. The entire electronics layout is housed behind a dark blue Perspex panel with labels to indicate the components underneath, in a similar style to HAL’s fascia. Although relatively simple, the panel represents another level of diagramming within the machine.

The final design I was able to build was able to successfully rotate a sphere to any angle. ***v3.2*** used an oversized tennis ball of diameter 180mm for the main sphere, rotated by three polypropylene attachments to the driveshafts of the stepper motors. This material combination had the right amount of friction to enable the main ball to turn smoothly and accurately in six directions by simply rotating two stepper motors at full speed in one direction, and the final one in the opposite direction (see diagram and chart). The speed of one or all of the stepper motors could also be varied in order to make the main sphere move faster or in any direction. In short, the design of ***v3.2*** eliminated all of the engineering issues of the previous models: it presented a highly accurate control mechanism to direct the ball in any direction, at any speed (see Figure 7-54 and Table 17-2 and Table 17-2).[10]

I built ***v3.2*** in the summer of 2011, at the same time as I began the ultimate stage of testing the *Ant Ballet* project. The final version, ***v3.4*** assembled after a long pause in project development (assembled December 2014) used a sphere more reminiscent of a Kubrick film: a chromed plastic sphere (with the appearance of a shiny metal), and black tennis balls as actuators. This has yet to be exhibited, for reasons that are discussed in chapter 1.

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[1] When programming, the number 0 is normally the first number in an index.

[2] Wheels designed to rotate in one plane, but allow movement in another. Omniwheels are common on factory floors or on contemporary self-driving robots.

[3] The use of laser-cut aluminium was influenced by the work of students in the Bartlett’s Unit 14: Subomi Fapohunda and Dave DiDuca.

[4] I had taken a course in 3D printing run by Matt Shaw (later of ScanLab) and Justin Goodyear of the Bartlett.

[5] I built several 500mm polystyrene balls which were rendered with plaster, and subsequently became damaged or destroyed through transport.

[6] Sophie E. F. Evison et al., ‘Combined Use of Pheromone Trails and Visual Landmarks by the Common Garden Ant Lasius Niger’, *Behavioural Ecology and Sociobiology* 63 (2008): 261–67, <https://doi.org/10.1007/s00265-008-0657-6>.

[7] Note that at the time of production, 3D printing in nylon was considerably more expensive (and harder to attain) than it is today. The Bartlett 3D printing service charged per cubic centimetre of the rectilinear volume of anything printed. In order to reduce this cost, the halo was printed in three identical parts, printed close together, then later assembled using the same type of bolts as in *Godot Machine* ***v2.x***. Having a background in product design, and having been previously subject to the limitations of injection moulding and other traditional manufacturing techniques, it was my ambition to ensure that every 3D printed design I made utilised the potential of the technology to do more than simply creating parts that could be injection moulded, with interlocking components or integrated mechanical systems: hence, in ***v2.x***, the printing of one-part omniwheels and fully integrated articulated lever systems. When printing more straightforward components such as the halo, the parts would always be printed inside a bounding ‘box’ with wall thickness 0.75mm, with large holes at either end for the removal of excess powder. This provided a means to ensure that smaller components were not lost from the densely-packed array that I would always print at one time.

Stanley Kubrick, *Dr. Strangelove (Or How I Learned to Stop Worrying and Love the Bomb)*, 1964.

[8] Although easier to programme, they did require separate driver boards. I will elaborate on these later.

[9] Stanley Kubrick, *2001: A Space Odyssey* (Metro Goldwyn-Meyer, 1968).

[10] Up to the highest speed of the motors – which by far exceeded the top speed of even the fastest *Lasius niger*.

# *Ant Ballet* technical development

The *Ant Ballet* project began with a simple project proposal – one which I had no intention of carrying out, but was simply using as a thought-experiment. Thinking about the analogy of ants in computer systems (this was the same time as initial *Godot Machine* development), and having read a little about invasive ant species, I approached Dr. Seirian Sumner at the Insitute of Zoology to talk about an ill-formed idea I’d had about invasive insect species being analogous to computer viruses. I had recently read a newspaper article[1] about a species of invasive ants (*Lasius neglectus*) who had entered the UK for the first time, and were famed for their attraction to electricity – something that, like the invasive ant *Solenopsis invicta* in the US, causes them to short-circuit electrical systems.[2] The hypothetical idea that I approached Seirian with was simple: to build a spatially distributed computer, with exposed wiring and components. A colony of invasive ants would then be introduced to cohabit the space with the computer, gradually becoming attracted to the exposed wiring, and biting, short-circuiting and destroying the computer; in effect, becoming a physical computer virus.[3]

I wrote to Dr. Sumner as I had seen her work identifying nest drifting behaviour of paper wasps, in which her team had placed RFID tags on hundreds of female members of a colony in order to track their movements between nests, and was excited by the innovative way an emergent technology had been used.[4] In conversation, Sumner told me details of the method used to collect, tag, track and analyse results with the wasps, using statistics programmes such as R to produce network visualisations of wasp behaviour.[5] Our conversation carried on for far longer than our allocated appointment time, and we both were excited by the others’ perspective on our own work. We agreed to meet again to develop ideas further.

By the next time we met, I had carried out more paper research into insect communication systems (of which olfaction is the most common[6]) and had developed a particular interest in ant pheromones. Jackson and Morgan describe these mechanisms in the paper ‘Insect Chemical Communication: Pheromones and exocrine glands of ants’.[7] They explain semiochemicals – that is, chemicals which allow for information exchange between organisms – can be divided into two main categories: alleochemics allow intra-species communication, whilst pheromones allow for communication within the same species. Pheromones either work as a *primer*, a semiochemical which causes a physiological change to the recipient, or a *releaser*, a semiochemical typically emitted from an ants’ Dufour gland, and encoded into the environment.[8] Releaser pheromones trigger seven main (occasionally overlapping) types of behaviour, signalling: sex, aggregation, dispersal, alarm, trail, territory, or surface.[9] These pheromone signals can display extraordinary complexity. The majority of technical papers describing ant pheromones and colony-wide behaviour are concerned with trail pheromones and emergent properties that arise from collective problem-solving. Notable among these are the works of Dorigo et al. initated in the 1990s.[10]

A year or so before starting *Ant Ballet*, I had been involved in a project at the Royal College of Art (RCA) initiated by artist and activist Cesar Harada, entitled *Open\_Sailing*. It was whilst spending time in the RCA’s (now defunct) Design Interactions department that I became aware of the World Transhumanist Association,[11] a group whose aim is to improve the ‘human condition’ through augmenting and artificially improving human bodies, claiming transhumanists’ desire to ‘extend their mental and physical (including reproductive) capacities and to improve their control over their own lives. We seek personal growth beyond our current biological limitations.’[12] Several of the RCA students were working on projects that related to ‘biohacking’, the deliberate alteration of the human body to adjust its natural capabilities (for example, the surgical placement of small magnets in the fingertips to allow for the detection of electromagnetic fields). At the time, I was intrigued by the world of online forums and tutorials that existed to support such activities, but surprised that so much of the work was purely focused on human experience. I could find little evidence of similar ‘hacking’ of animal systems, despite the wealth of pre-existing scientific knowledge that might be used for such a purpose.[13]

I developed the idea of using ant pheromones (rather than my previous notion of electricity) to control ant movement. Much had been written about the redundancy and optimisation abilities of ant trails, and the potential to control invasive species through pheromone manipulation (using synthetic pheromone traps to lead ants to poison traps, for example[14]). I had yet to see artificial ant pheromones used in an attempt to communicate with ants, or to manipulate their behaviour for artistic purposes. The idea of creating a choreographed movement of an ant colony was both absurda and technically challenging. I was already working on the *Godot Machine* and the equipment necessary to create an ant ballet would serve as an extension of my desire to create a functional diagrammatic machine. Over the coming months I would work out how the machine worked, and what it was a diagram of.

I spoke to several entomologists besides Dr. Sumner about the project, asking for advice or precedents. The first difficulty I came across with the project was the difficulty in accessing ant pheromones; they are not something available to the mass-market (I suspect due to low commercial interest). Identification of pheromones is complex and highly specialised, and even when the components of ants’ glands have been analysed, the function that each semiochemical has, and the methods and densities in which they are used, are still not known. I came across a website called *The Pherobase* which lists known pheromones in insect species, and often the papers which originally identified these compositions.[15] This became an invaluable resource. It was at this stage that I developed a basic set of rules that the project would adopt.

One of the entomologists I spoke to dismissively recommended that I use sugar-water to create the illusion of ant trails, and cited an occasion that they had used this method for a sugar television advert several years ago.[16] My immediate reaction was repulsion; given my desire for Kubrickian attention to detail, the idea of tricking an audience into thinking that the ants were doing one action when in fact they were doing another seemed reminiscent of the Disney documentary *White Wilderness*, in which the filmmakers reputedly staged shots which made it appear as if thousands of lemmings committed mass suicide by leaping off a cliff and swimming to sea.[17] Such inauthenticity would have no place in the project; one of my central goals with the project was authenticity rather than cinematic effect. It would be relatively easy to pretend to make ants dance using sugar water (or clever video editing, or any manner of other tricks), but appropriating their communication protocol in order to subtly change their behaviour would take hard work. Thus, the work would be produced according to two rules:

1. The project must accurately depict a diagram of the Theatre of the Absurd
2. The project should not be dismissable by scientists. This does not mean it needs to result in a published paper, but rather that it cannot use fakery.

The method of achieving (1) and (2) is to *really do* everything necessary to make ants dance. This also meant a high risk of failure: attempting something that had not been achieved before, which relied on a relatively high amount of scientific knowledge, for artistic merit, is intentionally risky. I am also happiest working when I am outside my comfort zone, making a project that could really fail.[18] My conversations with Dr. Sumner continued periodically throughout the project, and continued to shape and influence the direction the project took.

### Pheromone synthesis

After numerous attempts to speak to experts in biochemistry (both in industry and academia) about the feasibility of ant pheromone synthesis, I began a dialogue with Professor Jim Anderson of UCL Organic Chemistry and Chemical Biology.[19] Anderson’s profile states that ‘work in his laboratory covers a broad portfolio of projects that combine contemporary synthetic organic chemistry methodology with highly adventurous, blue sky research.’[20] In our initial conversation, he told me about numerous semiochemical effects that had been well documented, including 'Azadirachtin', a natural substance emitted by neem trees which repels locusts, and some of the intricacies of pheromone synthesis (including the concept of compound chirality).[21] Anderson offered to help with the synthesis of pheromones, providing expertise, materials and lab time, on the condition that we could identify pheromones that would be relatively easy to synthesise. I downloaded datasheets for every ant species available on the *Pherobase* at the time, then devised a matrix of conditions that pheromones would have to meet to be considered for synthesis.[22] In order to be considered, a species’ trail pheromone had to have been identified; the trail pheromone had to consist of one chemical (many pheromone trails are multi-component); the semiochemical had to have a low number of chiral bonds; and the species had to be fairly common somewhere in Europe so that I could get hold of some to test with.[23]

After researching the handful of species who met all of the criteria, one emerged as the most suitable. *Linepithema humile*, or the Argentine ant, is a well-documented invasive species who have recently spread around the world due to human travel.[24] Their trail compound comprises the hydrocarbon (Z)-9-hexadecenal (Z9-l6:Ald), and I found two papers describing different ways the pheromone had been synthesised and used as attractant for ants.[25] In a 1981 paper, Vorhis Key and Baker used synthetic pheromone to cause ants to follow a synthetic trail along a circular shape 14cm in diameter; [26] Tanaka et al, opting for a brute-force approach, testing synthetic pheromone as a pure attractant, placed in pots along pre-existing ant trails with the intention seemingly just to generate confusion among ants (an approach they filed a patent for in 2005).[27] Professor Anderson assigned the reproduction of the pheromone, bonded to silica powder (which had not been seen in any of the papers) to undergraduate student Jack Bestwick. A few months after our initial meeting, I was presented with approximately 3.5kg of silica powder, containing approximately 0.8g of synthesised pheromone.

In the meantime, I set about researching the species we had chosen. Since *L. humile* had spread extensively around Europe, most closely to the northwestern coast of Spain, it seemed logical to me to simply import ants from there.[28] However, it was upon talking to Dr. Sumber that I realised how invasive this particular species is, and what a risk to native ecosystems it would be to risk bringing any ants into the UK. Biologists Wetterer and Wetterer describe the species exhibits supercolonising traits, meaning that they form huge colonies with millions of queens which can stretch over vast distances. Ants from any nest within the supercolony can be introduced to ants from any other nest within the supercolony, and unlike most species, they will not fight. This gives them a huge advantage over local species, in that they do not lose members of the colony to intracolonial aggression.[29] The species has spread around the world, and the largest known supercolony is over 6,000km long, stretching through ‘Spain, Portugal, southern France and Italy’.[30]

The realisation that it would be irresponsible to introduce *L. humile* to the UK presented a real change to the design logic of the project. Until that point, I had been working on designs that presented the *Ant Ballet* as a machine, of approximately 2m diameter. My assumption had been that the manufacture of the machine would largely take place in the Bartlett workshop (with bespoke parts perhaps carried out via subcontracted waterjet-cut steel or aluminium). I realised that the testing of the pheromone would have to take place abroad, and that subsequently, all of the machinery would have to be designed to be taken abroad. At the time I had access to my sister’s car, a Volkswagen Polo, and a number of contacts in Barcelona, a city where *L. humile* was well documented.[31] I decided that the best way to resolve the project was to design and build the entire machinery to fit into the back of a hatchback car, and carry out all tests there. I believe that this decision was something that changed the nature of the project: rather than being a potentially eccentric, slightly absurd project that took place in north London,[32] I began designing and building an elaborate testing apparatus, with robotic control system, having also commissioned the manufacture of synthetic pheromones, to drive roughly 3200km on a round-trip – all for the purpose of slightly confusing some 5mm long ants. In many of the plays associated with the Theatre of the Absurd, the control systems that are expressed are highly abstract, removed and have strange behaviours. Like a character in a play, the ants would have no idea of the effort that had been put into the construction of an elaborate literal and figurative mechanism to change their behaviour. Much of the absurdity alluded to in this project is inspired by the plot structure of Kurt Vonnegut’s novel *Sirens of Titan*, wherein it is revealed slowly through the course of the book that increasingly abstract methods have been in place to subtly (and not-so-subtly) affect human behaviour through history, with a completely trivial outcome.[33]

Given the cinematic and theatrical origins of much of the projects’ inspiration, I conceived of the testing of ant pheromones as a performative act. This was, after all, not a rigorous scientific test (despite involving the participation of scientists), but rather the entire work was a diagram that could best be expressed through film. My initial designs for test apparatus had been based on the assumption that pheromones, like those within ant gasters, would be liquid in form. I drew inspiration from the William Blake etching *Ancient of Days (God as an Architect)*;[34] where Blake was presenting a monothiastic deity creating the world from on-high, the *Ant Ballet* machine would be using a similarly top-down, hierarchal approach to interfere with the ‘emergent’, non-hierarchal system of ant pheromones. Early on in the design process I had decided to construct a round test bed, both as an homage Ken Adams’ War Room in *Dr. Strangelove*, and in order to prevent the machine looking too much like a large-format printer.[35] My initial designs would use a heavy base material and a large rack-and-pinion set pair of ‘compasses’, mounted above the table surface, to draw pheromone trails, but as the criteria for the design changed to require packing and transportation via small car to Barcelona, the designs themselves changed. Having worked through a series of designs, I was encouraged to consider using a centrally-placed robotic arm emerging from the centre of the table itself by Ruairi Glynn (this would be far easier to assemble and calibrate off-site).

My final designs for the device itself took much from the sci-fi aesthetic of the 1974 cult film *Phase IV*, in which ants in the US desert develop psychic communication abilities and take over a scientific research station towards an unspecified catastrophic outcome in four seemingly coordinated phases.[36] The table was made entirely from aluminium. Starting from a heavy, box-section base with over-engineered 4mm-plate aluminium connecting plates, the design would become increasingly light the further it was from the ground. The circular aluminium test bed, in part supported by 10mm diagonal rods from the heavy legs, was in fact made of three layers of laser-cut aluminium.[37] The top layer, only 1mm thick (for cost reasons) was bolted to two 4mm thick support sections. Above the entire structure was a round light made of sections of lasercut aluminium, similar to that seen in *Dr. Strangelove*.[38] Unseen, in the centre of the light ring, was a webcam much like the setup of the *Godot Machine* (the intention being to use this during phase II onwards). The robotic arm was modelled on the contours of my own arm in order that it would have some sort of anthropomorphic, performative quality. I imported high-torque servos from the US to enable the control of the robotic arm.[39] I also set about constructing a basic control programme for the robotic arm via Processing and Arduino. The control mechanism consisted of a diagram of the machine in plan. Various versions were built that enabled both mouse input (as seen below) and autonomous control of the arms’ movement in pre-choreographed or semi-random patterns.

I worked through numerous dispersal mechanisms for the powdered pheromones. The eventual design I employed used a glass laboratory pipette with thin end attached to a silicon input pipe for pheromones, and attached to a 3D-printed with a vibration motor of the style found in mobile phones. When the vibration motor was activated, a fine (but not entirely steady) plume of silica powder was spread from the pipette.

In Barcelona, the machine was set up in the small town of La Floresta.[40] During the daytime, we met Espalder, who kindly introduced me to a local prolific nest, taught me how to identify *L. humile* (a technique by which one crushes a few of the ants, and smells the result for a vaguely almond-y scnet) and how to collect them. By this time, I had read many papers on ant behaviour, and spoken to several experts, but until this stage, I had not thought about the human element of these studies. For every clinically-written paper about testing trail following, in all likelihood someone in the lab had to go to a site, identify a certain species of ant, and use a device called an aspirator (made of tubing, cork and stockings) to manually suck ants into a tube then place them in a flourin-lined tub.[41] The almond-y smell of *L. humile*, after a few minutes’ sucking, translated to a bitter taste that hangs in the back of the throat for the next day or so. Espalder told me much about practicalities of collecting, settling and keeping ants. Ants require 24-48 hours in one place to settle, and display more natural behaviour when they have brood to take care of, he said. They like to be fed a weak solution of honey or sugar in water or milk.[42] We set the ants up in nests of pine tree bark and leaves on the machine’s test bed. The ants themselves were incredibly small, and kept finding new ways to escape from the machine.[43] It also became apparent that aluminium offers little for ants to grip: the slightest breeze could clear the table of ants. Fortunately, there was not much wind in Barcelona in July, particularly in the middle of a forest. Re-stocking the ant nest became a near-daily task. There were also numerous issues relating to the technicalities of running an experimental robotic machine in the middle of a forest, and it required constant maintenance. We tried numerous iterations of power supplies, running cables from the nearby house to the forest. Several components were replaced with supplies from local hardware shops.

Whilst setting up the machine, I also developed storyboards to work out how to explain the experiments visually. In London, I had approached the Metropolitan Police to ask what the protective clothing would be if there were a Phase IV-style ant outbreak in the city. I had been informed that Tyvek overalls, rubber gloves and respirators would likely do. Therefore, the ‘experimenters’ in the film would, at all times, wear this uniform.[44] The entire performance would take place in visual form only, so that there was no dialogue, and each component of the system would be displayed and introduced much like a character, complete with title card. The first shot would establish the location of the machine, in the middle of a forest. It seemed essential to me to show the context – particularly as the setting up of the machine in this location had incurred so much effort. I wanted an engaging, dynamic opening shot that revealed the machine. I built a dolly system using 50m of climbing rope that enabled a camera to move through the forested valley and reveal the machine.[45] It took several iterations, including various methods of controlling camera movement and reducing shake, to actually achieve the shot. The final device was remarkably low-tech: it used a towel to dampen movement, and the camera was launched down the dolly in free-fall.[46] Although only on-screen for a couple of seconds, the shot establishes the location and the machine, grounding the experiment in an indistinct place.

After the opening shot, the two human characters are introduced; the fact that they are unidentifiable and wearing Tyvek suits and respirators indicates that there is at least a sci-fi, if not a scientific, bias. Title cards introduce the major elements of the projects, such as ‘ANTS: linepthinema humile’ or ‘PHEROMONE: z-9-hexadecanal’. Modelled on the on-screen graphics of HAL in *2001: A Space Odyssey*[47], a subtly rotating graphic outline of the object, alongside widely-spaced one-word description[48] and a small description line. The title cards are immediately followed by a shot of the item being used, shot in a mode that deliberately mimics 1960s/70s cinematography: jump cuts, static in-camera pan-and-zoom. All of these shots were filmed over the first few days of the machine being in the forest, and were storyboarded in advance. The ‘machine waking up’ shot, in which the robot arm rises from a ‘sleeping’ position and becomes active (following a slide introducing the machine performing ‘choreography sequence CRM-114’) showed an error in machine calibration where in switching on, a cloud of silica powder was released – but this made for a more dramatic shot than every one where the machine simply switched on.[49]

In order to echo the absurdity of *Dr. Strangelove*, and create an absurdb diagram, I had wanted the storyboard to be visually reminiscent of the Ken Adams-designed war room. The experiment would similarly take place in a dark space, with the sole light source being a light ring suspended above. However, each time the ants were set up in colonies, and artificial pheromone trails were laid at night, the ants did not react at all. This was frustrating, as this was a different behaviour to that displayed when conducting manual pheromone tests in the park they were collected from (ants had in this case followed the trails). With the logistical issues of escaping ants and mechanical failures, and only wanting to film at night, the project was nearing the date we had to pack up and drive home. On the final night of filming the machine and the ants – and in fact the only night I managed to film the ants all night – it appeared that after laying a trail all night, no ants were following the trail. I was severely demotivated. Just as we were preparing to break the machine down to head home, thinking the experiment had been a total failure, my colleague went down to the machine to visually assess the task ahead. It was then – around 9.30 in the morning – that she noticed the ants were following the trails that had been laid overnight. In retrospect, this made sense: we had witnessed the ants’ behaviour change throughout the day whilst collecting them. In the mornings, the ants would create trails on one side to forage for food, and shift throughout the day towards other non-food related activities. Now on the test bed they were exhibiting similar behaviour: waking up in the morning, they were clearly hungry, and looking for the remnants of the trails that they expected to find from the previous day. The trails they encountered were the synthetic ones laid by the machine.[50] By this time, having filmed all night, all of the camera batteries had been depleted, save a pocket-camera; this is the one that was used to shoot the final scenes in the film where the ants actually follow the pheromone trails.

On return to London, I began compiling the video and documentation of the project. My initial focus was on the short overview of the project. The video is a composite, filmed over two weeks: the human performances are staged and stylised, but the ant behaviour is real. My initial cut of the video was around 3 minutes long, but this was pared down to exclude any shot – including several that had taken time and effort to film – to 1 minute 38 seconds. I wanted the film to contain as little extraneous detail as possible, so that it could be easily understood by a wide audience. The ease of comprehension is crucial to the legibility of the absurdb diagram.

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[1] Aleisha Scott, ‘“Electric” Ants Seen in UK for First Time - Nature, Environment - The Independent’, Newspaper, The Independent, 2009, <http://www.independent.co.uk/environment/nature/electric-ants-seen-in-uk-for-first-time-1766331.html>.

[2] Solenopsis *invicta* are notable as individual shocked ants release a number of semiochemical signals which can cause attraction (and often the death) of further ants. R. K. Vander Meer, T. J. Slowik, and H. G. Thorvilson, ‘Semiochemicals Released by Electrically Stimulated Red Imported Fire Ants, Solenopsis Invicta’, *Journal of Chemical Ecology* 28, no. 12 (December 2002): 2585–2600, <https://doi.org/10.1023/A:1021448522147>.

[3] I would like to clarify here that I never intended to carry out this project, but rather spark a conversation that enabled the discussion of ants as analogy in computer science.

[4] BBC News, ‘Radio Tags Track Wasp Behaviour’, *BBC News Online*, 24 January 2007, sec. Online, <http://news.bbc.co.uk/2/hi/science/nature/6291429.stm>.

[5] Sumner is also an advocate for the promotion of science in pop culture; she was a L’Oreal Women in Science, and ran an annual event called Soapbox Science, in which members of the public can ask scientists about their field of expertise. She had spent the evening before we met talking about creativity and science with Brian Eno.

[6] T. Lewis, *Insect Communication* (Academic Press, 1984).

[7] Brian D. Jackson and E. David Morgan, ‘Insect Chemical Communication: Pheromones and Exocrine Glands of Ants’, *Chemoecology* 4, no. 3 (1993): 125–44, <https://doi.org/10.1007/BF01256548>.

[8] The ‘vitual pheromones’ described in StarLogo earlier in this chapter, and those used by Dorigo in the Ant Colony Optimisation system are both simulations of releaser trail pheromones.

[9] Sex pheromones bring ants together for the purpose of mating. Jackson and Morgan, ‘Insect Chemical Communication: Pheromones and Exocrine Glands of Ants’.

Aggregation pheromones simply ‘cause members of the same species to aggregate in a particular area […] for mating or to a food source or a suitable habitat.’ Ibid., 127.

Aggregation pheromones, also known as spacing pheromones, are used to regulate or prevent overcrowding of food sources, etc. Ibid.

Surface pheromones are also known as cuticular hydrocarbons, and exist on ants’ body surfaces, allowing them to identify which colony other ants belong to. This is particularly important for food exchange. Ibid., 130.

[10] See for example, Marco Dorigo, Vittorio Maniezzo, and Alberto Colorni, ‘Positive Feedback as a Search Strategy’ (Milan: Politechnico di Milano, 1991); M. Dorigo, V. Maniezzo, and A. Colorni, ‘The Ant System: Optimization by a Colony of Cooperating Agents’, *IEEE Transactions on Systems, Man, and Cybernetics–Part B* 26, no. 1 (1996): 1–13; M. Dorigo and L.M. Gambardella, ‘Ant Colonies for the Travelling Salesman Problem’, *BioSystems* 43, no. 2 (1997): 73–81; M. Dorigo and T. Stützle, *Ant Colony Optimization*, A Bradford Book (Cambridge, MA; London, UK: Bradford Book, MIT Press, 2004).

[11] Now renamed *Humanity+*.

[12] Nick Bostrom, ‘A History of Transhumanist Thought’, *Journal of Evolution and Technology* 14, no. 1 (2005): 1–25.

[13] The compendium *Bio Art: Altered Realities*, released in 2015, now contains a wealth of such projects (including *Ant Ballet*). William Myers, *Bio Art: Altered Realities* (Thames & Hudson, 2015).

[14] See, for example, Y. Tanaka et al., ‘Trail-Following Disruption in the Invasive Argentine Ant with a Synthetic Trail Pheromone Component(Z)-9-Hexadecenal’, *Sociobiology* 54, no. 1 (2009): 139–152; László Poppe et al., ‘Convenient Synthetic Route to (+)-Faranal and (+)-13-Norfaranal : The Trail Pheromone of Pharaoh’s Ant and Its Congener 1’, *Tetrahedron* 44, no. 5 (1988): 1477–87, <https://doi.org/doi>: DOI: 10.1016/S0040-4020(01)85927-5.

[15] AM El-Sayed, ‘The Pherobase: Database of Insect Pheromones and Semiochemicals’, 2011, <http://www.pherobase.com/>.

[16] The entomologist will remain unnamed here.

[17] James Algar, *White Wilderness*, Documentary, Family, 1958; Margaret J. King, ‘The Audience in the Wilderness: The Disney Nature Films’, *Journal of Popular Film and Television* 24, no. 2 (April 1996): 60–68, <https://doi.org/10.1080/01956051.1996.9943715>.

[18] Chapter 3: *24fps Psycho* describes a project that had a high risk of failure, and in my opinion did fail.

[19] I found numerous companies in Asia who specialise in the production of synthetic pheromones for pest control purposes, but the lowest price I was quoted for 1g of any pheromone was USD $2700 (which was out of my budget).

[20] UCL Web Services, ‘Prof Jim C. Anderson, Head of Organic Chemistry and Chemical Biology Section’, UCL Chemistry, 20 April 2016, <https://www.ucl.ac.uk/chemistry/people/jim-anderson>.

[21] J. H. Butterworth and E. D. Morgan, ‘Isolation of a Substance That Suppresses Feeding in Locusts’, *Chemical Communications (London)*, no. 1 (1968): 23–24, <https://doi.org/10.1039/C19680000023>.

[22] 182 species in 2011; this included species whose pheromones had been identified, but the function of the pheromones remained undocumented.

[23] Some molecules express chirality, a property whereby a bond can be formed in two different directions. This yields molecules that are identical, yet opposite – like a left and right hand.

[24] *L. humile* was formerly known as *Iridomyrmex humilis* (Mayr). For more on *L. humile*’s global distribution, see N. Roura-Pascual et al., ‘Relative Roles of Climatic Suitability and Anthropogenic Influence in Determining the Pattern of Spread in a Global Invader’, *Proceedings of the National Academy of Sciences* 108, no. 1 (4 January 2011): 220–25, <https://doi.org/10.1073/pnas.1011723108>.

[25] S. E. Vorhis Key and T. C. Baker, ‘Specificity of Laboratory Trail Following by the Argentine Ant, Iridomyrmex Humilis (Mayr), to (Z)-9-Hexadecenal, Analogs, and Gaster Extract’, *Journal of Chemical Ecology* 8, no. 7 (1982): 1057–1063; Tanaka et al., ‘Trail-Following Disruption in the Invasive Argentine Ant with a Synthetic Trail Pheromone Component(Z)-9-Hexadecenal’.

[26] Vorhis Key and Baker, ‘Specificity of Laboratory Trail Following by the Argentine Ant, Iridomyrmex Humilis (Mayr), to (Z)-9-Hexadecenal, Analogs, and Gaster Extract’.

[27] Tanaka et al., ‘Trail-Following Disruption in the Invasive Argentine Ant with a Synthetic Trail Pheromone Component(Z)-9-Hexadecenal’; Sadahiro Tatsuki et al., Behavior-disrupting agent and behavior-disrupting method of Argentine ant, US2005/0209344A1, filed 23 February 2005, and issued October 2012, <http://www.google.com/patents/US8278360>.

[28] James K. Wetterer and Andrea L. Wetterer, ‘A Disjunct Argentine Ant Metacolony in Macaronesia and Southwestern Europe’, *Biological Invasions* 8, no. 5 (July 2006): 1573–1464, <https://doi.org/10.1007/s10530-005-8641-9>. This colony has also received some media coverage: for example, see *Argentine Invasion*, Radiolab Shorts, accessed 15 January 2017, <http://www.radiolab.org/story/226523-ants/>.

[29] N. D. Tsutsui, ‘Reduced Genetic Variation and the Success of an Invasive Species’, *Proceedings of the National Academy of Sciences* 97, no. 11 (May 2000): 5948–53, <https://doi.org/10.1073/pnas.100110397>.

[30] James K. Wetterer and Andrea L. Wetterer, ‘A Disjunct Argentine Ant Metacolony in Macaronesia and Southwestern Europe’, 1123.

[31] Bareclona is actually at the nexus of two *L. humile* supercolonies. *Argentine Invasion*.

[32] The Bartlett, UCL Organic Chemistry and the Institute of Zoology are all located within 3km of each other.

[33] Kurt Vonnegut, *The Sirens of Titan* (New York: Delacorte Press, 1959).

[34] William Blake, *Ancient of Days (God as an Architect)*, 1794, Relief etching with watercolor, 23 x 17 cm (9 x 7 inches), 1794, <http://www.artcyclopedia.com/masterscans/l24.html>.

[35] Stanley Kubrick, *Dr. Strangelove (Or How I Learned to Stop Worrying and Love the Bomb)*, 1964.

[36] Saul Bass, *Phase IV*, 1974.

[37] Credit for this design lies with Heechan Park; the style of the support struts was modelled after the Apollo 11 lunar lander.

[38] When this light was finally erected from between two trees in the forest outside Barcelona, in the dead of night, from a steel wire between two trees, the neighbour further down the hill, unaware of the experiment taking place on the adjacent plot of land, mistook the ring of light for a landing alien spacecraft and locked themselves into their house for most of the evening, venturing up to our encampment only once the light had stabilised (and with the protection of a yapping dog).

[39] The imperial measurements and bolts used by the American servos caused several annoying issues whilst building the machine.

[40] The precise location of the machine was 41° 26' 36.9168'' N, 2° 5' 27.7692'' E.

[41] Flourin is a specialist PTFE-derived lubricant which is used by entomologists to line things insects may escape from. It is invariably messy to apply to anything, and seems specially formulated to stick to clothes.

[42] Professor Espalder informed me that they don’t have the suction strength to enable consumption of raw honey.

[43] Flourin would not bind to the machine’s aluminium, so a moat of motor oil became the main defence against ant escape.

[44] In reality these roles were played myself and my colleague Helen Floate, who kindly assisted with the journey, experiment and filmmaking. The heat of the Barcelona forest in the middle of summer, along with the presence of tiger mosquitoes, made the process unbearable.

[45] Today, this would be easy to film via drone, but such technologies were not readily available in 2011.

[46] One camera was also completely destroyed/lost in the process.

[47] I visited the Kubrick Archives to see the original plates for the HAL graphics in preparation for this film.

[48] Set in thin DIN type

[49] CRM-114 is a reference to Kubrick’s constant use of the code throughout his films. In *Dr. Strangelove*, for example, CRM-114 is the communication-scrambling device whose failure causes the final line of communication between the bombers and their command-station to break down; in *A Clockwork Orange*, Serum 114 (a homophone for CRM-114) is the drug given to the lead protagonist to ‘cure’ his illness. Kubrick, *Dr. Strangelove (Or How I Learned to Stop Worrying and Love the Bomb)*; Stanley Kubrick, *A Clockwork Orange*, 1972.

[50] The movement of the ants along the trail was dependent on several factors: this was the first morning we’d watched the ants; only one of the pair of pheromone vats provoked a response.

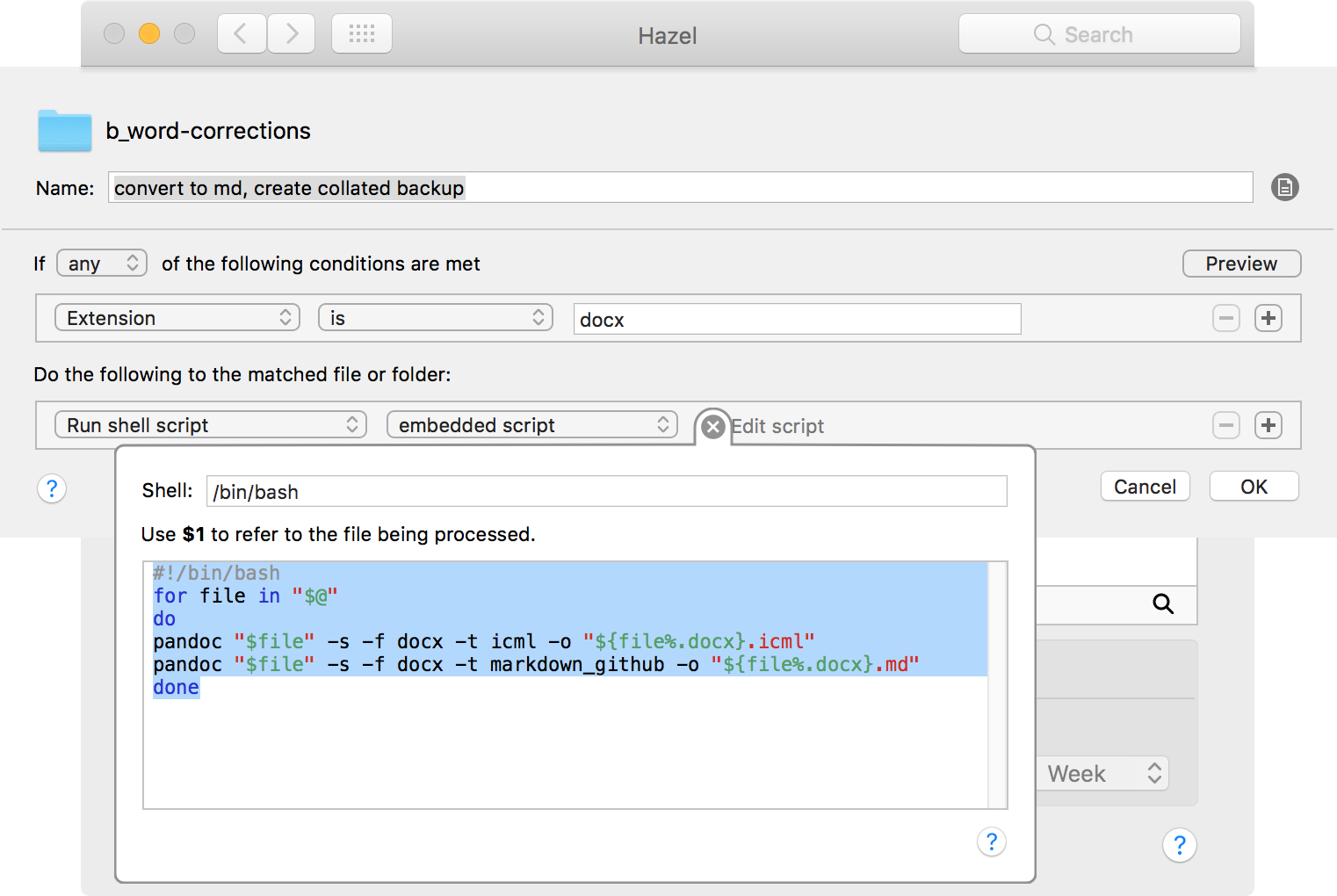
# thesis-corrections

This branch contains all corrections to my PhD thesis. The back-end on my computer automatically converts modified Word documents to Markdown (Github-flavoured) to sync with Github, and ICML for use with InDesign.

The file structure looks like this:

corrections # root  
|-- a\_word-input # original files exported from current InDesign files. Documents are copied from InDesign into Word as .DOCX, then cleaned up and stripped of any extraneous formatting.  
|-- b\_word-corrections # the files I work from for corrections. These are as stripped back as Word can manage, whenever it can avoid doing silly formatting.  
|-- c\_icml # the auto-generated .ICML files (created by Pandoc via Hazel action)  
|-- d\_markdown # the auto-generated .MD files (created by Pandoc via Hazel action)  
|-- examiner-reports # the reports back from the examiners with corrections to be made

The Hazel script monitors the b\_word-corrections folder and looks like this:



The embedded shell script:

#!/bin/bash  
for file in "$@"  
do  
pandoc "$file" -s -f docx -t icml -o "${file%.docx}.icml"  
pandoc "$file" -s -f docx -t markdown\_github -o "${file%.docx}.md"  
done

In reality, what's happening is Hazel creates the .icml and .md files in the same folder, then a later Hazel action moves these files to their respective folders. In fact, in reality the d\_markdown folder is somewhere else entirely, because the root folder is on Dropbox and I keep my Github folders elsewhere to avoid sync issues! But you get the idea. My original Word docs are preserved; my corrections can be done in Word, and then are auto-transformed into .icml and .md for importing straight into InDesign and for version control via Github respectively.

It is about as elegant a solution as I can find for this clunky, tedious process! Anything involving Word or InDesign seems to add a couple of extra stages to a workflow...