Rupert NORFOLK

The Mobility of Facts

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Abstract

This thesis investigates the reductive abstraction of the digital and the physical immediacy of the sculptural, commonly perceived as an antagonistic relationship. Through a practical dialogue between virtual and tangible media I ask: what can digital technology tell us about the nature of sculpture as a contemporary art form? My practical experiments adapted a flexible methodology of digitising found objects through 3D scanning, digital modelling and CAD drawing; transforming them via a mix of contemporary software; and then reconstituting them as physical objects through 3D printing, analogue casting and hand tooling. This approach allowed the characteristics of tangible materials and processes to feedback against the affordances and constraints of digital operations. The research demonstrates that this feedback occurs in ways that are generative rather than antagonistic. By strategically deploying digital media to develop autonomous sculpture, I reconnect haptic perception with critical reflection upon that experience driven by analyses of current understandings of how digital mediation works.

The first part of the written component involves a theoretical enquiry into the means applied to production. Drawing upon recent art historical, anthropological and philosophical arguments, I question tropes of digital immateriality, computational thinking, and the 'fixed facticity' of sculpture. The second part provides an account of new insights brought to light by the struggle to realise these artworks in physical matter and arrive at a cogent understanding of what is made present as a consequence of digital mediation in the finished works.

My research shows how digital technology can emphasise rather than undermine what is particular to sculpture. It emerges that sculpture must rely on a tension between its tangible form and abstract mediation if it is to suspend reification. On the other hand, these sculptures problematize the tendency of digital technologies to efface aspects of their very real materiality. They could be seen as paradigmatic of our contradictory relations to objects in a world where the limits of what we think of as reality have become less clear. This research proposes that it is the sensuousness of the embodied encounter that makes the abstract anomalies of digital operations so incongruous. By calling attention to themselves as made things – digital artifices – the artworks produced in this research generate moments of ambivalence that oscillate between presentation and representation, cognition and recognition, when consciousness might take itself as its object. As concrete abstractions, they encapsulate how digital mediation alters the material fabric of the world.

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For Soraya and Agustín

Introduction

What does digitalization tell us about the nature of sculpture as an art form? What could be productive and distinctive about tying the two together? My objective in this practice-led PhD research is to address these questions by using digital technology to produce a new body of sculptures. Not only does this research use digital media to generate sculptural artworks, but also it proposes an analysis of contemporary understandings of the digital in order to self-consciously reflect on the perceptual and conceptual conditions of current digital experience. It connects haptic experience to digital mediation with a form of criticality rooted in current understanding of sculptural practice. My hypothesis is based on an apparent conflict between the reductive abstraction of the digital and the physical immediacy of the sculptural, and an intuition that their relationship is not as straightforward as this binary opposition might suggest.

My methodology will involve experimenting with digital technologies - in particular three-dimensional scanning and printing processes - and direct making in the studio. The subsequent presentation of new artworks embodies the intersection and entwinement of these modes of production. My research by experimental praxis will be imbricated by a theoretical inquiry into the conditions of digital and sculptural experience. For the purposes of clarity, the first part of this written thesis (chapters 1 & 2) will focus on speculative theory and the second part (chapters 4 – 7) will focus on my empirical practice. However, both aspects of my research were conducted concurrently so that their correspondences and contradictions were mutually stimulating. Chapter 3 is pivotal to this text because it draws together these speculative and empirical aspects of my research to provide a detailed account of my practical procedure.

There is nothing especially original about employing digital media in the production of sculptural artworks. Established artists such as Jeff Koons, Charles Ray and Urs Fisher have been doing so for years and to spectacular effect. However, the forms of their work suggest that technology is primarily a practical means to an end and I have found little evidence that these artists are consciously critiquing digital or sculptural materiality. However, during the course of my PhD I have encountered examples of work by each of these artists that are unusual because they incorporate digital glitches such as *compenetration* – the phenomenon of digital interfusion that is an emblematic trope within my own research. For example, in September 2014 at Kunstmuseum Basel, I observed Charles Ray's polished stainless-steel sculpture *Shoe Tie* (2012), in which the crouching nude figure's elbow subtly intersects with his knee. Ray has explained this effect as an accidental glitch produced by the digital scanning procedure that he decided to just leave in:

"To begin my sculpture, I took photographs and also used a 3-D scanner to render my position. Because one cannot hold perfectly still in the confines of a scanner, there were intersections between elbow and thigh, and cheek and shoulder, where one body part was superimposed upon another. At first, when looking at my foam armature, I saw these intersections as mistakes. Later, I decided to keep subtler versions of the intersections as a reference to the ghost." (Ray 2014:134)

At Jeff Koons exhibition Now at Newport Street Gallery, London in October 2016, I encountered his sculpture *Sea Walrus* (Chairs) (2003 – 2009), a polychromed aluminium sculpture of two swimming pool inflatables perfectly embedded in a stack of poolside chairs. Although this sculpture resonated acutely with my concurrent experiments with intersecting objects, the preponderance of its pop sensibility within a context saturated by similar pop references (that were not intersecting) suggested that this was a playful formal anomaly rather than a critical device through which Koons intentionally questioned the contemporary condition of sculpture.

More recently through online research, I came across *Things* (2018) by Urs Fischer, a truly spectacular sculpture of a life-sized aluminium rhinoceros embedded with what seems to be an arbitrary assortment of household goods, office equipment and automobile parts. The same year, Mitsubishi car adverts also show a series of objects being gradually drawn towards Mitsubishi vehicles before being absorbed into the bodywork. These adverts, featuring the tagline "Absorbing Life", trade on images of accumulation and absorption very much like Fischer's *Things*, whist recalling Jeff Koons' *Walrus (Chairs)*, in their use of swimming pool inflatables. If the digital glitch produces an estrangement effect in these artworks, it is an effect that has already been assimilated and exploited by the advertising culture of commodity capitalism.

The technologies employed by these artists are well beyond the material resources available to my research and their exploitation of digital glitches appear to be one-offs. Nevertheless, they have all been instructive for my research in as much as I have sought innovative ways to investigate similar effects through the range of technical resources this research has enabled me to access. I mention the coincidences that these three specific works imply in order to demonstrate that aesthetic glitches are closely linked to digital fabrication processes (my experience suggests that they are an almost inevitable aspect of the processes of scanning and 3D image generation). This is also to make clear that I am not claiming to have invented compenetration, or to be the first artist to explore this glitch. In fact, from Bernini to Caro the Western sculptural canon is replete with intersecting forms that were not digitally achieved. What the digital affords is an unprecedented means to render the interfusion of sculptural form with mathematical and mimetic precision. My approach is distinctive because it critically reflects on the perceptual and conceptual possibilities of these digital effects through a constellation of materially disparate artworks that articulate the conditions of their own making and find new ways to absorb the contingencies that occurred within their own making processes.

There are of course other contemporary artists who are critically engaged with the digital. Mark Leckey, for instance, has famously built his career on an investigation of the Internet of things "in the round". However, Leckey has been open about his ambivalence towards sculpture, preferring to explore the possibilities of digital artefacts on screen "when it is no longer dumbly squatting on a plinth". After exhibiting 3D printed reproductions of artworks and artefacts that he had accumulated for his exhibition *The Universal Addressability of Dumb Things* (2013) in the subsequent exhibition *UniAddDum* (2014), the artist renounced his move to make digital objects tangible in physical space:

> But once I got my hand to the objects, the real things, and put them into galleries they were slightly – disappointing is too strong a word, but they lost a bit of the magic they had I had been manipulating them on screen. And also, it seemed so disingenuous: I didn't really know why I needed to make that translation from the screen – where the work seemed really effective – to the gallery. (Leckey 2015: 20)

Leckey exhibited his 3D prints as they were, so as not to make a species-leap away from the digital. "The resulting 3D objects have a very weird tactile quality: they are very sintered and chalky, and have a different weight. That makes them feel not entirely there. It's as if, although now real-world objects, they are still more bits than atoms." (Leckey 2015: 21). In contrast to Leckey's approach, my research always involves a material transformation away from the digital and is very much concerned with the imaginative possibilities of sculptures "dumbly squatting on a plinth", which I am inclined to think of as "Mute Objects of Expression" [1] to borrow translator Lee Fahnestock's neat encapsulation of the poems of Francis Ponge (Ponge 2008).

Oliver Laric, by contrast, is explicitly concerned with the physical materiality of digital processes. "Using digital media to conduct his research, Laric appropriates and processes his findings, filtering them back into reality by using a seemingly endless variability of computer software, much like a sculptor would use a set of tools. Creating 3D scans of art-historical sculptures and using a selection of software programs, Laric remixes his files producing unexpected and surprising chimera, finally materialising the results into reality via a 3D printer." (Kielmayer 2017). Although parts of Laric's sculptures are sometimes cast in resin using traditional processes, his reproductions of neoclassical sculptures tend to function like material swatches for assorted digital printing techniques. Frequently working in series, Laric's work reveals the capacity of digital media to produce and re-produce differentiation out of homogeneity in a visually arresting way. Like Leckey, his three-dimensional work tends to manifest directly through the automated processes of 3D printing such as stereolithography and rarely makes the leap into fully analogue or manual procedures. Laric frames his interest in the digital in terms of the egalitarian potential of new technology by making available his scan files for free download online: "Laric's process is on the one hand an unwritten and implied

manifesto for the democratisation of high culture, and on the other, evidence of his interest in the invigoration of historically canonized form through its very democratization. Others are encouraged to use specific digital data as sculptural material in order to represent or manifest their own ideas." (Kielmayer 2017). I will question political assumptions about the digital below in chapter 1, but what immediately distinguishes my research here is my commitment to reconstitute my digital experiments using a combination of analogue methods and manifestly non-digital materials so that any trace of the digital within the resulting unique artworks remains structural rather than material. My approach is distinct because it inscribes the digital through a formal system rather than material substance. Both Leckey and Laric's fascinating practices have been inspirational for my research, but they are not, to my mind, specifically concerned with applying the digital in order to critically reflect on sculptural experience within a contemporary context.

Theoretical research specifically about the relation between the sculptural and the digital is relatively sparse and as a new field of research (with one notable exception) the literature available has been published during the course of my PhD research, suggesting that my own research is both timely and pertinent. For example, in 2014 artist Eva Grubinger and critic Jörg Heiser published a transcription of their symposium *Sculpture Unlimited II: Materiality in Times of Immateriality*, held at the Kunstuniversität Linz. With contributions by artists and scholars, the symposium asked: "If we assume that computers and algorithms increasingly control our lives, that they not only regulate social and communicative traffic but also produce new materials and things, does this increase or decrease the space for artistic imagination and innovation? Where is the place of art in general and sculpture in particular, provided that we don't want art to resort to merely maintaining aesthetic traditions?" (Heiser & Grubinger 2015). With sculpture as a leading reference, the contributions address theory, aesthetics, and technology with an emphasis on new materialism, Object-Oriented Ontology and so-called post-Internet art.

Through its varied critical perspectives, this volume provides an invaluable discursive foundation on the subject of sculpture and the 'post-human'. However, its compendium format inevitably leaves many questions unanswered, especially in relation to the structural contradictions implicit in an aesthetic enquiry – as its carefully worded caveat anticipates. My own research will not "resort to merely aesthetic traditions", but it does take aesthetic traditions seriously, in order to situate them in a new critical relation to digital mediation. Notably, with the exception of editor Eva Grubinger herself, only two of the seven invited contributors were artists: Mark Leckey, whose practice I have already mentioned above, and Aleksandra Domanović , whose sculptural practice is exemplary in its use of technology to explore the interface between digital mediation and human body.

Two years later in 2016, Jörg Heiser chaired a panel discussion for the Nasher Prize Dialogues entitled: *The Work of Sculpture in the Age of Digital Production* (published in 2017). Nasher Sculpture Centre Director Jeremy Strick introduced the event in terms of "the way digital photography and images mediated by the computer screen have changed the way we perceive sculpture, how we understand its dimension, scale and surface, and how these tools have created a new set of criteria by which sculpture might be judged, but also ways it might be made". Playing off Walter Benjamin's famous essay *The Work of Art in the Age of Mechanical Reproduction* (1935), Heiser's introductory comments provide a useful background for my own research. He summarised Benjamin's "assumption that a new kind of revolutionary art using the latest technologies may be able to brush aside 'outmoded concepts such as creativity and genius, eternal value and mystery' which Benjamin identifies under the conditions of his own time in the 1930's as fascist." Highlighting the dialectical relationship of the artwork to mechanical reproduction that "undermines the aura of the unique art object, while at the same time emancipating 'the work of art from its practical dependence on ritual'" (ibid.), Heiser stresses how this emerges as a tension between cult value and exhibition value. Fast-forward to the present and the situation is dramatically different. Digital re-production almost seamlessly turns into production and "we could even go so far as saying this new technology going hand in hand with the new economy provokes a kind of compulsive production." (ibid.) Ritualised performing in the digital sphere of Facebook and Instagram, seems to have resulted in a merger of what Benjamin described as cult value and exhibition value.

Heiser also highlighted two cautionary issues pertaining to our assumptions about the digital: firstly, "the illusion of disembodied social and economic interaction" in light of the "sheer materiality and pressing existence of human and natural exploitation" that underpins it (for example, oil, plastic, rare earth metals, colonial conditions in African mines and Chinese sweat-shop assembly lines). Secondly, the estranging effect of overwhelming digitisation can produce "a yearning for the good old days" of history, material presence, nostalgia and conservative values. However, Heiser also makes clear that turning to history and the seemingly outmoded "is not necessarily and automatically nostalgic or regressive. It might in fact be an acknowledgement of the neglected or not yet understood." (ibid.).

Heiser's insights, especially this latter point about revisiting the "neglected or not yet understood" aspects of sculpture, have been instructive for my approach to looking to sculptural history, whilst avoiding a nostalgic return to conservative values. It is also notable that while the panel discussion was engaging and informative, it tended to reduce sculpture to the application of two-dimensional digital images to three-dimensional material substrates. Perhaps this is because the two contributing artists work primarily with photography: Bettina Pousttchi describes her own work as

"site-specific photographic interventions on buildings in public spaces", and Rachel de Joode explains that "I work through the use of photography – my work bounces between the physical and the virtual world exploring the relationship between three-dimensional object and its two-dimensional counterpart" (Ibid). Given the event's explicit reference to Benjamin's essay on photography, these artistic perspectives were pertinent for an event that sought to revisit these debates in light of the digital. However, it also helped me to identify the specificity of my own research, in terms of looking to incorporate aspects of the digital within the generative structure of the sculptural. Instead of applying the digital (image) to the tangible (object), my research focuses on materially and structurally incorporating their inherent contradictions.

The one exception in terms of literature on the subject that predates my PhD research is Mark Hansen's fascinating study *New Philosophy for New Media* (2006), which focuses on our "embodied" relation to the "digital image". Focusing on "digital art", Hensen argues that we filter the information we receive to create images, rather than simply receiving images as pre-existing technical forms. However, of the twenty-four "digital artworks" referenced in the book, only one could really be described as sculptural, in the sense that it presents tangible objects in physical space: Robert Lazzarini's *Skulls* (2000). Before I summarise Hansen's critical analysis of this sculptural work, I want to cite his characterisation of how the digital image "explodes the stability of the technical image", because it is foundational for my PhD research:

> Following its digitization, the image can no longer be understood as a fixed and objective viewpoint on "reality" . . . since it is now defined precisely through its almost complete flexibility and addressability, its numerical basis, and its constitutive "virtuality". (Hansen 2006: 8)

This abstraction to "a numerical image" constitutes the break with actuality that is at the crux of digitization. This translation of fixed fact into a mobile virtuality is the transformation at the centre of my PhD research methodology, and the condition that I aim to transpose into tangible sculpture. This is an ambition shared by Robert Lazzarini's project Skulls. Lazzarini's process corresponds closely to my own research procedure: "Lazarini laser-scanned an actual human skull to create a three-dimensional CAD (Computer-aided Design) file, which he then subjected to various distortions. The resulting distorted files became the models for four sculptures cast in solid bone" (Hansen 2006: 199). The effect of these distortions on the four skull sculptures is that they became warped "as though they existed in a space without any connection to the space you are inhabiting" (ibid: 198). Unsurprisingly, Hansen describes these warped skulls in relation to the famously anamorphic skull in Hans Holbein's *The Ambassadors* (1533), with which they bare an uncanny resemblance. Except, that is, for the fact that they are rendered in three-dimensions and unlike the painted skull, there is no spatial perspective from which the viewer can view the skull 'correctly' and the effect is therefore

"disorientating" from all viewpoints. As Hansen explains, "Lazzarini utilises what are, in effect, two-dimensional distortion techniques in order to model three-dimensional objects. The result is sculptural objects whose own depth interferes with the illusionary resolution of perspectival distortion" (ibid: 202). For Hansen, Lazzarini's *Skulls* is "exemplary of new media art" because it "deploys the capacities proper to the digital image" – digital modulation concerns the way the digital itself opens onto a continuous flux of transformation – to trigger a bodily intuition of a computer-processed form. "Lazzarini's work functions by catalysing an affective process of embodied form-giving, a process that creates place within our bodies. And since it is through such creation that we get a sense for the weirdness of digital topology, we might well think of it as a correlate to the impossible experience offered by the work" [my emphasis] (ibid: 203).

Hansen's interpretation of *Skulls* is based on analogy, "whatever possibility we may have of experiencing it [digital modulation] can only come from an affective "analogy" produced by our bodily response to it and whose "content" is a warped space felt within the body" (ibid: 203). In other words, the "weirdness" felt by the viewer correlates with the digitally warped forms bearing traces of inhuman topological manipulation. "If our apprehension of these artefacts doesn't give us direct experience of digital space, it does comprise a new form of "affection image" – a digital affection-image that unfolds in and as the viewer-participant's bodily intuition of sheer alienness of these forms" (ibid: 204). Hansen's analysis reveals that as a sculpture *Skulls* manages to generate a sensation of "weirdness" (Hansen's term) in the viewer because the objects cannot be reconciled with intuitive experience or perspectival convention. Hansen's interpretive leap is to suggest that this sensation is analogous to contact with the "radically inhuman realm" of "digital space". Since only a computer could generate the objects that cause the physical sensation, the sensation seems to correspond to computation. There are two kinds of illusion at work here. The warped form of the work produces a subjective illusion that tricks the eye through a dissonance between representation and presentation. Meanwhile, Hansen's analogy suggests an objective illusion that the physical sensation of "weirdness" is caused by an encounter with the digital. Hansen is therefore careful to clarify the relation: "Rather than deploying the digital as a new vehicle of expression, Lazzarini mobilizes the digital in order to provoke a virtualisation of the body. What *Skulls* affords is, consequently, not a direct apprehension of an alien space that is digital, but a bodily apprehension of just how radically alien the formal field of the computer is from the perspective of the phenomenal modes of embodied spatial experience" (ibid: 206).

Hansen's example has been instrumental for my research, not only because the production process of *Skulls* maps neatly onto my own practical procedure, but because of his emphasis on the "affectively attuned, haptic or tactile bodily functioning as an 'aesthetic analogy' for the digital realm"

(ibid: 206). Nevertheless, I have misgivings about the implications of this analogy. Hansen describes the digital in terms of "number images" and yet numbers have no quality at all and so can only offer a tenuous approximation of intuitive experience. It is not enough to offer a deeper level of qualitative experience and then liken it to a purely quantitative concept by proxy. This is to gloss over the central contradiction between concrete form and mathematical abstraction that is manifested in the void between empiricism and speculation. This is why my PhD research will eschew illusion and analogy in favour of an approach that is more akin to allegory in its aim to preserve and embody the fundamental contradiction.

I have sketched out these various contributions to research in relation to the sculptural and the digital in order to acknowledge their significant influence on my research and also to highlight the limitations of scope that they offer. In a time when digital experience has become experience in general, it is no surprise that there has been a revival of interest in objects and sculpture. My research aims to flesh out this critical relationship by rendering its intangible tensions tangible. In order to build upon the literature reviewed above, I will draw upon art history and contemporary art criticism, in particular key discourses on sculpture, as well as wider fields including: anthropology, philosophy, political theory and cognitive archaeology. Chapter 1 initiates my enquiry by unpacking and elaborating my initial presuppositions, namely the reductive abstraction of the digital and the physical immediacy of the sculptural. I will begin by considering theories of digital anthropology, architecture, photography and museum artefacts. Then I will briefly review the genealogy of contemporary sculpture, before examining the experiential particulars of sculptural matter, space and time. Chapter 2 will then focus on an investigation of digital matter, material and materiality in order to debunk the trope of digital immateriality. I will then turn to recent theories of vibrant matter, material engagement, and morphogenetics, in order to uncover notions of material agency beyond the scope of aesthetic or sociological theories of art and challenge the 'computational model' of human cognition. Chapter 3 will summarise insights from my first two speculative chapters, in order to set up a detailed account of my practical methodology and my approach to articulating my empirical research in the subsequent chapters. Chapters 4 – 7 will then offer a critical account of four sculptural research projects, each engaging with different objects, materials and technologies according to the flexible procedure outlined in chapter 3. These four (in fact five) sculptures could be seen as case studies or "object lessons" (to borrow anthropologist Haidy Geismar's term) that epitomise contrasting aspects of my research. However, since the generative process of making these works really constitutes the main form of my research, my accounts of these experiments, successes, failures, decisions and insights are a central means of documenting the development of this PhD research. My thesis is accompanied by five separate appendices: Appendix 1 contains details and

images documenting the four sculpture exhibitions and one symposium that I curated early in my research as a direct means of reflecting on different aspects of the sculptural. There are only one or two explicit references to these projects within the main text. However, the reader is invited to review these materials with a view to recognising the implicit resonances and correspondences that resound in words and images within the thesis. Appendices 2 – 5 correspond to each of the four case studies accounted for in chapters 4 – 7. They include photographs of the finished artworks from different viewpoints alongside a visual essay comprehensively documenting the processes of research, development, and production. These supporting figures are numbered for easy access and will be cross-referenced throughout the written thesis where appropriate.

Notes

(1) Francis Ponge himself titled another collection of his prose poems '*Le Parti Pris des Chose'*, which has been published in translations as variously 'The Nature of Things' (Fahnestock 1995),'The Bias of Things' (Temmer 1966) or 'The Voice of Things' (Archer 1972). In an article for The Independent newspaper, novelist Tom McCarthy mused on the ambiguity intrinsic to Ponge's writing on things by offering alternative translations: "It's not really possible to do it "correctly", but that's the point. Even the title's untranslatable: it could mean "Taking the Side of Things", "Taking Things On", or "Taking a Part (Out) of Things (but Leaving the Rest Behind)". McCarthy appositely suggests that "Whereas for Hegel and his followers, the task of art is to abstract the world into pure concept, Ponge returns both world and concept to their rich material bases. As the philosopher Simon Critchley likes to put it, he "lets matter matter". (McCarthy 2010). Elsewhere Crichley has written about how Ponge "let things be in their separateness from us" . . ."let things thing" and describes "the sheer 'there is' of things where they look at us rather than us looking at them" (Crichely 2005: 86). The ambiguity of Ponge's linguistic re-expressions of lowly things has been a frequent inspiration to my research. The infinite potential for the abstractions of language to render the ambiguities of concrete things as difference, corresponds in some way to the infinite possibilities for 3D re-presentation promised by the digital.

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1. The Sculptural and the Digital

Both 'digital' and 'sculptural' are unreliable terms. In commonplace usage, the digital is often used as a vague catchall for new technology. However, the digital itself qua technology can't really be defined because it has no character at all unless it is applied. In order to approach an understanding of the digital, it is therefore necessary to ask under what conditions is it applied. Sculpture, as a canonical fine art category, has been embroiled in a conflict between formalism and conceptualism since the 1960's. In order to arrive at a contemporary understanding of the sculptural, it is necessary to examine how the term has become historically conditioned and reflect upon its relation to present social conditions.

As I have suggested above, there is currently a lack of research about the digital specifically in relation to the sculptural. I will begin this chapter with a general enquiry into the social implications of the digital with reference to recent research in the nascent field of digital anthropology. Broadly speaking, the conditions in which the digital is applied are those of capitalist exchange and I will highlight analogies between the digital, money and the commodity form, positing a general argument that digital technology reproduces and intensifies existing social relations. It is via the work of anthropologists Heather Horst and Daniel Miller that I arrive at a dialectical understanding of the digital that oscillates between homogeneity and differentiation; a dialectic that will recur in different forms throughout this chapter and indeed this thesis. I then begin to hone my enquiry in the direction of the sculptural by first considering the spatial consequences of digitisation on architecture, with reference to Henri Lefebvre's critique of abstract space. Turning then to the field of fine art, I will deconstruct the process of digital photography to identify its moment of 'radical discontinuity' as invisible data that has no analogue. I will also consider Peter Osborne's claim that digital photography represents a generic field that is close to a meta-medium of conceptual art. Finally, in order to consider a proxy for digital sculpture, I will look to anthropologist Haidy Geismar's research into 3D imaging and printing of digital artefacts in museums. Geismar's work reveals the extent to which 3D digital artefacts are subjective constructions that efface evidence of their own craftsmanship in order to pass themselves off as objective reproductions. It is through Geismar's 'object lessons' that I come to consider the digital as a material object and not merely a form of mediation. At the same time, Gesimar's provocation that "the digital does not exist" underscores the digital's duel identity as both sensible and suprasensible, concrete and abstract.

Having arrived at a dialectical understanding of the digital, I will turn my attention to the sculptural. Jeff Wall provides a useful historical reconstruction that posits what he sees as a 'bifurcation' of contemporary art between autonomous forms (like sculpture) and pseudo-

heteronomous conceptual practices. I will critique Wall's account with reference to recent Marxist arguments for the critical potential of autonomous art in the present moment, and then develop the possibility of semi-autonomous practices whereby autonomous art forms such as sculpture might make their critical reappearance. Having set out these contested historical conditions I look to art history to elaborate upon qualities that are particular to a sculptural imaginary through close readings of several essays by Alex Potts. Pott's analyses of the tactility, spatial staging and temporality of sculpture reveal the various ways that the sculptural is dialectical or duplicitous, always oscillating between projected idea and concrete fact. Potts's call for an expansive redefinition of medium foregrounds the conceptual mixing of materials and connects his autonomous notion of the sculptural to Peter Osborne's notion that post-medium art is always the result of a strategic mixing of means.

These two lines of enquiry destabilise initial assumptions about digital abstraction and concrete sculpture. Both the digital and the sculptural are revealed to be intrinsically contradictory. On the one hand you cannot think the digital in isolation because it is always dependent on existing material forms and so it should be observed as another kind of thing in the world. On the other hand, sculpture must retain a tension between its material form and its social actuality if it is to suspend reification. I argue that the digital and the sculptural are therefore both dependent on the material and social conditions of their experience. The digital tends toward the abstraction inherent to social objectification; the sculptural, if it is to retain critical autonomy, is bound to physically resist subsumption to the commodity form.

Digital Anthropology

To the senses, digital information doesn't actually exist. Binary data is an unformed ideal that always has to be constructed. The digital documents of our lives – correspondence, music, photographs, calendars and accounts – can only be experienced through the trans-mediation of software. The intractable abstraction of digital data, along with the infinite multiplicity of its potential actualisations, might well be a cause of some aspects of contemporary anxiety or tension. "The need frequently to re-concretize the products of daily work evokes in many of us a sense of instability and uncertainty that bleeds into all aspects of existence in the current era, lending to life itself an unsettling tenuousness." (Kellner & Thomas 2003: 3). Digitization now pervades all areas of life, transforming our relation to the world to the extent that it feels unstable. Digital experience is contemporary experience in general. For the purposes of this thesis and in order to analyse the potential implications that digitization holds for sculpture, I want to begin by suggesting a definition of the digital borrowed from contemporary anthropology.

> Rather than a general distinction between the digital and the analogue, the digital is defined as everything that has been developed by, or can be reduced to, the binary – that is bits consisting of 0s and 1s. (Horst & Miller 2012: 5)

Not only do Horst & Miller define the digital in terms of its constitution as binary code, but they also open the category to include "everything that has been developed by" the binary. This definition is pertinent to my thesis because it doesn't limit the digital to electronically projected imagery, text, or 3D prints, but allows for tangible objects that were initially developed using digital technology – including sculpture. Defining the digital by the numerical system of binary has the advantage of helping to identify a historical precedent. Like the digital, money represented a new phase in human abstraction because it enabled practically anything to be reduced to the same element. Money can be seen as virtual because it extends the possibilities of abstraction.

> If the digital is defined as our ability to reduce so much of the world to the commonality of the binary, a sort of baseline 2, then we can also reflect upon humanity's ability to previously reduce much of the world to baseline 10, the decimal foundation for systems of modern money. (Horst & Miller 2012: 5)

Horst & Miller's analogy suggests that digitization intensifies the existing dialectical nature of material culture because, with both the digital and money, the further we reduce all elements to the same baseline, the more we can create difference. "The principle of the dialectic is that it is an intrinsic condition of digital technologies to expand both, and the impact is also intrinsically contradictory, producing both positive and negative effects." (Horst & Miller 2012: 11) Horst & Miller make a further observation that's pertinent here concerning humanity's capacity to re-impose normativity just as quickly as digital technologies create conditions for change. The ease with which we adapt to and accept these mediations means that to a certain degree they go unnoticed. Herein lies one of the critical issues of the digital: its generic abstractions converge with the concrete particulars of life. For example, the Facebook social network is in fact profoundly anti-social because its only purpose is marketing, turning users into self-marketers. In this sense, digital abstraction is more aligned to Marx's notion of abstract labour than money.

When labour becomes a commodity, it has existential ramifications. The reduction of human qualities to number is when alienation occurs. When Facebook extracts surplus value (as a commodity) from the personal data of its users (what Shoshana Zuboff identifies as 'behavioural surplus' in her recent book *The Age of Surveillance Capitalism*, 2019), they become alienated from this unwitting 'labour'. The failure to cognitively understand this abstract commodity production reflects a breakdown in causal reasoning. The digital mode of thought is internalised as an objective illusion (of the social), where actual conditions become inverted and projected. Under established

capitalist conditions of commodity production, digital abstraction intensifies the formation of cultural ideas (ideology), and with the failure of self-knowledge (alienation) that this produces, the reality of the human is lost. Alienation, ideology and commodity fetishism are connected structurally and it is where these issues converge that there is a connection to art.

> "I see the digital in a different way. I see it as the most anti-hierarchical, anti-racist thing that's happened culturally in a long time - no pixel thinks they're better than another pixel, no pixel will not work with another pixel and when two pixels collide and make another pixel, nobody pays any attention to what color they are. I like pixels." (Weiner 2013)

It's tempting to attribute political ideals as characteristic of the digital. Lawrence Weiner's quip, suggests that digital technology has an inherently egalitarian character. However, one has only to substitute the word 'pixel' for 'pencil' to see that this could be said of any other technology or tool. Pixels are no less hierarchical than pencils. If a Minimalist like Donald Judd pushed sculpture to a subjective extreme by reducing the art experience to the phenomenology of 'specific objects', then Weiner, who famously stated that "the artwork need not be made", presents 'sculptures' that are objectively reduced to the conceptual abstractions of language. It is therefore easy to appreciate how digitization might correspond to the almost Platonic ideal of Weiner's linguistic 'sculptural' propositions, but the same advantages are equally available to the designs of authoritarian propaganda or commercial advertising. There is nothing intrinsically anti-hierarchical about the digital because however accessible it may be, it also serves to intensify the hegemonic possibilities of media. Meanwhile, as the numerical form of digitization infiltrates material culture, subtle traces are perceptible that reflect how the capacity to increase quantitative difference corresponds to a decrease in qualitative difference:

> CHARLES RAY: …These days a lot of design is perhaps too dependent on the computer alone. Everything looks like a tennis shoe, like my new pair of Nikes — a boat, a car.
>
> WILL SELF: I noticed that about 10 years ago—cars started to look like tennis shoes. What is that about?
> (Self 2013)

Philosopher Peter Osborne has argued that all 'technologies' are essentially ambivalent because they are constituted by a combination of their specific material form or process (*techné*) and the contingent rationale (*logos*) with which it is applied (Osborne 2013: 120). This highlights a methodological argument for the requirement to look at and understand the digital in the context of its specific use. Since, there is currently a lack of theory concerning the specific relation between the digital and the sculptural, the following sections will look first to architecture, then digital

photography, and finally to the 3D digitization of museum artifacts, with a view to abducting insights that might be pertinent to my sculptural disquisition.

Abstract space

One field in which the abstract patterns of digital technology have become saliently concrete is architecture, where the homogenising reduction of binary code is embedded in the identikit modules that increasingly make up our cities. Digital technology has had a significant impact on recent architecture, not simply because it is the ubiquitous design tool, but because its structure is abstract rather than physical and so it intrinsically prioritises idea over space, the intelligible over the sensuous. Architectural historian Tom Dyckhoff has looked to Lego's successors and at how cult computer game Minecraft may be set to transform the architecture of cities of the future (Dyckhoff 2014). He observes how architects have often cited their formative play with toys as having informed an absence of mystery – you can understand how it's made. For example, the wooden blocks that influenced Frank Lloyd Wright, Gropius and Le Corbusier, the Meccano that informed the engineered structures of Richard Rogers, or the Lego that helped shape the buildings of James Sterling and more recently Bjarke Ingels. Dyckhoff speculates that today's young architects are more likely to be influenced by their disembodied interaction with computer games like Minecraft, shifting the emphasis from the physical experience of tangible relations, to the abstract calculations of affordability and sustainability. Such rational ideals might represent a welcome shift in architectural bias from formal to social imperatives, but perhaps it is also with architecture that the analogous abstractions of money and the digital become perceptible in less utopian ways. The current proliferation of residential property development across London, for instance, uses the exacting geometric algorithms of software to introduce just enough design difference to make potential buyers feel individual, whilst churning out more and more of the same generic boxes with ruthless economic precision. The homogeneous architectural space produced by the digital is precisely the kind of abstract space that the Marxist sociologist and philosopher Henri Lefebvre anticipated, analysed and offset with social and spatial practice.

In his seminal book, *The Production of Space* (1974, 1991), Henri Lefebvre sought to reconcile 'perceived space' and 'conceived space' by introducing the third element of 'lived space'. Lefebvre considered space is a mental and material construct, to which he introduced the notion of the lived as a third term between the poles of conception and perception. He articulated how the three terms of this conceptual triad interact to produce space: spatial practice relates to the bodily negotiation of physical, concrete, material or real space, "space that is generated and used" (Lefebvre 1991: 33). 'Representations of space' are conceptualizations like plans, maps, and mathematical models. This is

the abstract, mental, geometric, or imagined mode of space and is therefore akin to computational space. (Ibid: 38) 'Representational space' "is the dominated – hence passively experienced – space which the imagination seeks to change and appropriate. It overlays physical space, making symbolic use of its objects". (Ibid: 39) Lefebvre explains that through this spatial triad "we are confronted not by one social space but by many . . . which we refer to generically as 'social space'." (Ibid: 86) Social spaces are therefore concrete abstractions characterized by intertwinement:

> Social spaces interpenetrate one another and/or superimpose themselves on one another. They are not things, which have mutually limiting boundaries and which collide because of their contours or as a result of inertia. . . Visible boundaries, such as walls or enclosures in general, give rise for their part to an appearance of separation between spaces where in fact what exists is an ambiguous continuity. (Lefebvre 1991: 88-87).

Digital space corresponds to Lefebvre's abstract space and in the present day, digital technologies have amplified the potential of measured, quantitative abstraction to be instrumentalised by those with knowledge and power. Abstract space, in these terms, is the space of advanced capitalism and authoritarianism; homogeneity and control. As urban scholars Garrett Wolf and Nathan Mahaffey have pointed out, Lefebvre's "abstract space is real space generalized or abstracted, the materializations or the domination of conceived space (Merrifield: 2006). Ideas of abstract space are influenced by behaviorist ideals of space, that space can control people's movements and behavior." However, the homogenization of abstract space conceals contradictions: "Abstract space is particularly interesting because it acts negatively by destroying difference, by attempting to homogenize all manner of spaces. Abstract space also acts positively, because it produces something new, replacements for the various spaces it generalizes". (Wolf & Mahaffey: 61). In Lefebvre's words:

> The reproduction of the social relations of production within this space inevitably obeys two tendencies: the dissolution of old relations on the one hand and the generation of new relations on the other. Thus, despite—or rather because of—its negativity, abstract space carries within itself the seeds of a new kind of space. I shall call that new space 'differential space', because, inasmuch as abstract space tends towards homogeneity, towards the elimination of existing differences or peculiarities, a new space cannot be born (produced) unless it accentuates differences. (Lefebvre 1991: 52)

Lefebvre's conception of abstract space therefore mirrors Horst & Miller's argument that digital abstraction intensifies the dialectic between homogeneity and difference,

For Lefebvre, abstract (quantitative) space ultimately denies concrete (qualitative) space, which is the differential space of bodily and experiential particularity. "The more carefully one examines space," Lefebvre explains, "considering it not only with the eyes, not only with the intellect, but also

with all the senses, with the total body, the more clearly one becomes aware of the conflicts at work within it, conflicts which foster the explosion of abstract space and the production of a space that is other" [my emphasis] (Lefebvre 1991: 391). It is this alienating effect of abstract space that aligns it with Marx's notion of the alienating effect of abstract labour. The contradictions of global capitalism are therefore manifested as contradictions of space, but they are concealed by its homogeneity. Architectural historian Lukasc Stanek has argued that "Lefebvre's approach to space as a product of historically specific material, conceptual and quotidian practices was facilitated by his use of the concept of concrete abstraction." (Stanek 2007: 62). He explains how "Marx's understanding of concrete abstraction as a "sensual-suprasensual thing" inspired Lefebvre to theorize the paradoxical character of contemporary space as simultaneously homogenous and fragmented" (Stanek 2007: 63). By seeking to render the intangible, tangible, my practical research encapsulates the contradictions between conceived space and perceived space, homogeneity and fragmentation. Because digital space is an abstract representation, it is conditioned by a logic that is unconcerned with qualitative difference. The danger, as far as Lefebvre was concerned, is that the concrete particulars of lived experience become displaced by objectified abstraction.

Digital Images

It is not just the designs of cars, tennis shoes and architecture that have become digitally aestheticized but all commodities, along with the infinity of digital images that advertise them. Material and cultural histories also are caught up and transformed by a similar process. If the digital can only really be examined and understood in the context of its use, then what are the implications of digitisation on the historical concept of art? In his essay *Infinite Exchange: The Social Ontology of the Photographic Image*, the philosopher of modern and contemporary art, Peter Osborne, argues that technological developments within photography "along with digital-based image production more generally, are driving the historical development of art." (Osborne 2010: 61) Osborne implicates digitization within the two distinct moments of the photographic process: the acts of image capture and image production. "It is the disjunction between these two processes that raises the possibility of the manipulation and transformation of 'photographic' data, subsequent to the taking of a picture, prior to its projection as an image – that is, computerised image processing. And it is this possibility that generates ontological concern – anxiety – about the 'no longer indexical' character of digital photographs." (Ibid: 63). As Osborne is quick to point out, this disjunction (and its potential for manipulation) was always a part of the analogue photographic process, so the anxiety must correspond to something particular about the translation of an image into binary data. For media theorist Boris Groys, the crucial difference is that the digital photograph is a copy of invisible data

rather than a photographic negative. "The difference between original and copy is obliterated in the case of digitization only by the fact that the original data are invisible: they exist in the invisible space behind the image, inside the computer." (Groys 2008: 84) This specific condition of the digital data file suggests that digital visualisation remains uncertain and any resulting image is always already transformed by the use of different technology: "the digital original – the data file of the digital data – is moved by its visualisation from the space of invisibility, from the status of 'non-image' to the space of visibility, to the status of 'image'". (Ibid: 86) This movement makes the digital image impossible to stabilize and always "dissimilar to itself".

Groys likens the digital image to a "Byzantine icon – as a visible copy of an invisible God" (Ibid 84). He is using theology here in the Marxian sense, to indicate a failure of comprehension. Osborne, similarly speculates that the source of the anxiety has nothing to do with photography itself, but "has rather to do with the nature of the *abstraction of social relations* characteristic of societies based on relations of exchange" (Osborne 2010: 64). For Osborne, the invisibility of digital data corresponds to the way that the most 'real' (determinative) part of the economy – finance capital – is commonly misunderstood to be 'unreal'. So, the cause of the "anxiety" is actually that of the relationship between social form and value form (the absence of a necessary relation between use-value and exchange value) that becomes displaced onto the digital process. In this insightful alignment, Osborne's theory expands Horst & Miller's analogy between the digital and money, by suggesting that the digital image figures a convergence between art and the commodity form. A crucial point here is that "computerised image processing" functions to place photography within a "generic field of the digital image". "This generically digital-based field is the closest thing there is to a material medium of the generic concept of 'art'." (Osborne 2010: 66). Elsewhere, this "disjunctive unity" of the digital prompts Osborne to ask the question: "Is digital imaging, which pervades all areas of life, a new artistic meta-medium, at once technologically unifying an otherwise disparate field and connecting it to life practices?" (Osborne 2013: 117). For Osborne, then, it is the generic form and social relation of the digital that reflect the post-conceptual ontology of contemporary art. For obvious reasons, digitisation has not had anywhere near as profound an impact on sculpture as it has on photography, to date. However, the question remains how sculpture relates to a generic field of contemporary art, epitomised by the digital.

Digital Objects

There is a lack of theory about digitisation in the field of sculpture, as I have outlined above. However, I identified Haidy Geismar's pioneering work in the nascent field of digital anthropology as pertinent to my sculptural research, because it examines how developments in digital technology

have impacted on the presentation and reception of objects in museum collections. In particular, her investigation into the digitization of museum artefacts reveals the creative tensions, limits and materialities of digital technologies to produce what she calls "object lessons" about the digital. Geismar's analysis of the digital replication process describes how digital technicians working with museum collections see their three-dimensional images as 'real' representations of artefacts – what they describe as "digital surrogates".

> Digital surrogates not only represent the geometry and measurement of an artefact, but also its perceptual qualities. They privilege the visual as the way to generate knowledge about objects. The process of making these digital objects starts photographically, with the construction of point clouds generated by laser scanning, or of large numbers of photographs through the process of photogrammetry, both of which capture data by taking information through light reflected directly from the surface of the object. However, the subsequent processing of this data uses photography as a reference point in terms of texture, colour and so on but departs radically from analogue photographic technologies, using specialist software to create a simulation or model of a photograph (a simulation of indexicality rather than an indexical simulation). (Geismar 2018: 97)

Although this process clearly resembles the photographic, particularly in the act of data capture, the act of three-dimensional image production is actually more akin to model making. "The craft of stitching together data and working from photographs to create a digital simulation that effaces the process of its own fabrication is intensively skills-based rather than automatic." (Geismar 2018: 97) The nonindexical gap in the process of digital photography, which both Groys and Osborne found in the reduction of the image to invisible code, is revealed in three-dimensional digital replication processes to be an abyss that demands invention to span. Moreover, it is a self-conscious artifice because it "effaces the process of its own fabrication" – in other words, the digital surrogate is an illusion: "three-dimensional images are instances crafted almost entirely from within the computer to generate visual authority through the production of a photographic aura that evokes rather than denotes contact with the object itself." (ibid: 99) The illusionary ambition of a digital surrogate is to present itself as an objective fact resulting from a technological process and it does so by erasing the subjectivity of the technician who actually authored it. If the objective truth suggested by indexicality is compromised by the artifice intrinsic to processes of digitising three-dimensional objects, the materials of digital 3D printing do nothing to conceal this, because they bear little or no resemblance to the original source objects. Instead, "The medium of 3D printing is almost willed away through an interpretive sleight of hand that focuses on the magic of conjuring a solid artefact out of a supposedly immaterial image." (Ibid: 108) In other words, experiencing a museum digital surrogate *as if* 'real' requires the willing suspension of disbelief, a mode of self-conscious illusion that has long been associated with art.

The dubious indexicality of digital replication is at best unstable and at worst fictional and it has been described (ironically) as 'theological' (Groys), 'spectral' (Osborne) and 'magical' (Geismar). Notable, then, that the very 'real' agency of digitisation is consistently perceived as if supernatural, at the same time that it is so rapidly and universally normalised within culture to the point of banality. No wonder the digital is frequently associated with anxiety and tension on the one hand and "myth, magic and mysticism" on the other. (Davis 1998)

The final 'object lesson' recounted in Geismar's book, *Museum Object Lessons for the Digital Age*, concerns a 3D print of an illicit scan by artists Nora Al-Badri and Jan Nikolai Nelles of a bust of Nefertiti held at the Neues Museum in Berlin.

> In December 2015, the two artists released 3D scanned data into the public domain along with a video showing how they had clandestinely stolen the data during museum visits by walking around the bust with Kinect scanners hidden under their coats. Alongside the open source provision of data and the video, the project has also included a true-to-original 3D print of the bust and a discussion hosted by the artists in Cairo of the relationship between contemporary art and heritage. (Geismar 2018: 110)

Ostensibly, this activist hack proposed a virtual repatriation of the surrogate bust in Egypt and the presentation of the video suggested an analogy between the theft of data and the theft of the original artefact. However, Geismar continues the story by relating how technologists subsequently challenged the plausibility that the high-resolution 3D print could have been generated from the handheld scanners used by the artists. It emerged that the Neues Museum had previously commissioned a higher-resolution scan, which they had not made public (or available for "repatriation") and that the artists might have accessed this data through third party hackers. Clearly the artists' ambition, or sociological motivation, was to undermine the museum's sovereign authority over its artefacts and their digital surrogates, revealing the ways that digital media become implicated within institutional ideologies – "both reifying existing conceptual and material orders and provoking a radical re-examination of their future". (Geismar 2018: 112) However, from the standpoint of art, the artists' project doesn't really hold together. It isn't legible whether the artists intended to pass off the 3D print as the actual index of the data they purported to have scanned personally, or whether the eventual exposure of their contrivance was anticipated. Either way, the project remains formally incoherent since the 3D print was not the plausible consequence of the scanning operation that was documented. What is remarkable about this formal incoherence is that it maps precisely onto the ambiguity and opacity of the digitization process – the absence of a necessary relation of resemblance between object capture and object production. If there is a symbolic equivalence between the original Nefertiti and *Nefertiti 2.0*, the video of the artists' scanning had nothing to do with it. The inherent invisibility of abstract mediation, that both Groys and Osborne have also highlighted,

concealed the substitution of the digital data.

Geismar highlights an imperative to explore how digital objects are used to constitute what she calls 'reality effects' – "the perceptions of the real that are actually carefully constructed and produced through a wide range of media" (Geismar 2018: 27) – that alter and participate in how we see and understand the world. This perspective is key to unpacking common assumptions about the digital's immateriality, abstraction, inauthenticity and sociality. From an anthropological standpoint, Geismar demonstrates how the digital is no less material than anything else and how its abstraction is dialectically bound to differentiation. My research will argue that there is further convergence between the form of the digitization process, the generic form of contemporary art and the commodity form. However autonomous art might purport to be, it is always objectively social, in that it is historically conditioned and also dependent on exchange relations.

Geismar's account shows how the Berlin Nefertiti project was interpretively flawed by its implausible material form. The artists' clear socio-political compulsion (beyond the work itself) undermined the coherence of the work's (inherent) formal structure. My research seeks to re-assert materiality, not as a conservative impulse, but because it is concerned with how the critical nature of materiality does not join to the digital in an easy binary manner. I have shown that the troublesome invisibility of the data file has been variously compared to God, ghosts and magic – all euphemisms for incomprehension. Geismar's rejoinder to the intractability and invisibility of digital data is the scientific provocation that "the digital does not exist." But this assertion does not necessarily mean that there is no such thing as a digital object. "The politics of material participation that the digital effects in our understanding of the real world as a set of refractions from one kind of object to another are yet to be fully uncovered." (Geismar 2018: 112) The politics of material participation with the digital will be one of the principle concerns of the next chapter. But before developing this central tension, I need to address the possibilities of the 'sculptural' within my thesis. Geismar concludes her recent book with an insightful suggestion: "It is better to think about the interface between different material forms, and between objects and people, than it is to think about either the digital or the analogue in isolation from one another." (Geismar 2018: 112). I am struck by her emphasis on "the interface between material forms, and between objects and people", because it resonates with Lawrence Weiner's famously reductive assertion that "Art (per se) is the physical presentation of the inter-relationships of objects [material] to objects in relation to human beings." (Weiner 2004: 381). Weiner has reiterated this declaration with the frequency of a mantra, and occasionally he reframes it specifically in relation to sculpture: "they are sculptures, since they show the relationship of objects to objects and that is the idea and purpose of sculpture." (Weiner 2019). Weiner's definition suggests that sculpture could be well suited to respond to Geismar's provocation to "think about the interface

between different material forms, and between objects and people". In order to explore how sculpture can present "existing materials within another (often not noticed) configuration to bring about another perception of the relationships of human beings to objects" (Weiner 2004: 318). It will be necessary to begin by situating sculpture critically within present cultural conditions.

Post-conceptual sculpture

The historicising of sculpture frequently seems to explain away its presence in contemporary art practice. The 'expanded field' of sculpture (Krauss 1979) gave way to the 'post-medium condition' (Krauss 1999) in which all works of art, regardless of their specific medium, enter a condition of general equivalency. From the standpoint of postmodernism, aesthetic sculptural concerns became redundant, and if the term 'sculpture' remains in common usage across the full ecology of art production and reception – from the university to the museum – it tends to be either an historicist nod to the canon, or flagging the practical requirements for production, access and storage of bulky three-dimensional artworks. The consequence of art's general equivalency was an increase in its heteronomy. The 'objecthood' so lamented by Michael Fried (1967) has prevailed. Generic art objects, no longer constrained by the rules of the modernist game, can appropriate any form whatsoever, including the back catalogue of art history. Moreover, at the same time that art was assimilating the lifeworld, the lifeworld was, as Fredrick Jameson noted, becoming increasingly aestheticized. "What has happened is that aesthetic production today has become integrated into commodity production generally" (Jameson, 1991: 4). Digital image production has been instrumental in the intensification of the aesthetic within the culture industry to the point of saturation. Inevitably, under these contemporary conditions, the heteronomous artworks of the postmodern project have become indistinguishable from any other commodity object and subsumed by the art market. The question, therefore, is whether sculpture could become newly useful, not as an exclusive practice, medium or tradition, but because it elicits particular form of (aesthetic) experience embodying a plausible alternative to the pervasive experience of the digital landscape of advanced capitalism.

Jeff Wall is an artist who has restricted his practice to the production of photographic images, which are frequently digitally manipulated. However, despite his conceptual deployment of the digital, his carefully constructed images evidence his obvious commitment to aesthetic autonomy. Wall's essay *Depiction, Object, Event* (2006), provides a useful genealogy of the ambivalent state of contemporary art in relation to objects and sculpture. Avoiding the term 'medium' entirely, Wall outlines a trajectory of modern–modernist–contemporary art that is grounded in the dialectic of what he calls 'depiction and anti-depiction'. He attributes the shift from specific instances of art (Drawing, Painting, Photography and Sculpture) to general instances of art (post-conceptual art), to a disavowal

of artistic autonomy (internal cohesion) and an attempt to reconnect art to the lifeworld (external social relations). Wall identifies two decisive moments in this transition: 1. Duchamp's 'readymade' (whereby artistic status can be nominated rather than made) and, 2. Conceptual art's reduction of art to a text that negates the artwork by declaring itself art. Both the readymade and the conceptual reduction not only challenged the formal qualities of artworks, but also undermined the traditional values of skill and process. From these negative dialectics, Wall deduced two critical insights. Firstly, neither the readymade nor the conceptual reduction actually reduced the field of art, but instead they expanded it. In Wall's view, the double negative of "the inability to deny [art] status to any given object" in no way rendered the canonical forms obsolete. At the same time, he cautioned that following the readymade and conceptual reduction there can be no "meaningful innovation" produced from within the depictive arts, only from outside. Sculpture, therefore, remains a 'legitimate' practice, but its critical potential is limited to an affirmation of autonomy. Wall's conflation of meaning with innovation reveals its historicist (modernist) basis. Critical theorist Nicholas Brown has argued this relation differently, because as he sees it, meaning can only derive from the intentionality intrinsic to autonomous aesthetics and never from outside, but novelty, which is the imperative of the commodity in high capitalism, can only now be derived from outside the restricted field of modernism. As Brown explains "Meanings are made possible by autonomisation, but these meanings themselves are increasingly only formal meanings – that is, they are legible as intentions, but the only meanings they convey are specifically painterly, musical, writerly, etcetera." This is the difficulty with old, modernist autonomy, "the very dynamic that makes it possible tends at the same time to restrict its movement to an increasingly narrow ambit." (Brown 2012: 14)

For Wall then, conceptual reduction caused a bifurcation between canonical and post-conceptual art. On one hand there is autonomous art, which is valid, but can only be judged according to depictive criteria. On the other hand, depictive criteria are suspended to allow a "pseudo-heteronomous art", for which there are no criteria of judgement since it exists merely as equivalent instances of art. Wall's first position is consistent with the historicist ideology of Michael Fried, who recently updated his formalist critique of Minimalist sculpture in *Art and Objecthood*, (Fried 1967) to state that while "authenticity [is the] sine qua non of serious [artistic] achievement" (Fried 2011: 132) "I would no longer wish to argue that for the work of art to deeply matter it has in all cases to be understood as doing so as an instance of a particular art or medium." (Ibid: 221). Meanwhile, Wall's second position resembles Peter Osborne's argument that post-conceptual art exists only as a specific instance of art in its intrinsic opposition to the aesthetic autonomy of high modernism. For Osborne all contemporary art is by definition post-conceptual art, and consequently historical categories such as sculpture are no longer ontologically valid (Osborne 2013). As Osborne sees it, the post-conceptual

condition of heteronomy is universal because it constitutes a fundamental shift in art's mode of being – a change in art's "ontology". Osborne understands the post-conceptual condition of all contemporary art to be a generic field of art characterised by its "distributive unity" – "the relationship between its conceptual dimension (infinite in all its actualisations) and its multiple actual materialisations" (Osborne 2010: 117). As this thesis has previously argued, through his critique of digital photography, Osborne identifies a correlation between his delineation of contemporary art as a conceptual dimension manifested by multiple actual materialisations, with the process of digitisation, where an abstract data file can potentially engender an infinite number of different, material 'copies'. Osborne's notable insight is to align these two structures within the dominant social structure of full-blown capitalism, the commodity form. For Osborne, there can be no logical exception to the rule that all artworks must now exist within the generic field of heteronomous art.

Osborne has argued that part of the significance of Matias Faldbakken's work is that it "stages a struggle with the problematic conditions of contemporary art, in which those conditions become legible." (Osborne 2009: 51). In Osborne's analysis, Faldbakken presents elements of reproductive technologies, such as photocopies and scans, as themselves object-images, de-functioned and re-purposed in different ways, so as to highlight aesthetic aspects of their materialities. For example, "*Supernote (PN–14342)* (2006) – a photographic triptych of close-up scans of a US 100-dollar bill – contributes to the established conceptual genre of money works, which reflect on the contradictions between the universality of money as a form of value (Marx's 'universal equivalent') and the contingencies – aesthetic, cultural, legal and political –of its material tokens (currencies)." (Osborne 2009: 53)

Wall's narrative permits the coexistence of both sides of the argument, but not their reconciliation or synthesis. Is it possible to engage with the sculptural without either reducing it to aesthetic autonomy, or losing it to social structure? Is there scope for a semi-autonomous zone for artworks that entail the interplay of internal and external relations – to emerge from this conflict? Wall pins the mutual exclusivity of autonomous and heteronomous art on the impossibility of anything depictive (any material ground that has been transformed by depiction) to be eligible for appropriation as a readymade. On the other hand, he describes heteronomous art as "the culture of the second appearance" – a domain in which anything that is not depictive can reappear as art via post-conceptual mimesis (contingent upon its institutional re-framing). Wall gives the example of Warhol's *Factory*, but we could as easily think of Broodthaers's *Museum*, or countless other examples in which everything from: supermarket, theatre and cinema; sports and catering; documentary and pedagogy, have made reappearances as art. In his postscript, Wall speculated that "pseudo-heteronomy may be the necessary form in which traditional or canonical forms can survive and even

reflect upon themselves, as a phantom form of aesthetic education." (Wall 2006: 39) Although Wall leaves this notion undeveloped, he seems to suggest a semi-autonomous zone in which autonomous art forms such as sculpture could reappear as an instance of art within the heteronomous field like a Trojan horse. In the final analysis, perhaps sculpture can be appropriated to make its phantom re-appearance as post-conceptual art. Such an argument provides an uncanny account for the sculptural apparitions of Katharina Fritsch, Jeff Koons and Charles Ray that were brought together for the exhibition, *Sculpture after Sculpture*, at the Moderna Museet, Stockholm (Bankowsky 2014) When I visited this exhibition I was struck by how these homogeneous figures projected a unifying image of themselves seemingly detached from their material facticity. This spectral quality was made explicit by Fritsch's sculpture *Ghost* (1988), which manages to depict itself simultaneously as both the spectacle of a hovering phantom and the material reality of a studio assistant standing on a box, draped with a sheet.

Wall's argument for the mutual exclusivity of autonomous art and heteronomous art rests upon his claims that post-conceptual art is absolutely anti-depictive and that depictive art is absolutely autonomous. And yet the phenomenon of post-conceptual reappearance or mimesis can be seen as, at least in some respects, depictive – Broodthaers' fictional *Museum of Modern Art*, functioned as an institutional critique precisely because it presented a recognisable image of the museum structure. Broodthaers was the first to point out that mimesis cuts both ways – "a fiction allows us to grasp reality and at the same time what it hides" (Kraus 1972: 47). By the same token, any claim of pure autonomy also smacks of pretence. Art's autonomy was the principle target for critique because it supposedly isolated itself from the lifeworld. For instance, Krauss observed that "The specific mediums – painting, sculpture, drawing – had vested their claims to purity in being autonomous, which is to say that their declaration of being about nothing but their own essence, they were necessarily disengaged from everything outside their frames", before she conceded the paradox that even highly abstract painting's mode of serial production "carried the imprint of the industrially produced commodity object" (Kraus 1999: 11) – an inadvertent mimesis of the external conditions of its social production. Ironically, it is through post-conceptual art's mimesis of an aestheticised lifeworld that its objects become indistinguishable from commodities. This inability to distinguish was the foundation of art critic Arthur Danto's famous declaration of the end of art – his epiphany deriving from what he saw as total parity between Warhol's Brillo boxes and actual Brillo boxes. If there were no discernible difference between an art object and a non-art object, reasoned Danto, then art no longer required an object (Danto 1997).

Danto tried to figure out what art *is*, by logically excluding what it isn't. A more constructive line of questioning might be to ask instead: what does art *do*? To reframe art's crisis in terms of action or

agency is to see art making (of sculpture, or anything else) as a certain kind of behaviour that is radically free and autonomous. In his essay *The Importance of Being Autonomous*, critical theorist Jackson Petsche takes issue with the notion of artistic autonomy's purported disavowal of art's social role, exposing this simplistic binary as a fallacy. Drawing on Theodor Adorno's critical theory, Petsche argues that autonomous art is dialectically interdependent upon social relations and modes of production and that it is only through its autonomy that art can express opposition to the society from which it cannot be separated. As Adorno himself put it "art becomes social by its opposition to society, and it occupies this position only as autonomous art . . . it criticizes by merely existing." (Adorno cited by Petche 2012: 146) Adorno took this view further to assert that art can only achieve social critique through its autonomy. "In all art that is still possible, social critique must be raised to the level of form, to the point that it wipes out all manifestly social content." (Adorno cited by Petsche 2012: 147) Petsche argues that this idea needs to be revisited and developed now that the socially engaged strategies of committed art have become as marketable as the alienating effects of avant-garde art. Under the new background of consumerism within advanced capitalism commodities have become just as aesthetic as artworks and advertising appropriates the estrangement effects of art to promote products. The bombardment of images, advertisements and objects produces a sensory overload and a state of distraction that Petsche identifies as the cause of tension and anxiety.

> This tension, furthermore, is a symptom of art's being estranged from what Marcuse delineates as art's "estranging form". When advertisements utilize the aesthetic of former modes of artistic production, when mass reproduction of artistic images has deteriorated into the worst commodity fetishism in a way that Benjamin could not have foreseen, then the aesthetic becomes empty and superficial. The subject has nothing to grasp. (Petsche 2012: 149)

Under these conditions, predominant perceptions of the world become shallow and superficial and there is insufficient personal space to develop subjective inner experience, both subject and object become lost. In order to salvage aesthetic autonomy and resuscitate sensory awareness against the flood of images and objects (that are immediately commodities) in advanced capitalism, "it becomes increasingly necessary to differentiate the work of art from the commodity if art is to have any promise for the future at all" (Petche 2012: 155). Petsche calls for a reconsideration of autonomous art, and to do so he brings Herbert Marcuse, to the rescue. Just as for Adorno, autonomous art was inherently socially productive because of its ability to change consciousness, for Marcuse "the truth of art lies in its power to break the monopoly of established reality (i.e. of those who established it) to define what is real. In this rupture, which is the achievement of the aesthetic form, the fictitious world of art appears as true reality." (Marcuse 1978: 9, cited by Petsche 2012: 150) For Marcuse, art cannot change social relations directly, but it does have the power to cause

change in consciousness through its negation of established reality – what Petsche terms "an almost intangible shift in consciousness." (Petche 2012: 150). It is worth quoting Marcuse in at length here:

> But even in bourgeois society, insistence on the truth and the right of inwardness is not really a bourgeois value. With the affirmation of the inwardness of subjectivity, the individual steps out of the network of exchange relationships and exchange values, withdraws from the reality of bourgeois society, and enters another dimension of existence. Indeed, this escape from reality led to an experience which could (and did) become a powerful force invalidating the actual prevailing bourgeois values, namely by shifting the locus of the individual's realisation from the domain of the performance principle and the profit motive to that of the inner resources of the human being: passion, imagination, conscience. (Marcuse 1978: 4-5)

Petsche's deployment of Marcuse is useful here, not only because it challenges the false binary of autonomous/post-conceptual art by showing that autonomous art is always intrinsically, if dialectically, social. But because it also underscores how culture has been transformed, primarily by digital media, to produce an existing reality in which the aesthetics of commodities and heteronomous art objects have become indistinguishable and where an overload of images and objects reduce subjectivity to shallow and superficial distraction (and commodification). Autonomous art demands that we are, in Walter Pater's words, "present always in the focus". For Petsche, "focus" affords a "subjective experience that can negate the shallow subjectivity constructed by capitalism itself." Whereas, Wall's somewhat resigned position holds that autonomous art is still valid, but can only be affirmative, Petsche manages to recover autonomous art's radical negativity against a background of consumerism that has been intensified by the digital. Autonomy is thus key to my argument for a re-examination of sculptural interests against an existing reality that is saturated by the shallow subjectivity of digitally aestheticised commodities. A sculptural encounter, I suggest, can cause "an almost intangible shift in consciousness" that affords an inwardness that the abstractions of the digitised lifeworld generally preclude. Against this same backdrop of ubiquitous commodification, even the most three-dimensional heteronomous artworks tend not to function sculpturally, but act more as markers or waypoints toward external concerns. Autonomous sculpture, by contrast, has the potential to suspend or invalidate the logic of capital, precisely because it elicits close interpretive attention through a sensuous confrontation with its spatiotemporal and material determinations. If aesthetic autonomy can be seen newly as a "plausible other" to a neoliberal culture industry that has exceeded Adorno's speculations, then sculpture could be seen to have regained its critical potential.

The sculptural imaginary

In his recent review of *Frieze Sculpture Park 2019*, the art critic, JJ Charlesworth appositely framed the crisis currently facing sculpture with specific reference to the digital image: "but it's a

stand-off between these more subtle works that care about sculptural ideas – like the slipperiness of visual reference, or the position one looks at a thing from, or the sense of presence of a material – and those works that deliver their message like a jpeg." (Charlesworth 2019) In order to better understand how autonomous sculpture could critically reemerge in the present moment, these more subtle "sculptural ideas" need to be reexamined in light of cultural conditions that flatten sculptural space "like a jpeg". As a consequence of the move from specific art forms to post-conceptual art in general, there has been relatively little commentary of the development of sculpture per se in the last twenty years. The principle exception here is art historian Alex Potts's ongoing critical analysis of what he frequently refers to as "the sculptural imaginary" (Potts 2000). Pott's phrasing of "sculptural" instead of 'sculpture' suggests that he is more concerned with the particular qualities that are experienced, than the object or discipline itself; "imaginary" as opposed to 'imagination', underscores a relation to a shared or collective experience, that is to say, a social dimension. In contrast to the traditional definition of sculpture as an historical discipline (Lessing) or the modernist doctrine of medium specificity (Greenberg), Potts' notion of an evolving sculptural imaginary gives particular prominence to materiality and to the viewer's "embodied and potentially tactile engagement with things and environments". Analytical focus is therefore shifted from the sculpture to its apprehension, from production to reception (the latter entails recapitulating he former). But for Potts, sculpture also has an emphatically ambiguous status as both tangible object and as the projection of something that cannot literally be objectified (Potts, 2007: xiv). Throughout his writing about sculpture, Potts consistently draws attention to this central ambivalence by using terms like: tension, alternation, oscillation and dialectic, all of which serve to mobilize sculpture's facticity. Potts has developed his rethinking of sculptural norms through close readings of Minimalist and Post-minimalist sculptures of the 1960's and 1970's. In two independent essays, Potts addressed the particulars of post-conceptual sculpture's materiality and staging respectively.

In *Tactility: The interrogation of medium in art of the 1960's* (2004), Potts investigates the ways in which sculptures by Beuys, Oldenburg and Hesse manage to "fuse an intensified tactility with an effacing of plastic form". Potts finds that while the formal imperatives of Modernist medium specificity had to do with adopting structural approaches appropriate to the formal characteristics of a generic medium, these subsequent works took the focus on tactility to the point where all that seemed to matter was the substance and manipulability of their raw materials. Potts sees this focus on the properties of materials as a way of "problematizing the illusions generated by the consumer economy that human ideas and desires could somehow be fully lodged in material things". Drawing on localized history, Potts compares divided attitudes to materials in the art world – fetishizing materials and process on one hand and the desire to escape material and formal constraints on the

other – to divided perceptions of the economy of the time, where a heightened interest in industrial production processes coexisted with a new, intensified concern with consumption and systems of exchange. Potts acknowledges that medium, whether substance or formal constraint, has largely ceased to be a generating principle of most present-day artistic production or consumption. I am curious whether Potts' historical analysis could in fact be newly applied to the conditions of contemporary sculptural production, in an era when the abstract processes of digital production have radically intensified consumption and systems of exchange.

Potts is curious about this too, because he writes: "To get any purchase on the formal and material specificities of contemporary art practice, perhaps at this juncture a new understanding of medium is needed." He goes on to suggest that: "In this expansive definition of medium, we would have to consider the nature and symbolic resonances of a range of different objects and piles of stuff… To caricature the situation in this way is to indicate how, in this abundant multiplicity, we lose the constitutive core of the modernist focus on medium". And yet by attending closely to medium in the way that the modernists did, the spectator is invited to reflect on the possibilities and the limits of realizing something in material form that could carry a larger charge or significance in our encounter with it." (Potts 2004: 301). The contradictory crux of Potts' analysis of sculptural materiality is the idea that art presents its audience with a material reality where affectively charged possibilities are intimated that the actual work denies. The postwar artworks Potts presents as examples are convincing, precisely because as actual things they obstruct access to the ideas and affects they seem to realize and by doing so they resist reification.

Peter Osborne's analysis of Faldbakken reinforces this notion of contradiction as the only useful way to arrive at a definition of a particular set of paradigms in contemporary sculpture. "Conceptual transfiguration," he argues, "is essential to produce and maintain a tension between the appearance of the work as an objectimage and its reflective artistic meanings. It is this tension that raises the works above the banality of a purely sculptural (commodity) form – a form of presentation that is nonetheless deliberately courted." (Osborne 2009: 53). Osborne argues that the material disposability of certain works by Faldbakken stage "the threat of contingency that haunts all contemporary art: the destruction of its social actuality by the destruction of its monetary value." (Osborne 2009: 67) Here increasing formalism – in Faldbakken's case 'painterliness' is seen as the dialectical balance to its contingent value. This tension is made explicit in the geometrical abstraction of Faldbakken's MDF series. Osborne argues that these works "seek a similar point of indifference between materials (which, as elements, paradoxically insist on being nothing more than this) and an artistic meaning derived from the wholeness of the work. In this respect, they must stave off too great a formal success, at all costs, or their tension will be lost and they will return to painting – a condition that

would destroy both their contemporaneity and effective artistic meaning." (Osborne 2009: 67) While Pott's historical sculptural examples intimate possibilities that the material reality denies, Osborne's contradictory account of Faldbakken's work hinges on the avoidance of a formalism that is nonetheless staged.

In his essay *Installation and Sculpture* (2001), Potts' interrogates the extent to which sculpture has changed in character as a result of a shift from object-like to installation-orientated work. Here he is concerned with sculpture's "mode of display and its interpolating the viewer in a particular way." The issue here is less the constitution of the artwork, than how its staging can result in an "interplay between focused and dispersed apprehension". With most sculpture, the ever-shifting close views it offers are anchored by a single distanced view that frames the work on approach. Potts uses Canova as an example of how the affective potential of this tension can be exploited in a "dialectic of self-presentation and turning away". Installation art, by contrast, places the viewer inside the frame as its first order appearance. When aspects of certain installations also serve to exclude or alienate the viewer (here Potts gives works by Bourgeois, Nauman and Hatoum as examples) the combined effect produces a strong sense of displacement in the viewer. In the push-pull of a sculptural encounter Potts identifies another form of double take. He sees it in historical terms as a reaction against the formulaic and restrictive privileging of the autonomous object in mainstream post-war, high modernist conceptions of sculpture.

> These apparent reversals in twentieth century sculptural aesthetics can be seen as playing out a larger dialectic of modernity characterized by the oscillation between the cult of objectification and positivist insistence on firmly defined entities on the one hand, and a cult of dispersal, a radical undoing and unfixing of the definable object on the other. (Potts, 2001: 16)

In the staging of sculpture Potts sees another link between the sculptural dialectic and the "double logic of commodification" – "the disruptive and destabilizing interplay between reification and a restless unfixing." In a passage that likens the experience of viewing installation art to viewing cinema, because it privileges fragmented close-ups and panning shots over a singular view of the whole, Potts makes an important observation that in the blackened space of cinema "one's viewing fills the space defined by the work, while the body doing the viewing remains invisible" whereas with a sculpture installation such as Carl Andre's, "one is made to feel the positioning of ones' own body in relation to the space in which one is planted". "The intriguing effect of alternating presence and absence is generated from one's interiorized sense of being in close proximity to, while also being a little displaced from" the work.

> The crucial aspect of the shift to installation . . . is the focusing on staging and display as integral

to the very substance of work. We could think of installation as sculpture that has now been fully absorbed within the modern, or post-modern, society of the spectacle. (Potts, 2001: 19)

Between the represented figure and its staging, Potts identifies (and also provides examples from both pre-modern religious art and post-modern contemporary art) a double action generated in the sense of alienation produced by an immersion in the excessive immediacy of the work as a material phenomenon; between the objective facticity and the subjectively projected aspects of the spectacle into which one is drawn.

To summarize, Potts' sculptural imaginary is characterized by the tension between the work's material presence and the contingencies of the viewer's encounter. In turn, these two aspects of sculpture are themselves replete with internal contradictions. Central to Potts interrogation of sculpture's tactility is its unhinging from plastic form. The tension between what the work purports to offer and what its materiality denies. At the heart of Potts investigation of sculpture's mode of address are oscillations between a sense of inclusion and exclusion, presence and absence. Potts is careful to point out that it is no longer viable to be readily associated with a definable strategy or particular set of critical concerns in the way that post-war artists did. Yet Potts' thinking about sculpture offers important clues as to how contemporary sculpture might "effect some shift in the material fabric of the world we inhabit that is puzzling and incongruous and also compelling for not being fully subsumed within the operations of consumer culture". (Potts 2004: 302)

In response to my invitation to contribute to a research symposium, *Physical Information*, Potts delivered a new paper on the subject of *Temporality in Sculpture* (2017). By way of a conceptual framework, Potts began by summarising two of the more modern attempts to explore the nature of internal time consciousness. On one hand, Bergson's essay *Time and Free Will* plays a key role because it attempted to arrive at a subjective understanding of temporality that operated independently of the strictly measured timekeeping of the clock – durational experience as an on-going continuity. On the other hand, Bachelard's *Dialectic of Duration* proposes a less passive time awareness marked by events and intensified awareness of change. Bachelard's sense of time is constituted in the mind by successive instants of engagement separated by relatively empty intervals. Potts' concern was to try to draw out these contrasting conceptions of temporality that might have a direct bearing on apprehending a work of sculpture as somehow enduring *and* animated, through the on-going duration and event-like moments of discontinuity and change. "What really matters is the capacity of a sculpture's material configuration to convey through formal and conceptual subtleties, a sense of what it means to exist in time". (Potts 2017)

For example, in Giacometti's figures Potts finds that "suggestions of momentary intensified awareness and presence interrupt rather than fuse with the calm of a steady duration". He feels that

Rodin's *Thinker*, is compelling partly because its pose and form suggest a conflation of two quite different modes of being in time – "it can seem still, immersed in contemplation, and at the same time tense and on edge". In two later examples, Potts looked at works that are no longer determined in terms of the figure or the object but have as much to do with environments as with things, bringing different issues of temporality into play. In both Smithson's *Spiral Jetty* and Kienholz' *Beanery*, the interplay between a sense of the durational and of an event-like rupturing or punctuating of an on-going unfolding of time plays a key role. With Smithson's Jetty one experiences a constant push-and-pull between the sharply defined shape of the spiral and the continuously changing spectacle that presents itself as one scans the flat expanse of the lake, rock and grass. "The durational quality of viewing the surrounding environment keeps being interrupted by the event-like apparition of the jetty." For Potts then this work is intriguing because it plays-out its existence in two different time frames: "the human time of a localisable event" such as people intervening and reshaping the environment, and the "inhuman time" of geological erosion, "submerging and ultimately obliterating the structures erected by human endeavour". Kienholz's works, by contrast, often draw attention to disparities between the on-going localised sense of time generated by social space and the intrusion of temporal discontinuities created by events taking place in the world outside. *The Beanery*, for instance, "makes much of its impact through the vivid particularities of the ¾ scale reconstructed setting of the enclosed world of the bar and at the same time it gains considerable resonance from the disruptions taking place in the uncertain political world beyond, as a result of the violent events in Vietnam announced in the newspaper on the exterior of the sculpture". In Potts' view, these artists were committed to making works that dealt with questions about modernity's spatial and temporal worlds. Smithson's metaphysical concerns had to do with an imaginatively expansive awareness of a material environment that had no regard for human imperatives or timeframes. Kienholz was concerned with the seemingly enduring temporality inside the closed social environment and with the impingement on it of events disturbing the spatially and temporarily more extensive world outside.

Consistent with Potts' other writings, he discussed sculptural temporality in terms of a tension or dialectic in the experience of the viewer that belies the underlying stasis of sculptural form. The notion that sculpture is about existence in time as well as space is pertinent to its relation to the discontinuous and a-temporal realm of the digital.

> Why make sculpture? What does it do? What does it mean? No work will offer clear-cut answers to such questions, but if it merits serious attention, it must in some way sustain this asking – and must do so through having a distinctive raison d'être. The autonomy of the work's existence as a physical thing and the intricacies of its material make-up may at one level get in the way of its referential breadth and symbolic power. At the same time, such muteness opens up possibilities for seeing in it something more than motifs and forms to which we can assign meaning. […] If it is to mean anything at all, we have to be induced to take note of and pleasure

in it as a material phenomenon we apprehend primarily in sensory terms. […] What the sculpture comes to mean as we think about the ideas conjured up by its form and possibly its title has something gratuitous about it, as if in the end this is never quite what sculpture is really about. (Potts 2015: 31)

This extract was taken from the concluding paragraph of Alex Potts's recent essay, *The Persistence of Sculpture*, about the work of contemporary American sculptor Martin Puryear, who represented the US in the 1919 Venice Biennale. Sculpture worthy of attention, according to Potts, is critical through its particular purpose. It is more than a vehicle for symbolic meanings, which are unnecessary and not what sculpture is really about. For Potts, the essence of sculpture is "the autonomy of the work's existence as a physical thing and the intricacies of its material make-up". In the final analysis, a sculpture's distinctive purpose and criticality hinge primarily on the dynamics of a sensory encounter with a material phenomenon.

However, earlier in the text, Potts put the same point less polemically. "Associations should not be primary, and certainly they must not overpower a work's sculptural qualities. But the work should also bear testimony to the artist's purposes, which, if worth taking seriously, will have undercurrents that are not exclusively about making art". (Potts 2015: 31) In other words, a sculpture's self-legislating physical, material and sensorial qualities are primary, but it must also critically reflect concerns beyond itself. There is a conflict here between the requirement for sculpture to be a physical entity in its own right – evidenced by his emphasis on "autonomy" and "insistent presence" throughout the essay, but at the same time, "if it is worth taking seriously" it must also engage with the life-world. For Potts, sculpture is necessarily poised between autonomy and heteronomy, but the bias is definitely on the side of autonomy. Martin Puryear has couched his own practice in similar, though more reticent terms. "If I were forced to describe my work, I'd say I'm interested in making sculpture that tries to describe itself to the world, work that acknowledges its maker and that offers an experience that's probably more tactile and sensate than strictly cerebral." (Potts 2015: 31) And yet the cultural forms that inspired Puryear's sculptures – the phrygian (freedom) cap or the shackle for example – frequently underscored by his titles, or reinforced by the distinctly non-Western (specifically, West African) carpentry techniques, always remain legible to situate the work within a transnational, post-colonial discourse.

Potts's essay pays close attention to the significance of Puryear's "craft", which was inspired by observing Sierra Leone carpenters at work and by the artist's subsequent apprenticeship with a furniture maker in Sweden. Potts makes a leading suggestion about a causal relation between the mode of production and the mode of reception of contemporary sculpture. "The struggle to realise an object through Puryear's manner of working demands a different kind of viewing than the more instantaneous recognition elicited by more image-based work" (ibid). Potts is referring to the work of

contemporary sculptors like Katharina Fritsch, Jeff Koons and Charles Ray, who in Puryear's view are "focused mainly on capturing a resonant image that defines the sculpture" (Potts 2015 :29) This is precisely the critical distinction observed by Charlesworth at the *Frieze Sculpture Park 2019*, when he contrasted those works that "care about sculptural ideas" and "those that deliver their message like a jpeg". The crucial difference is the "kind of viewing" required from the viewer.

Fritsch, Koons and Ray are well known to employ digital technologies including 3D scanning and CAD machining, as well as laborious hand finishing to produce their sculptures. However, there is no reason to assume that they experience any less of a struggle to realise their objects – in fact descriptions of Ray's fabrication processes, for example, document drawn-out battles to resolve formal details through numerous iterations of generate-and-test. These accounts hint at a hands-on artistic virtuosity that Puryear deliberately avoids by designing his sculptures "a priori" before beginning construction. It is also the case, as Haidy Geismar has argued, that the technical labour of preparing and manipulating digital files is no less a specialist craft than the skilled labour of the welders and polishers who finish these high-budget sculptures.

Hence, if these so-called "image-based" sculptors utilise just as much 'craft' in their struggles to realise their objects, then it cannot be their "manner of working" that "demands a different kind of viewing". "Image-based" sculptors aren't alienated from their labour because they have assistants or use technology. Rather, it is the viewer who is immediately alienated from these image-objects. The sculptures of Fritsch, Koons and Ray don't "describe themselves to the world" because their surfaces have often been laboriously finished to efface their means of construction. This effacement of traces of fabrication is reminiscent of the museum technicians that Geismar described as self-consciously erasing their subjective authorship from digital surrogates. They haven't been under-crafted, but over-crafted, so that their homogenous surfaces render their materiality secret, like magic, so that it cannot be understood. The effect of this structural concealment is to foreground the image aspect of these sculptures, which of course represent other things. If they elicit immediate recognition, it is because they are highly naturalistic and precisely stylised figurative sculptures. If Puryear's sculptures elicit a different kind of viewing, then it is not because he uses traditional craft, nor because he crafted them himself, but because formally, they are more ambiguous. It is because they describe themselves more than they describe other things, their autonomy holds recognition in abeyance.

Poised between autonomy and heteronomy, but definitely inclined towards the former, the dialectic of Potts' sculptural imaginary could be seen as a zone of semi-autonomy. In this zone, sculpture channels its inner coherence not on any specific medium or historically determined novelty game, but on artistic materials and processes appropriated from the lifeworld. The semi-autonomous zone allows for work both within canonical thinking and against the grain of that thinking. The

difficulty with Fried's historicist argument for old modernist autonomy is its dependence on (or even subjugation to) the hierarchy of a singular western art history. Modernist aesthetics required what Bourdieu called "a field of restricted production" in order to perform its critical distance. Yet as curator Okwui Enwezor has remarked "In today's complex conditions, the legacy of the Western historical avant-garde seems inadequate to the job of producing a unified theory of contemporary art" (Enwezor 2008: 222) Enwezor's point is that the globalization of contemporary art demands decolonization, and in this climate, the status of the artwork cannot simply be restricted to a single imperial history. He suggests, instead, that we could arrive at "an understanding of the artwork as being produced and mobilized in a field of relations".

The notion of semi-autonomy might seem a contradiction in terms, but as Brown has made plain: "Pure autonomy would have no relation to the world and pure heteronomy would be indistinguishable from it." If sculpture that appears as a specific instance of post-conceptual art (what Wall calls pseudo-heteronomous art) is governed by its external concerns, sculptural works that evoke (but is not reducible to) heteronomous concerns, might propose a model of semi-autonomy. In this way, making sculpture is a form of investigating new tropes and concepts, whilst remaining radically self-legislating. As Enwezor put it in an interview following a meeting with a jury to decide the first Nasher Sculpture Prize Laureate:

> Sculpture has this capacity of absorbing everything that surrounds it. And that's what makes it so refreshing. That's what makes it so challenging. But at the same time it's what makes it very approachable in many ways. Even when you don't understand it, the attractiveness of sculpture is in its facility to be both open and at the same time mysterious. (Enwezor 2015)

Digital Sculpture

This chapter set out to problematize and question the central presuppositions of my thesis, the digital and the sculptural, in order to better understand their relationship. It transpires that this is not as straight forward as a dualism between analogue and digital or material and immaterial, but rather a complex interplay of contradictions: the digital is contradictory in its simultaneous generic abstraction and manifold concrete potential, while sculpture is contradictory in its interdependent autonomy and heteronomy. Critically, both sculpture and the digital exacerbate but also reveal those embodied contradictions. The inherent contradiction of digital media – the radical discontinuity between its virtual data and actualised copies produces anxiety and tension, not only because it undermines the indexicality assumed between original and copy, but also because this peculiar relationship resembles and intensifies the form of commodity exchange in high capitalism. On the other hand, the requirement for sculpture to retain aesthetic autonomy in order to generate meaning

as art produces tension with the pressing imperative to engage with the multiplicities of the globalised lifeworld and the inevitability of its commoditization. Potts demonstrated how sculpture's capacity to deploy its material particulars to impede the tendency towards reification. Osborne exposed how the structure of digital reproduction correlates with the structure of commodity exchange and how the anxiety or tension associated with each derives from the abstraction to number, which makes the movement of trans-mediation unclear. Geismar's account of digital surrogates revealed how digital replication in three-dimensions transforms this uncertainty into an outright fiction. Digital technologies have proliferated a vastly increased field of cultural forms, producing the *shallow* subjectivity and superficial distraction associated with the intensified background of consumerism. Jameson attributed these conditions to the inseparability of artwork and commodity in postmodernity. The transformation of information from virtual 1's and 0's into facsimiles of objects, images, audio recordings, books, movies, etcetera, has made the digital a constitutive concept for contemporary culture and society.

The central disjunction discussed above, therefore, is not between experiences of abstract codification and concrete experience. The question of materiality and affective experience will be addressed in the next chapter. Rather, this chapter has revealed the discrepancy between digital form (in its complicity with the commodity form) and sculptural form (in its need to invoke and suspend reification). Or, to put it another way, between the nonindexical gap of the digital form (the lack of necessary internal coherence between the found object and its reconstruction – the 'magical' fetish quality of the digital), and the autonomy of sculptural form (the requirement to articulate internal cohesion). The problem, for my practice-led research, is how to impart form to this dialectic; how to present the beholder with these two distinct worlds in a single sculpture; to incorporate both forms into a structure that frames their relation.

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2. Physical Information

The previous chapter established that very little, if anything qualitative, can be said about the digital per se and that to think of it qua technology we need to consider it in its specific use. Anthropologists like Heather Horst and Daniel Miller suggest that there is a parallel between the binary abstraction of the digital and the decimal abstraction of money that can be understood dialectically as a relation between universal abstraction and concrete particularity. As Peter Osborne has suggested, this implies that the homogeneous process of digitisation and the differential material production it generates reflects the commodity form under advanced capitalism, along with the alienation and anxiety it elicits. Any critical analysis of the digital or the sculptural therefore needs to at least consider ramifications within this common social context.

Focusing on the digital in the context of art, I examined the process of digital photography and then the generation of 3D digital models, and I found that both processes are marked by a radical discontinuity or indexical rupture at the moment of digital abstraction. Because the digital abstraction that marks this disjunction is both invisible and intractable, it figures one of the dominant ideas about the digital – its apparent *immateriality*. Meanwhile, anthropologists of material culture like Horst, Miller and Geismar suggest that the digital is as material as anything else. Chapter 2 begins by investigating this seeming contradiction by asking: what exactly is meant by digital materiality?

Having established that digital materiality exists, but tends to be displaced from the user interface, I then turn to the material presence of the sculptural. Starting from the conventional understanding that some material aspects of artworks matter whist others do not, I will look to contemporary 'thing theories' of Bill Brown and WJT Mitchell to explore the ways that material things can affect people and generate non-discursive meanings outside of the social (aesthetic and commercial) values we ascribe to them. Through a close reading of Lambros Malafouris and Jane Bennett, I consider notions of *enactive engagement* and *material agency* that exceed the communicative powers we normally associated with sculpture. However, experiencing 'things' in this way demands a suspension of our critical judgement. Without critical reflection we risk slipping back into formalism, so to keep this tendency in check I will end the chapter by considering the affinities and tensions between these object-oriented philosophies and Adorno's critical theory, with specific reference to his concept of non-identity and an attempt to think the preponderance of the object.

The trope of immateriality

The previous chapter considered arguments that the source of the anxiety and tension frequently associated with the digital corresponds to the moment of transformation from physical

signals into discrete binary units. I found that the binary data that constitutes a digital file has been described variously as divine, spectral and magical, due to its invisibility and intangibility on the one hand, and very real agency on the other. These phantasmagorical characterisations derive from the ironic language employed by Marx to indicate a failure to comprehend the commodity form. This moment of digital abstraction corresponds to the nonindexical gap of digital photography (Osborne 2010) that was seen to be an even more emphatic discontinuity with processes of 3D digital reproduction (Geismar 2018). At the same time, I showed that anthropology and material culture studies consistently argue that digital artefacts are no less material than any other kind of artefact (Horst & Miller 2012, Geismar 2018). There seems, then, to be a contradiction between a conception of pure information as 1's and 0's floating in immaterial space, and the material terms with which digital artefacts are frequently described. In art schools today, critical discourse is routinely based on concepts like 'sculptural materiality' and 'digital immateriality'. It would seem that a great deal hangs on understanding what is meant by *materiality* in relation to digital abstraction.

One can, of course, point to the obvious materiality of the tangible hardware infrastructure that supports digital media, including: minerals mined in Africa to make processors, the copper and fibre optic cables that constitute the network of the World Wide Web or the server farms in New Mexico and the Arctic that are the all too material foundation of the so-called 'cloud', as the writer and artist James Bridle makes explicit:

> The cloud is not weightless; it is not amorphous, or even invisible, if you know where to look for it. The cloud is not some magical faraway place, made of water vapour and radio waves, where everything just works. It is a physical infrastructure consisting of phone lines, fibre optics, satellites, cables on the ocean floor, and vast warehouses filled with computers, which consume huge amounts of water and energy and reside within national and legal jurisdictions. (Bridle 2018: 7)

However, whilst digital terminology such as "cloud" is misleading as it implies a weightless, amorphous, floating accumulation of vapour, this material substrate is displaced in other ways from our experience of using digital media so as to seem practically irrelevant. A physical analysis of the digital artefact doesn't get us much further:

> Digital objects appear to human users as colourful and visible beings. At a level of programming they are text files; further down the operating system they are binary coded; finally, at the level of circuit boards they are nothing but signals generated by the values of voltage and the operation of logic gates. How, then, can we think about the voltage differences as being the substance of the digital object? Searching downward we may end up with the mediation of silicon and metal. And finally, we could go into the particles and fields. But this kind of reduction doesn't tell us much about the world. (Hui 2012: 387, cited by Geismar 2018: 18)

Yet, however ambiguous and opaque the digital might seem, common sense suggests that information cannot exist outside of material forms. In his essay, *A Material History of Bits* (2011), the computer scientist Jean-Francois Blanchette argues that "bits cannot escape the material constraints of the physical devices that manipulate, store, and exchange them. Such an analysis reveals a surprising picture of computing as material process through and through" (Blanchette 2011: 1). He asks: "If digital information is not immaterial, in what ways is it material?" (Blanchette 2011: 5). Blanchette suggests that the promise of immateriality has been fundamental to the capability of the digital to usurp the analogue world. It is the reason why any media that can be digitised will eventually succumb to the logic of digital information and its electronic circulation. "The liberation of information from matter" was the basis of architect Nicholas Negroponte's influential book *Being Digital* (1995), reflected by his slogan "from atom to bits". Challenging this vision, Blanchette argues that "bits are necessarily both logical and material" and that "computing systems are suffused through and through with the constraints of their materiality." However, as we shall see, "computing infrastructure is tasked with relieving users from the specific constraints of the material resources of computation." (Blanchette 2011: 2) By focusing on the materiality of the digital, Blanchette draws attention to the fundamental fact that computation is a mechanical process based on the limited resources of processing power, storage and connectivity. Blanchette's analysis of the digital is focused on the "self-portrayal of the computing sciences as primarily concerned with the design of efficient abstractions". He identifies the core mechanism for abstracting, structuring and distributing the material resources of computation to be "modularity functions" at the cost of "efficiency trade-offs". Modularity is a strategy for designing the architecture of an artefact that determines the relationship of its function to its structure (Ulrich, 2007). The most efficient programs are custom designed to be function specific and have no capacity for generalised use. The more generalised the abstractions become, the greater the loss of efficiency. "This is because the specification of an abstraction (the interface) general enough to accommodate a wide range of implementations necessarily involves trade-offs, "between the freedom that the abstraction provides and the efficiency of possible implementation." (Agre 1997)" (Blanchette 2011: 10) There is therefore a dialectical relationship between abstraction from the material substrate and the efficiency trade-offs that this abstraction requires - accuracy versus capacity. What Blanchette highlights is that computing literature doesn't like to acknowledge the design trade-offs inherent in abstracting from physical resources. However, these material resources do bring characteristics to the performance of computational operations, including "susceptibility to interference, frequency of mechanical failure, relative lack of speed, resistance and attenuation, and of course cost" (Blanchette 2011: 11). In other words, the material

resources upon which digital abstraction is based introduce all sorts of interference and noise to digital processes.

How have the computer sciences been so successful in downplaying these "mechanical" issues? Blanchette finds the answer in digital theorist Matthew Kischenbaum's research: "All forms of modern digital technology incorporate hyper-redundant error checking routines that serve to sustain an illusion of immateriality by detecting error and correcting it, reviving the quality of the signal…" ((Kirschenbaum 12) Blanchette 2011: 11). In other words, digital media use error-correction codes, buffering and other techniques to disguise the entropic signs of their own materiality. As Blanchette puts it "It is this ability to ceaselessly clean up after its own noise that so powerfully enables computers to seemingly sever their dependency on physical processes that underlie processing, storage and connectivity." (Blanchette 2011: 11). But all this noise and interference can only be concealed or corrected at the cost of other resources, that is, trade-offs. So, although we rarely notice the intrusion of material factors, they invisibly set the efficiency limits of whatever program we are using. There are two opposing forces at play then: "On the one hand, the freedom provided by modular design and the resulting trade-offs; on the other hand, the primary drive of computing systems design, greater efficiency, as measured by "the amount of useful computational work that gets done in the service of specified goals by a given amount of machinery in a given amount of time." (Agre 1997) cited by Blanchette 2011: 12). Blanchette's essay reveals that the conflicting pressures of these two forces determine the evolution of the abstractions that link digital information to its material basis. This is a crucial insight because it demonstrates that digital immateriality (so far as tangible substance is concerned) is an illusion that can only be maintained through embedded self-effacement techniques. Rather than allow the intrinsic materiality underpinning its mechanisms to emerge, the digital industry conceals its material basis and the trade-off is efficiency. Ultimately, the illusion of immateriality is valued more than the cost of efficiency. We only really become aware of the efficiency thresholds when a process hits a "power wall" and the "physical limitations on the ability of transistors to dissipate heat efficiently (resulting in burning hot laptops!)" (Blanchette 2011: 14). Blanchette's analysis provides an account of the physical materiality behind computing that is at odds with the trope of immateriality. The magic of digital abstraction is revealed to be an illusion – smoke and mirrors – that obscures and displaces the material substrate from direct experience. Immateriality is seen to be an ideology of the digital.

Professor of Technology Management, Paul Leonardi, by contrast, approaches the question of digital materiality in management, communication and sociology by way of semantics. In his essay *Digital Materiality? How artefacts without matter, matter* (2010), Leonardi locates the difficulty in the common-sense association of the noun 'matter' with physical substance: "At first glance materiality

seems to imply tangibility." (Leonardi 2010: 3) The confusion is related to the dualism between physical and conceptual phenomena "The physical (obviously) can be touched while the conceptual cannot." (Leonadi 2010: 1-2) Because it lacks matter, the conceptual offers freedom of improvisation and re-creation that the physical does not. Like Blanchette, Leonardi recognises that software is characterised by its materiality and insists that the digital should not be confused with the conceptual. "Although it has no physical properties, software clearly does not exist in a conceptual domain because it provides hard constraints and affordances in much the same way as physical artefacts do. Indeed, many researchers suggest that software, intangible though it may be, can be described in terms of its materiality (Hutchby, 2001; Jackson, 1996; Leonardi, 2007; Orlikowski, 2007; Suchman, 2000; Volkoff, et al., 2007)" (Leonadi 2010: 1-2). Leonardi's point is that if materiality is defined simply as matter, then digital artefacts themselves cannot be said to have materiality. Accepting that the physical matter out of which objects are constructed is not all that important when defining materiality, Leonardi's strategy is to look at how scholars use the adjective 'material' when they refer to intangible artefacts like software and he begins by looking up alternative definitions in the OED. He settles on two particular applications of the adjective 'material': 1. Designating to the practical aspect of something as opposed to the theoretical aspect. 2. Having significance or relevance. A digital technology could be seen as "a practical instantiation of a theoretical idea" when it provides users with the capability to perform some action. Calling something material in such a way emphasizes its performativity. "Thus, when those researchers describe artefacts as having "material" properties, aspects or features, we might safely say that what makes them "material" is that they provide capabilities that afford or constrain action." (Leonardi 2010: 7) According to this definition then, an artefact's materiality depends on its ability to be useful, not whether it is physical or digital. In chapter 1, I argued that the digital has no character unless it is applied. Leonardi underscores this point by suggesting that an artefact is only 'material' when it translates an idea into action.

Leonardi's third definition of 'material' (after 'substantial' and 'practical') emphasises 'significance', in the sense that the law describes witnesses and facts as material when they are pertinent to the issue at hand. "In short, this definition suggests that something is "material" if it makes a difference to the current situation". (Leonardi 2010: 9). In this sense, a technology's materiality is contingent on context. In one situation an artefact's properties might have material significance and in other circumstance, not. The implication of Leonardi's argument is that while a line of binary code cannot be said to have materiality-in-substance, it could be said to have materiality-in-practice or material significance in context. However, what this line of argument suggests is that the materiality of digital artefacts does not refer to their inherent properties, but only to the way that they relate to people. "These alternative, relational definitions move materiality 'out of the artefact'

and into the space of interaction between people and artefacts. No matter whether those artefacts are physical or digital, their 'materiality' is determined, to a substantial degree, by when, how and why they are used. These definitions imply that materiality is not a property of artefacts, but a product of the relationships between artefacts and people who produce and consume them." "All this shifts the object of enquiry onto the subject – the 'social' specified and something that exists independently and prior to the physical." (Leonardi 2010: 7).

In summary, digital materiality can be understood in terms of concrete substance, but its tangible properties are displaced in the process of digital abstraction, which uses inbuilt error-correction codes to remove material interference from user experience. On the other hand, digital materiality can be considered in terms of its social function or relevance - as a matter of judgment. Digital objects, just like physical objects, are only material to the extent that they are useful or pertinent to people. From each standpoint, the digital artefact itself is not material but is an abstraction from physical substance on one hand and reduction to social judgement on the other. The digital artefact itself seems to exist in the realm of the excluded middle of the longstanding philosophical dualism between object and subject.

Addressing this problematic duality of subjects and objects, digital anthropologist, Daniel Miller bases his understanding of material culture on Hegel's dialectical theory of historical materialism. "In his *Phenomenology of Spirit*, Hegel (1977) suggests that there can be no fundamental separation between humanity and materiality – that everything that we are and do arises out of the reflection upon ourselves given by the mirror image of the process by which we create form and are created by this same process." The historical world is seen here as a material mirror that confronts us and evolves through us. Crucially, this mirroring process has the effect of making the things we have produced appear and become alien to us.

> We may not recognise our creations as those of history or ourselves. They may take on their own interest and trajectory. A social order, such as a hierarchy, may come to us as immutable and one that situates us as oppressed [. . .] But once we appreciate that these things are created in history or in imaginations, we can start to understand the very process which accounts for our own specificity, and this understanding changes us into a new kind of person, one who can potentially act upon that understanding." (Miller 2005: 8-9)

The process of objectification is dialectical in that we both produce and are the products of these historical processes. This philosophical understanding of materiality is clearly at odds with the common place usage conveying tangible things. From the standpoint of *material culture*, it is easy to see why the digital is considered as material. The digital artefacts that we produce have unquestionably transformed the world and us with it. At the same time, materiality here is over-determined by the social to the extent that material things are nothing beyond their

instrumentalisation: "There are no pre-objectified forms, and any romantic claims by, for example, art, primitivism, psychoanalysis, evolutionary psychology, or others that imply such a possibility can be safely rejected" (Miller 2005: 10).

Blanchette, Leonadi and Miller each make different arguments about the application of the term material, but they all make compelling cases for the materiality of digital artefacts. Between them, they seem to refute the possibility of calling anything immaterial. Both sculptures and digital objects can be seen to have materiality in that their particular material constraints and affordances determine their efficiency, social use and significance. The relation of the digital to the sculptural clearly cannot be reduced to the simplistic binary of material/immaterial or even concrete/abstract. However, returning once more to the phantasmatic moment of digital abstraction and its indexical leap between digital and physical, imperceptible and tangible, there is, at least, a category shift. The positivist division between idealist abstraction and empirical reality doesn't quite fit because we know that the binary code of a data file really exists, even if it cannot be directly perceived - it can be copied, stored, accessed and deleted. If angels, ghosts and illusions all figure the 'almost-there' status of the digital, then perhaps a more accurate descriptor than abstract is virtual, a term that shifts common sense notions of the real away from material.

The virtual

In his demystifying analysis, *The Virtual* (2003), sociologist and cultural theorist, Rob Shields begins his investigation of the virtual with the Oxford English Dictionary: "The basic dictionary definition of the virtual is 'anything that is so in essence . . . although not . . . actually' (OED) as in a task which is 'virtually complete'. A related term, 'virtue' suggests the intangible or latent quality of virtuality – there but not necessarily obvious to the senses." (Shields 2003: 16-17). He also considers historical forms of the virtual in social interaction, ranging from liminal rituals, rites of passage and the transubstantiation of the Christian Eucharist ("Actually real, material and blood, insisted the [Catholic] church. 'virtually real', argued Reformation theologians"), to "virtual images" such as mirror reflections, forced perspective and trompe-l'oeil. Shields argues that the virtual has long been a significant cultural category and that computer-mediated, digital virtuality is a new continuation of such processes that returns the virtual to our social activity.

Rather than contrasting the 'essentiality' of the virtual with a common-sense notion of the 'real', Shields argues that a better contrast opposes the virtual with the concrete, both of which are real. "The virtual is ideal but not abstract, real but not actual" (Shields 2003: 43). Crucially, this formulation distinguishes between the virtual and the abstract "The virtual is distinct not only from the concrete, but also from the abstract" (Shields 2003: 29). By tracing evolving conceptualisations of

the virtual through the philosophical genealogy of Proust–Bergson–Deleuze, Shields develops a schema for the relationships between virtual, concrete, abstract and probable that he presents in tabula form (Shields 2003: 29 Table 2.1):

	Real (existing)	Possible (not existing)
Ideal	virtual (ideally real)	abstract (possible ideal)
Actual	concrete present (actually real)	probable (actual possibility)

Shield's table is useful here, because it suggests a clear set of terms and relationships that correspond to my practical methodology. The virtual is a 'real idealization' such as a digital file, memory, dream or an intention, whereas the concrete is an 'actual real' such as a taken-for-granted thing, an actualized idea and anything that embodies memories or represents digital data. Symbols or code make abstractions present by giving them virtual form. Abstraction conceptualises the concrete present as a pure (non-existing) idealisation. The transformation between virtual and concrete (the indexical leap) is one of actualisation, and not realisation (as between index and copy).

> Realisation is the process of bringing the possible (abstract or the probable) into existence in a manner that resembles it. In contrast, the virtual is fully real but can be actualised as the concrete. For Deleuze, 'the actualisation breaks with resemblance as a process no less than it does with identity as a principle. Actual terms [the concrete] never resemble the [virtual] singularities they incarnate. In this sense, actualisation . . . is always a genuine creation' (Deleuze 1981: 125) (Shields 2003: 30)

Later in the passage that Shields cites here, Gilles Deleuze describes actualisation as a "dramatization" that enacts a simulation rather than copying an original (Deleuze 1981: 216-220). The indexical leap between virtual and actual is a "simulation" that is always mediated and is contingent on what Shields calls 'techniques of the virtual'. Techniques of the virtual include "props, simulations, partial presences [. . .] and rituals". Digital renderings or 3D prints, for example, create the illusion of presence by giving concrete form to virtual data. However, as anthropologist Haidy Geismar argues (cited above in Ch 1), "The medium of 3D printing is almost willed away through an interpretive sleight of hand that focuses on the magic of conjuring a solid artefact out of a supposedly immaterial image" (Geismar 2018: 108). This "willing away" or self-conscious illusion is what Shields refers to as

metaxis: "the operation of the imagination which connects the perceptual environment with the virtual and abstract world of meanings which over-code our perceptions" (Shields 2003: 39). The indexical rupture that Osborne identified in the process of digital photography is understood here as a space or distance between virtual and concrete – a liminal zone of imagination. Simulations (digital renderings) and props (3D prints), as well as representational conventions like perspective, support the virtual by giving it tangible presence. But they can only do this by aiding "metaxis, or the ability to imaginatively close up the gap between fiction and reality and between virtual and actual" (Shields 2003: 43). The subjective effacement of Geismar's museum technologists and the self-effacement of algorithmic auto-correction code, each play a decisive part in glossing over the intrinsically fictional dimension of digital techniques.

Recasting the moment of digital abstraction as 'virtual' moves it to a different register. Although it always involves abstraction, it is not merely an incomplete imitation of the real, or an encoding of concrete reality. "The virtual has its own autonomy from the concrete. As rendered by computer and network software and hardware, digital virtuality is dependent on the technology: fidelity, resolution, bandwidth [etcetera]" (Shields 2003: 69). Shield's analysis reveals the virtual to be both real and completely independent of the concrete. And at the same time, it is entirely dependent on the materiality of technology and human imagination. It is also worth noting that in practice, the *virtual*, *concrete*, *abstract* and *probable* are never isolated, but always woven together in everyday cognition and interaction - "Walter Henry in a trenchant analysis points out that "all communication involves the concrete (voice, inked letters), the virtual (coded meaning), the abstract (ideas), and the probable (author's intention) (Henry 2001)" (Shields 2003: 33)

Considered as virtual, the digital is real, but it remains displaced from its material substrate and exists outside of space and time. It cannot be encountered, only simulated. Digital simulations involve a kind of triangulation between binary code, materiality and imagination that is always creative or fictional. This illusion of presence accounts for the phantasmic terms with which the digital is frequently figured. The sculptural, on the other hand, depends directly upon a bodily encounter with tangible materials in space and time. We might say that what a sculptural object is, that a digital artefact is not, is a *thing*. So, I will now shift my focus to the particular ways in which the concrete presence of physical things can bring efficacy or agency through a direct bodily encounter. It's an enquiry that will consider an understanding of materialism that is antithetical to the sociological interpretations of material culture discussed above.

Art Things

The Art Critic Arthur Danto laid the groundwork for an institutional definition of twentieth Century art. Explaining his theory of "art after the end of art", Danto claimed that certain material elements of artworks matter, while others are immaterial to the artwork's meaning. "You can begin to divide the properties of the thing into those that belong to the work of art and those that just belong to the object." (Danto 2008) How does one identify the pertinent elements? As an example, Danto points to Malevich's famous *Black Square* (1915):

> If you look at the first black square of Malevich - it was on view in New York a couple of years ago in the Guggenheim – it looked like it was used in a window to keep the drafts out. It's all cracked and so forth and so on. What you know is the cracks are not part of the artwork. Whatever he was doing when he painted the first supremacist painting, those cracks have nothing to do with it. (Danto 2008: 1:07:25)

Malevich's painting obviously represents an abstraction. An idea embodied by the physical properties of the painting. But, according to Danto, not all its properties are part of the artwork, because they don't enter into its interpretation or meaning. In other words, they're surplus to the concept's structure of recognition. If we know which are which, it is because we understand the artwork's relation to the historical trajectory of Modernism. That's to say, our awareness doesn't actually derive from apprehension of the physical artwork in itself, but to the institutional conditions of its presentation.

However, as the quotidian terms of Danto's description make clear, there is a conflict between the painting's abstract idea and the all too concrete deterioration of its physical surface, which brings it back down to earth. This conflict could be interpreted as either a failure (desublimation) of its abstract aspirations, or as the inevitable (but unintended) traces of a conceptual gesture's contingent afterlife. Considered from the standpoint of Potts's sculptural imaginary, we might interpret the visible traces of entropy as a pertinent block to reification, because they expose that concept and thing are not identical. It may not have been Malevich's intention, but this tension between abstract idea and material fact, is unavoidable when viewing the work now. It might seem tenuous to judge a painting in sculptural terms, but it is worth remembering that Malevich famously installed this painting high across the corner of a room as if it were an orthodox Russian icon. His self-conscious gesture invoked the dualism of transubstantiation, wherein a tangible object is simultaneously understood to be sacred and profane, concrete and abstract. Religious icons might represent the Holy Spirit, but their affective charge frequently derives from their earthly and contingent details. Is this really so different from a sculpture that is at once Venus (whatever that is) and also a lump of hewn stone? Malevich's unconventional presentation set up an encounter with his

painting as both abstract idea and concrete thing. The cracks in the surface of the painting are the spatio-temporal effects of time; unstable materials and contingent events. They remind us that there are always other forces at play; non-human agencies that undermine objectification. They might not have been part of Malevich's original concept, but I wonder if he wouldn't have recognised the wear-and-tear as akin to the discoloration of orthodox icons whose surfaces gradually deteriorate in dusty corners. What Danto's account brings into focus is that the substantial damage to Malevich's painting revealed a material aspect of the art object that had previously remained unnoticed, beneath the radar of artistic discourse. Perhaps these material qualities that exceed the object's art identity could be thought of as the object's 'thingness'.

In his seminal essay *Thing Theory* (2001), critical theorist Bill Brown describes the distinction between object and thing by figuring objects as transparent and things as opaque: "We look through objects because they are codes by which our interpretive attention makes them meaningful, because there is a discourse of objectivity that allows us to use them as facts. A thing, in contrast, can hardly function as a window. We begin to confront the thingness of objects when they stop working for us …" (Brown, 2001: 4) Objects, therefore are determined by their historical, social, natural, or cultural functions. Objects become things when they lose these functions or meanings; when they become merely other. "The story of objects asserting themselves as things, then, is the story of a changed relation to the human subject and thus the story of how the thing really names less an object than a particular subject-object relation." (Brown, 2001: 4) There is something ambiguous about a thing that can be glimpsed, but not known, physically encountered, but not quite apprehended. Brown imagines the thing, on the one hand, as the "amorphousness out of which objects are materialised by the (ap)perceiving subject" and also as "what exceeds their materialisation as objects". The thing is seen both as the raw matter of the not-yet-formed object and as what remains physically in excess of the object. Brown is careful to note that this before-and-after characterisation implies a temporality that obscures the simultaneity of what he calls the object/thing dialectic (Brown, 2001: 5).

Critical theorist, WJT Mitchell's account of the dialectic between objects and things echoes Brown's notion that things suggest the latency or excess of objects: "brute materiality awaiting organisation by a system of objects", or else "the detritus and waste when an object becomes useless, obsolete, extinct". Notably, in Mitchell's characterisation, the material thing assumes a more animated and unpredictable role where "matter seems to matter in a newly vivid and urgent way" (Mitchell, 2005: 153). Things themselves "have a habit of breaking out of the circuit, shattering the matrix of virtual objects and imaginary objectives". The thing is "invisible, blurry, or illegible" and cannot be perceived or represented, but appears as a nameless figure of the real. "When it takes on a single, recognisable face, a stable image it becomes an object" and, conversely, "when the object

becomes Other . . . when the subject experiences the object as uncanny" signals the moment when it becomes thing. Objects are therefore stable, whereas things are unstable and emerge to human apprehension as moments of "uncertainty" and "ambivalence" experienced as uncanny.

Both Brown and Mitchell were writing at a time when the dominance of linguistic or discursive theory was becoming challenged by what has become known as the 'objective turn'. They both speculated that the revival of interest in objects and things may have something to do with a response to the digital: "if the topic of things attained a new urgency in the closing decades of that century, this may have been a response to the digitization of our world" (Brown, 2001:16); "The age of disembodied, immaterial virtuality and cyberspace is upon us, and therefore we are compelled to think about material objects" (Mitchell, 2005: 149). Is this revived interest in material things merely a symptom of the anxiety and tension caused by displacing incomprehension of the commodity form onto digital processes, as Peter Osborne has suggested? (see above in chapter 1). Or, does it reflect the loss of a particular mode of experience produced through direct contact with material things?

In order to address the latter question, I will turn to two non-representational materialist theories that are very much concerned with the ways in which substantial things directly produce effects on humans. By doing so I seek to explore how concrete sculptural objects could generate meaning at a non-discursive level, outside of human projection. In particular, I will look to two essays that specifically address the moments of latent and excessive materiality - before and after the objectification - in which both Brown and Mitchell glimpsed the thingness of things. Firstly, cognitive archaeologist, Lambros Malafouris's study of the creative agency of 'raw' matter in the process of its shaping what he calls 'creative *thinging'* (2014), and secondly, philosopher and political theorist, Jane Bennett's reflection of the affective power of damaged and written-off artworks that have lost their cultural identity in *Encounters with an Art-Thing* (2014). As I will show, the theories of Malafouris and Bennett share many points of agreement, but they are subtly different projects – Malafouris is primarily concerned with a corrective rethinking of the nature of human cognition, whilst Bennett's more sentient (poetic) approach has a political and ethical agenda. Mindful of the risk of inadvertent mission-creep into retrograde formalism, I will critically reflect on the ramifications of these two theories with recourse to Adorno's negative dialectics.

Creative *thinging*

Lambros Malafouris's essay 'Creative *thinging'* aims to draw attention to the kind of 'cognitive life' instantiated by acts of thinking and feeling with, through and about things. The foundation of creative *thinging* is its challenge to the dominant understanding of human cognition as a representational logic – "the metaphor of the mind as a computer" (Malafouris 2014: 141). This

characterisation of conceptual representation or cognitivism as computational has obvious implications for my thesis and Malafouris has elaborated on it elsewhere in relation to Material Engagement Theory (MET):

> Grounded on the premises of this broad representational thesis, cognitivism, or the so-called computational view of mind, emerged during the 1960s as an attempt to redefine human conceptual architecture in the image of the digital computer, which was developing rapidly at the time (Gardener 1985; Depuy 2000). A powerful metaphor was spreading rapidly: that the mind is to the brain as a computer program is to the hardware of the computer on which it runs. (Malafouris, 2013: 26)

Malafouris argues that the dominant paradigm of present-day cognitive science conceives cognition according to the model of a computer program and not the other way around, as one might imagine. Representation is seen as a disembodied mechanism by which information from the world is 'inputted' to brains to be 'processed', before being 'outputted' back into the world. Clearly this mechanistic separation of brain and world implies corresponding distinctions between mind and matter, subject and object. For the purposes of my thesis, it is pertinent that the paradigm against which Malafouris's emphatically opposes MET is that of the digital processes constitutive of computing: "we should resist or bypass our modern representational or computational preoccupations and allow a truly meaningful sense of how the material world constitutes our existence as human beings to emerge." (Malafouris 2013: 87). Malafouris aims to move beyond the limits of computation and the legacy of representation by understanding the material world as a constitutive part of the human cognitive system. He cites Edwin Hutchins in order to summarise his approach:

> A good deal of contemporary thinking, and probably an even greater proportion of ancient thinking, happens in interaction of brain and body with the world. This seems innocent enough and many people take it to mean simply that thinking is something that happens in the brain as a consequence of interaction with the world. That is not the claim being made here. The claim here is that, first and foremost, thinking is interactions of brain and body with the world. Those interactions are not evidence of, or reflections of, underlying thought processes. They are instead the thinking processes themselves. (Hutchins 2008, 2112)

MET involves three core hypothetical concepts: extended mind, enactive signification and material agency. Extended mind explores the intertwining of cognition with material culture by asserting the primacy of bodily experience in the structuring of human conceptual processes. "A cognitive process is not simply what happens inside the brain; a cognitive process can be what happens in the interaction between brain and thing" (Malafouris 2014: 67). Enactive signification shifts the focus of enquiry from what a sign means to how it means. "Things act most powerfully at the non-discursive level", because the physical properties of the medium of representation such as

colour and texture affect human cognition. "The material sign instantiates rather than symbolizes. It brings forth the concept as a concrete exemplar and a substantiating instance" (Malafouris 2013: 97). A material sign can therefore be seen to operate simultaneously as a signifier and a signified. It can be used both as something in itself and as a representation of something other than itself. Most object-oriented philosophies involve some notion of material agency, although they vary in definition. Malafouris's approach to agency is unusual in that he does not claim that things, or people, possess agency. "Agency and intentionality may not be innate properties of things, but they are not the innate properties of humans either; they are the emergent properties of material engagement" (Malafouris 2013: 149).

To illustrate the entanglement of thinking and working with materials in creative *thinging*, Malafouris provides the example of a potter working with clay. "One differentiating feature of feeling of and for clay is that it demands a great deal of improvisation in discovering the relevant affordances and becoming attuned to the forces of matter and form-generating skills, but no obsession with novelty." (Malafouris 2014: 149). Immediately we can see that this is an altogether different exercise from learning by rote the fixed pre-coded rules of a computer program. Malafouris outlines what he sees as two major forms of material consciousness that are especially pertinent to creative *thinging*: The first form of material consciousness is material agency. What is distinctive about Malfouris's version of material agency is that it is reciprocal and emerges through the dynamical, unstable nature of the creative process. The "perceived agentive and animate quality of clay" is not an illusion, but the "dynamical product of the participatory interaction between the potter and the clay" (Malafouris 2014: 150). According to Malafouris the process involves bodily fine-tuning, memory and affordance-responsiveness that results in the mutual incorporation of maker and material. This common intercorporality is likened to human social encounters where people unconsciously coordinate their movements, posture, speed or intonations to coordinate their sense-making. Malafouris suggests that this action gains a life of its own through the coupling of human and material agency.

The second form of material consciousness at play is creativity by submission. By this term, Malafouris seeks to highlight the way in which a potter follows the material, and at the same time the clay yields to the potter. Creativity is seen here as a temporal unfolding in which the negotiations between fingers and material oscillate in a "dialectic of agency and patiency". The terms agent and patient are borrowed from anthropologist Alfred Gell who held that agency is neither a property of non-human objects or humans, but rather a role assumed by each alternately as they act upon one another. Whereas Gell retained a hierarchy between humans and things in terms of primary and secondary actors, Malafouris insists on a total symmetry between actors (borrowed from Bruno Latour's Actor Network Theory). But the crucial insight that Malafouris elicits from the apparent give-

and-take between potter and clay is that: "Agency is the emergent product of action and not its cause" (2014: 154). This is the crux of Malafouris's challenge to the problem *hylomorphism* - the imposition of abstract form on inert matter or the transcription of pre-existent form realised in some abstract domain to the material domain of the physical world. By asserting a *hylonoetic* [3] view of creativity, Malafouris suggests that creativity is a process of enactive discovery and material engagement in which mind and matter are one, and thus the processes of forming are as much physical as they are mental.

The argument that Malafouris puts forward for Creative *thinging* is that creativity does not emerge from a computational or *hylomorphic* process, but through the dynamic interaction between maker and matter that constitutes a *hylonoetic* process. His argument hinges on the primacy of material engagement, from which creative agency emerges. Creative *thinging* has important implications for conventional notions of authorship and causality. "Who or what is responsible for the performance of the creative encounter by which an amorphous mass of clay is transformed into something new, like the form of a vase" (2014: 152). In a process described as "a dynamic flow between organic and inorganic" in which it is "the flow of this rhythmic covariation of gestures that drives the creative process forward" (2014: 153) any purity of human authorship seems to be lost. Malafouris's theory of Creative *thinging* is pertinent to my thesis because it explicitly contrasts the algorithmic, problem-solving model of digital computation (albeit as a metaphor for cognitivism, or conceptual representation) with the sensuous and dynamic processes of material engagement. However, there are a number of anomalies and inconsistencies in the argument that need to be considered before accepting his thesis as pertinent to this research. One problem with his account of the potter's creative process of working with the vibrant matter of clay is the complete omission of any mention the potter's wheel. It is one thing to claim that "the flow of this rhythmic covariation of gestures that drives the creative process forward", but surely what is actually (literally) driving the process is the wheel. It's strange that a discussion of agency should overlook the machine central to this creative process. Stanger still, a whole chapter in his earlier book *How Things Shape the Mind* (2013), entitled "Becoming One with Clay" is replete with illustrations of potter's wheels and the sub-heading "At the potter's wheel", and yet Malafouris makes no reference to the wheel within his analysis. To speak of a "temporally unfolding" "dynamic flow" without considering that agency of a spinning wheel is quite an oversight. On a potter's wheel, it is largely the rotation and centrifugal force that cause the clay to press back against the potter's fingers, and it is unquestionably the wheel's circular motion that determines the generic shape of a pot – you cannot throw a square pot on a wheel. If not a third agent, the wheel is at least a catalyst for the potter and clay's alternate agency and patiency. This omission does not necessarily undermine the thrust of Malafouris's

argument, because most of his points would still apply, perhaps even more pointedly, were he to enter a comparative discussion of the manual assembly of a coiled pot, whereby the final form would not be mechanistically predetermined. However, Malafouris would have to concede that the process under analysis would be somewhat less "dynamical".

Another difficulty is Malafouris's insistence on symmetrical relations between potter and clay. His crucial point is that the final form is not (cannot be) known in advance. This is because the human/matter entanglement of material engagement is very much contingent on the material consistency of the clay, varied by the temperature and humidity of the room, maybe the temperature of the water and the speed of the wheel, and perhaps what the potter ate for breakfast. But given that a clay pot is one of the most archetypal forms in the history of human creativity, can we really discount a degree of historical determination in the intentionality of the potter? Whenever I have thrown a pot, I have had a pretty good idea of what I have been shooting for, but I have never felt that the clay had any conscious ambition. Even if one were to concede that there is no difference in kind of agency between hand and clay, surely there is a difference of degree. The concept of subjective agency seems to have been appropriated and then somewhat reduced in its application to material. Nevertheless, as every potter knows, the shape held in mind is not necessarily the shape arrived at through 'enactive engagement' and very often an attempt needs to be aborted due to material recalcitrance. While the broad schema may be preconceived, the eventual form is always the dynamic result of a reciprocal negotiation between potter and clay, alternating in their roles as agent and patient. It is this divergence through material engagement that is useful for my research because it underscores how materials themselves co-author forms of material creativity.

Thing Power

In her essay, *Encounters with an Art-Thing* (2014), Jane Bennett applies the insights of her earlier book, *Vibrant Matter* (2010), to certain objects acquired by the Salvage Art Institute [4] namely, broken or otherwise damaged artworks officially no longer in cultural or commercial circulation. It's an enquiry especially pertinent to my thesis because she tries to hone in on the thing-power that emerges from damage, because it exceeds the auratic, artistic or commodity functions normally established within whole art objects. It's an affirmative project openly pitched against the dominant theories of material culture – "But it seemed to me that the normal (social) constructivist, Marxist, historicist) ways of acknowledging the presence of (human) culture, politics, and economics in the artwork had its limits. It tended, for example, to blunt our ability to detect that extra something provided by the presence and posture of the thing, that affecting oomph issuing from its shapes, colours, textures, material composition – from the way it inhabits space" (2014: 3). In other words,

Bennett argues for an approach to thing-power that is perceptual rather than (only) conceptual. She is mindful that this could be construed as a reversion to formalism. "While I did seek to adjust the distribution of attention more toward the thing than our constructions of it, 'formalism' was not really the point". But for Bennett the elision of cultural criticism is necessary in order to reveal the thing-power of damaged artworks. "The idea was to start with the assumption that material bodies, both human and nonhuman, produce material effects in excess of the symbolic ones they also bear" (2014: 4). So, it seems that to become attentive to thing-power, there is a requirement to overlook human instrumentalisation and suspend interpretation or critical thought. But what could be achieved from suspending thought to privilege feeling, other than the aesthetic pseudo-practice of formalism? Bennett's answer is counterintuitive:

> What I'm calling for, then, is the endeavour to sound some minor chords in our thinking and sensibility: to approach the archive of damaged art with attentiveness to the ways things act upon and change us (while also, of course, being affected by our acts of discussion, exhibition, etc) and to the ways in which the human mind-body is susceptible to the affections endeavoured by things. These affections are transfers of energy from one site to another, and insofar as one of the effects of this process can be the emergence of "meaning", these transports of affections might also qualify as a kind of semiosis. (Bennett 2014: 6)

There is a resonance here with Malafouris's notions of how enactive signification and material agency affect human cognition. However, Bennett's account shifts the emphasis away from thinking subjects towards feeling bodily objects. Instead of agency emerging from co-constitution of situated action, "energy" is transferred between human and thing (and visa versa) in a meaningful way. Just as we humans strive to affect things, Bennett suggests, things also try to affect us. In order to understand this process better, I will examine the example Bennett offers, by way of her reading of artist Elka Krajewska's account of an encounter with one of these "demoted artworks":

> When I arrived at an art conservation studio and saw 'the corpse': smears and clumps of chocolate stuck to its plexibox container and irregularly broken pieces accumulated at the bottom edge I thought I could simply take it. I was thrilled by its useless, demoted state, its orphan stance, its loss of ambition and almost erotic, glaring nakedness. But soon I found out I could not take it, and that though worthless it now belonged to the insurance company who as its new owner had the right to its future." (Krajewska 2011, cited by Bennett 2014: 12)

From this brief account, Bennett hones in on the energy transfer of a "thrill passing between bodies". In her ensuing analysis, she explores the anthropomorphic language used by Krajewska, which she argues "has the effect of sharpening our capacity to detect the presence and powers of materials" (2014: 12). Anthropomorhism is seen as a bridge between self and object that can reveal parallels between natural and cultural material forms. So as to unpack this "circuit of pathos", Bennett clarifies how she understands a thing to differ from an object. The crucial thing about the

object of Krajewska's encounter is its recent change of status or "demotion". Damage exposes it to judgement in relation to a standard and in that sense, it becomes demoted. However, Bennett suggests that when demotion goes so far that the object is a "total loss", it becomes released from judgement and becomes a thing. As a thing it acquires a new "capacity to affect and be affected" (2014: 13). So, for Bennett, the object becomes a thing when it has lost its cultural projections, its concepts and criticality. Only then do "we now become more sensitive to real forces that previously operated below the threshold of reflective attention" ((2014: 14). It seems significant, however, that the object did once possess cultural value to be lost, because this loss is what prompted Krajewska's scrutiny and sympathetic attention - we are still discussing a demoted artwork rather than any old piece of rubbish. This double identity corresponds to Malafouris's notion that a material sign can simultaneously signify itself and something else. While Bennett explicitly argues for a suspension of criticality, she invests much in the "irregular, broken, useless, demoted, orphaned, ambitionless, naked, and worthless "corpse". The thing is the reverse image of normal subjectivity in entrepreneurial America…" (Bennett 2014: 14). It's almost as though it represents a critique – both affecting thing and critical image. It begs the question of whether art objects can only become affecting things when they are demoted and broken (or conversely, as they emerge from amorphous matter, as with Malafouris), or to what extent they could be simultaneously materially affecting and conceptually critical.

> In the face of the artwork, we can become temporarily relieved of the burden of normal subjectivity, of the strenuous effort and bent-back posture of the autonomous agent, we can relax into and inhabit more fully the homely shape of thinghood. This is part of the thrill of aesthetic experience, an affect that may become intensified as the art-object approaches full demotion. (Bennett 2014: 15)

It seems that for Bennett, the aesthetic experience of thinghood can be experienced in an artwork, but that this experience paradoxically intensifies as the artwork is demoted. However, by this account the intensification increases in inverse proportion to the critical judgement applied to it. Bennett alternates between analysing a particular substantive thing – the "corpse" (whatever that actually is) – and her general concept of thingness, which "can manifest as a recalcitrant or headstrong materiality that both enables and chafes against, overflows, or even breaks the mould of subjectivity" (Bennett 2014: 15). Thingness is ambivalent in that it can both yield to and resist instrumentalization. Whether it is experienced positively as a "thrill" or negatively as "uncanny" seems to depend more on the particulars of the material substrate itself. Either way, through subjective identification with the thing's "take me or leave me" shrug, Krajewska has encountered, according to Bennett, her own latent thinghood. "The thrill may also involve something like

recognition. By this I mean an uncanny feeling of being in the presence of an aspect of oneself that is located in the body of another, or the acknowledgement of a kinship between bodies conventionally said to be unrelated" (Bennett 2014: 16).

In Bennett's interpretation, the affective currents coursing between person and thing expose the thingness in the human – "the animistic presence of an 'it' internal to the 'I'" (Bennett 2014: 17). The damaged or demoted object, having shed its cultural meanings, allows a glimpse of thing-power. But this isn't a meaningless experience, because a self-awareness of thingness activates the body's sensory capacities to detect material agency, which, for Bennett, has ethical and political implications. When the physical presence of an external thing and a subject's internal thingness resonate, the subject's experience of what it is to be human is altered and recomposed.

The Uncanny

Both Mitchell and Bennett both identify thingness with an experience of *the uncanny*. An uncanny feeling is therefore posited as a general symptom of thing-power - the psychological and physical effect of material agency on people. This generalisation – the uncanny as a symptom of material agency emanating as an affective current from inanimate things – implies that it is an objective phenomenon. For Austrian neurologist and the founder of psychoanalysis Sigmund Freud, however, the uncanny was an entirely subjective phenomenon of subconscious projection. "It may be true that the uncanny is nothing else than the hidden, familiar thing that has undergone repression and then emerged from it" (Freud 1929), cited by Kelley 1993: 1). This raises the question whether we can really attribute uncanniness to some (normally withdrawn) quality of objects or artworks, or rather whether it is the projection or reflection of subjective (subconscious) desires and fears. In his famous essay *Playing with Dead Things: On the Uncanny* (1993), the late artist Mike Kelley introduced the phenomenon in a way that corresponds closely to Bennett's analysis, but in highly subjective terms:

> The uncanny is apprehended as a physical sensation, like the one I have always associated with an "art" experience – especially when we interact with an object or film. This sensation is tied to the act of remembering. I can still recall, as everyone can, certain strong, uncanny, aesthetic experiences I had as a child. Such past feelings (which recur even now in my recollection of them) seem to have been provoked by disturbing, unrecallable memories. They were provoked by a confrontation between "me" and an "it" that was highly charged, so much so that "me" and "it" became confused.
> (Kelley 1993: 1)

According to Freud, the uncanny is located in doubts about "whether an apparently animate being is really alive; or conversely, whether a lifeless object might not in fact be animate". Kelley

elaborates that the uncanny manifests itself physically through goose bumps and spine tingling as well as feelings of déjà vu, "creepiness" or "weirdness". The effects are certainly real, but the cause is profoundly subjective: "All of these things are provoked by an object that has a life of its own that is somehow dependent on you, and is intimately connected in some secret manner to your life" (Kelley 1993: 1). Understood in these terms, the uncanny relates to a resurfacing of individual memory and in that respect has something in common with Proust's celebrated notion of involuntary memory.

Kelley's essay is useful here because as a corollary to his famous exhibition of figurative sculpture and other objects *The Uncanny* (1992), it explores specific instances of the uncanny in relation to sculptural objects, and reveals pertinent insights about how certain formal tensions within artworks can elicit feelings of the uncanny precisely through a juxtaposition of the generic with the particular. For example, Kelley suggests that the "shift from the general, or should I say "essential", to the specific is quite disturbing" (Kelley 1993: 6). To illustrate this, Kelley offers a number of diverse examples. In Degas' *Little Dancer Aged Fourteen* (1878-1881) the uncanny emerges through the mix of sculptural convention and literalness "It truly looks like a sculpture that has been dressed in children's clothes" (Kelley 1996: 7). Kelley identifies a similar tension between the "standard, store-bought, nude male mannequin" and its "superrealist cast of male genitals" in Charles Ray's *Male Mannequin* (1990). "The realism of the genitals throws the stylization of the mannequin into question" (Kelley 1993: 21). In works by Bruce Nauman and Jasper Johns, Kelley observes "it is the tactile quality of the material that supersedes the calming effect of monochrome". Here the tension is between the "Platonism of modernism, as signified by monochrome coloration, and an unsettling sensation of the "real" – manifested especially through the evocation of self-conscious body awareness" (Kelley 1993: 10). In all these works it is the conflict between stylisation and naturalism, catalysed by bodily self-awareness that causes intellectual uncertainty and the feeling of the uncanny. Kelley's insights are pertinent here because they suggest that the tension between (social) object and thing-in-itself, between representation and presentation, when encountered physically, can produce an uncanny effect. Note that it is not the 'thing' that causes the uncanny, but the juxtaposition of thing and object – their non-identity.

Kelley takes a different tack in his interpretation of the readymade as a double. Contra Jeff Wall's claims that the readymades were, de facto, non-depictive (See chapter 1), he describes Duchamp's readymades as mimetic self-depictions – "he sculpts an object in its true material". Simultaneously real objects and an absurd reduction of modernist self-referentiality, "they refuse to stay themselves and become their own doppelgangers." For Kelley, this dual existence as material thing and dematerialised art object introduces a temporal dimension that problematizes their presentation as sculptural still-life: "one wonders *when* they are real objects, and *when* they are an

illusion" (Kelley 1993: 14). Here the tension between art and thing is superimposed so it can only oscillate within the temporal experience of the viewer.

All these sculptural examples of the uncanny suggest that the uncanny isn't necessarily restricted to an individual's personal repressed memories, but perhaps to a collective imaginary and that it can be invoked by a tension between the ideal the real. However, Kelley concludes his essay by reframing the uncanny in Freudian terms again. "It is the unfamiliar familiar, the conventional made suspect. This once-familiar thing is the infantile primary narcissism that holds sway in the mind of the child and is still harboured unconsciously in the adult. The narcissistic personality projects its thoughts onto others; others are its double. The alien self can be substituted for its own, by *doubling, dividing, and interchanging itself*" [my emphasis] (Kelley 1993: 21). According to Kelley's interpretation of Freud, the uncanny is as much an effect of unconscious projection as of the material agency of the object that lends itself to it. "When something happens to us in the "real" world that seems to support our old, discarded psychic world, we get the feeling of the uncanny" (Kelley 1993: 22). In a strange way then, the uncanny could be understood as simultaneously an actual effect of thing-power, and a mirror effect of the social; both substantial *and* relational.

Enchantment and disenchantment

The influential post war philosopher Theodor W. Adorno developed his critical social theory of culture by developing Marx's critique of the commodity fetish and a dialectic derived from Hegelian materialism. In contrast to Bennett's recent positivist approach, Adorno's critical turn towards the object negated the notion that the subject can fully identify with the object using concepts. He described the object as 'non-identical' with its conceptual identifications and by revealing this non-identity he sought to expose social hegemonies. Bennett explicitly identifies her notion of thing-power with Adorno's concept of non-identity, but clearly, they approach the issue from different standpoints – Bennett seeking to kindle attentiveness to the sensuous *enchantment* of 'thing-power' and Adorno seeking to foster *disenchantment* through an intellectual experience of 'non-identity' that uses concepts to go beyond the concept. They both move away from anthropocentrism, but they disagree firmly on our capacity to experience the withdrawn aspect of objects and things directly. It is therefore revealing that Adorno also made a reference to Freud in order to point to the non-identity that constitutes the object's preponderance. He highlights the attention Freud paid to "the dross, the 'dregs of the phenomenal world', to otherwise neglected phenomena" (Adorno 2008: 69). For Adorno the non-conceptual itself is mediated by concepts in a negative sense, such as the neglected and excluded, because they are repressed. Often what is excluded by the concept is "what has been repressed in certain objects by the general consciousness" and therefore remains unobserved and

deemed undeserving of scrutiny. (Adorno 2008: 70). We see then a close correlation between Bennett's decision to write about artworks that can no longer be considered as art or commodities (the dross or dregs of art) and her identification of thing-power via the affective charge of the uncanny, and Adorno's suggestion that the non-conceptual (the object's non-identity with its concept) as what has been excluded by societal repression. Both Adorno and Bennett are seeking that withdrawn aspect of things that are neither commodity nor cultural artefact. For Bennett, *feeling* this requires a suspension of critique and for Adorno *thinking* it demands a doubling down of critique through self-reflection. Since Bennett is explicit about this critical conflict, I want to consider her argument against Adorno, before reconsidering Bennett's position from the standpoint of Adorno's critical theory.

In her book *Vibrant Matter* (2010), Bennett argues that the historical materialist project of demystification "tends to screen from view the vitality of matter and to reduce political agency to human agency." If we are to connect with non-human agency we need to drop our guard. "The capacity to detect the presence of impersonal affect requires that one is caught up in it. One needs, at least for a while, to suspend suspicion and adopt a more open-ended comportment." (Bennett 2010 XV). Whereas Malafouris directs his attention to the relational possibilities of enactive engagement, Bennett's approach is to focus "less on the relational capacities resulting from affective catalysts and focus more on the catalyst itself" (Malafouris 2010: xi). She explains that her project was inspired by a chance encounter with five objects in the grate of a storm drain in Baltimore: a glove, a mat of pollen, a dead rat, a bottle cap and a stick of wood. "As I encountered these items, they shimmied back and forth between debris and thing – between, on the one hand, stuff to ignore, except insofar as it beckoned human activity (…) and, on the other hand, stuff that commanded attention in its own right, as existents in excess of their association with human meanings, habits or projects" (Bennett 2010: 4). Immediately she identifies the quality that "commanded attention" to be "in excess" of their identity as cultural objects. Adorno would call this quality their non-identity. However, for Adorno, non-identity cannot be known, experienced or sensed. Bennett attributes her ability to experience the appearance of objects as things to "a certain anticipatory readiness" and by a "perceptual style open to the appearance of thing-power" (Bennett 2010: 5). Adorno refers to something very much along the lines of "a certain anticipatory readiness" when he cautions that "what these things mean cannot be anticipated . . . However, if you have a theory like Freud's, and a well-formed theory of repression, you will be able to see in advance that such apparently lifeless, obscure objects may contain something of interest that has been pulled out of shape." (Adorno 2008: 69). He could be speaking of Bennett's encounter at the storm drain, or Krajewska's encounter with "the corpse".

When Bennett explains that thing-power "gestures toward the strange ability of ordinary, man-made items to exceed their status as objects and to manifest traces of independence or aliveness, constituting the outside of our own experience" (Bennett 2010: xvi), Adorno, following Freud, identifies the "outside of our own experience" with what is repressed by consciousness; what is withdrawn from conceptualisation. Bennett acknowledges that, for Adorno, the gap between concept and reality, or object and thing, is ineradicable: "the most that can be said with confidence about the thing is that it eludes capture by the concept, that there is always "non-identity" between it and any representation" (Bennett 2010: 13). However, she points out that even Adorno sought ways to access this out-side. She quotes from his Negative Dialectics "what we may call a thing itself is not positively and immediately at hand, he who wants to know it must think more, not less". While Adorno rejected direct sensuous apprehension, he doesn't reject intellectual experience. There are many affinities between Adorno's non-identity and Bennett's thing-power. Bennett points out that Adorno describes non-identity as a force that acts upon us: "we knowers are haunted, he says, by a painful nagging feeling that something's been forgotten or left out" (Bennett 2010: 14). Again, this suggests Freud's notion of the uncanny as "the hidden, familiar thing that has undergone repression". Bennett argues that it is precisely this "discomforting experience" that Adorno sets out to accentuate and ascribe meaning with his negative dialectics.

Adorno's ethical project alerts us that "objects do not go into their concepts without leaving a remainder". The practice of negative dialectics, Bennett suggests, reminds us that life always exceeds our knowledge and control. By making the process of conceptualisation the object of thought, critical reflection exposes the manner in which the concept obscures its own inadequacy. Bennett's ethical project, by contrast, is to "cultivate the ability to discern nonhuman vitality, to become perceptually open to it". This is the tension between their two approaches in a nutshell. The tension between perceptual and conceptual approaches to a 'thingness' that eludes direct knowledge is the difference between philosophical approaches - that of a positivism, on the one hand, and critical deconstruction, on the other. There are clear affinities between Bennett and Adorno's turn to objects. They agree that there is a non-identity between concept and object and that the real object is withdrawn from human access. But from Adorno's perspective, Bennett's affirmative account of thing-power claims to know more than it is possible to know.

Returning to Bennett's reading of Krajewska's encounter with a damaged art-thing - that "total loss" referred to enigmatically as "the corpse". Bennett speculates that the "thrill" or "uncanny feeling" derives from "being in the presence of an aspect of oneself that is located in the body of another" (Bennett 2014: 17). In an extract from his *Lectures on Negative Dialectics* (2008), Adorno

levels a critique at Bergson and Husserl for their attempts to break out of the hegemony of conceptual abstraction that could equally have been directed at Bennett:

> Every attempt at a breakout that is initiated by the subject [. . .] is doomed to futility. . . We might say that the objectivity in which it immerses itself really was a kind of mirror effect. If a breakout is at all possible, it cannot be the product of the postulate of something alien to the subject; it cannot result from postulating a Not-I – we know of course from the history of philosophy that the subjective postulate of the Not-I was in fact the Zenith of Idealism. (Adorno 2008; 73)

For Adorno the only available path out of positive identity with the object is critical reflection, whereby the subject recognises itself to be postulated. However, Adorno is careful to underscore that despite what he sees as the failure of Bergson and Husserl's attempts to approach the object empirically, "what they aspired to reflected a very profound collective need" (Adorno 2008: 73). It is beyond the scope of this thesis to attempt to resolve the conflict between the perceptual insights of Malafouris and Bennett, and Adorno's conceptual insights. In any case, it is a philosophical rather than an artistic problem, since art isn't limited to the use of concepts in the way that philosophy is. However, Bennett and Malafouris's approaches offer crucial theoretical insights as to how enactive, embodied engagement with 'creative *thinging*' and 'art-things' can generate affective charge and non-discursive meaning. The gaps and elisions between these positions have helped me to locate tensions between human and non-human agency that have proved fertile as a source for the making processes of my sculptures as much as offering a generative model for ongoing thinking and writing. In parallel, Adorno's Negative Dialectics alerts us to the dangers of a reversion to formalism and proposes a model of critical self-reflection that allows thought to recognise the non-conceptual in objects, and at the same time to think of the relationship of those objects to a social whole. Bennett and Malafouris emphasise the vitality of things and the embodiment of practice to challenge the construction of human subjectivity as separate from a rationally calculable natural world. However, as critical theorist Alastair Morgan has highlighted:

> The poetics of objective agency is largely a fetishizing of an enchantment by objects that obscures both an engagement with objects on the terms of natural science, and an enquiry into human entanglement with objects. It becomes a way of eliding the question of human consciousness and representation, and the bracketing out of the question of conceptual representation is also a bracketing out of the way in which a historical domination of objectivity becomes instituted within conceptual categories. (Morgan 2017: 27)

Bennett's concept of vibrant matter, or thing-power, is the notion that vitality and affect are intrinsic to materiality. While Malafouris pitched his 'Material Engagement Theory' and 'Creative *thinging'* in opposition to computational or representational modes of cognition, Bennett explicitly

sets her vital materialism against the legacy of historical materialism – "How did Marx's notion of materiality – as economic structures and exchanges that provoke any other events – come to stand for the materialist perspective per se?" Nevertheless, as Morgan argues, "The nature of the object as commodity as a central form in which objects are produced and made to circulate needs to be thought through and not just ignored" (Morgan 2017: 27).

Conclusion

I began this chapter with a critique of the idea that the digital is somehow immaterial. We saw that there are at least two senses with which the term material is used: as rooted in substance and as socially determined. In each case the digital was found to be profoundly material. However, in the former, substantial, sense, this materiality is not only displaced, but also deliberately effaced by human labour and self-correcting algorithms. The trope of immateriality is fostered as an ideology that sells digital artefacts. The displacement and concealment of the material substrate, moreover, isolates material affordances and constraints from any direct contact with users at the cost of efficiency trade-offs; qualitative traits are exchanged for quantitative limits.

If a digital artefact and a sculptural object are equally material in the socially determined sense, digital materiality becomes a moot point in a discussion of their distinction. In order to better conceive the relation between the digital and the sculptural, I explored the concept of the virtual as the antithesis of the concrete. Following Rob Shield's analysis, I argue that the virtual, as a realisation of the abstract, is just as real as the concrete. However, the process of transforming the virtual into a concrete actualisation always involves a creative element. For Shields, the digital is simply a new form of the virtual, which has historical (and aesthetic) precursors in perspective and trompe l'oeil for example. But his account doesn't recognise the radical discontinuity of digital abstraction that we found in Osborne's account of digital photography in chapter 1. It is this radical discontinuity that demands the creative element that Deleuze acknowledges, and it is what makes the digital a radically new form of the virtual.

Having seen that substantial materiality is displaced from experience of digital media, but remains a key to sculptural experience, I explored accounts of different conceptions of the ways that concrete 'things' affect people. In particular, I considered Malafouris' notion of 'creative *thinging*' and Bennett's theory of 'thing-power'. The former emphasised the role played by human/material entanglement and saw material agency not as an intrinsic property of things or people, but as emerging from enactive engagement and mutual interaction. Crucially, Malafouris argues that material signs generate meanings at a non-discursive level. They are not symbols, but material substantiations that simultaneously present and re-present themselves. This capacity distinguishes

material signs from computational representations that can only represent something else and have no substantial presence nor direct index.

Jane Bennett drew our attention to the way that thing-power can become more resonant when an object loses its social identity (as art or commodity). Artworks, for example always have thing-power (the ability to affect us) but we aren't always aware of it because an artwork's aura, aesthetics and commodity value can get in the way. If the viewer becomes more sensitised to the vibrancy of materials, this offers the possibility of becoming more alert to the energy flowing between humans and the nonhuman object. Through the application of a little anthropomurphism and a process of seeing ourselves in things, the parallel recognition of our own thingness becomes palpable, and as in Bennett's account of de-commodified artworks of the Salvage Institute, this can be felt as a thrill or sense of the uncanny.

However, to experience creative *thinging* like Malafouris we need to "resist or bypass our modern representational or computational preoccupations". And to experience 'thing-power' like Bennett, we are required to "suspend suspicion and adopt a more open-ended comportment". Resisting conceptual representation or suspending critical reflection in order to experience something affirmative risks a fall back into formalism that ignores the social conditions of production and reception from which things cannot be extricated. Adorno reminds us of the need for self-reflection here and I questioned the extent to which the uncanny feeling of thing-power is in fact the resurfacing of a repressed aspect of ourselves, catalysed by that aspect of the object that exceeds its concept.

The theories of Malafouris and Bennett, strongly suggest that the actualisation of any virtual digital model into a concrete sculptural form would evolve through enactive cognition – a reciprocal entangling between maker and matter that generates the agency – the creative thinging – with which the digital's radical discontinuity can be overcome. Moreover, the thing-power experienced in a finished sculpture has the potential to affect the viewer physically and psychologically. In this sense we might think of the actualisation of a digital object is on one hand *hylomorphic*, in that it is rooted in a virtual model. On the other hand, it is intrinsically *hylonoic*, because it involves a triangulation of agency (authorship) between maker, material and contingency. These two modes of experience are characterised by the *self-effacement* of digital materiality (so-called digital immateriality) and the *self-description* of sculptural materiality (sculptural presence). The challenge, for my practice-led research, is to subsume this conflict between computational representation and non-representational material engagement (including affective bodily elements and contingent experience) within the formal structure of the work.

Notes

(1) Malafouris anticipates the criticism against using anthropomorphic terms to articulate material agency with a clarification of the difference between anthropocentrism and anthropomorphism: "To engage in anthropomorphism is to perceive reality in human terms. Anthropocentrism is a bad intellectual habit, characteristic of Western modernity that we need to overcome. Anthropomorphism is a biological necessity of the human condition that we need to embrace, or else we run a constant risk of removing the human subject from the center of the social universe only to place this subject in a god-like position on top and outside of it." (Malafouris 2013: 131)

(2) Greek: *hyle* (matter); *morph* (form); *nous* (mind).

(3) The Salvage Art Institute is an archive acquired and managed by artist Elka Krajewska in New York City, consisting of artworks officially deemed a "total loss" by AXA Art Insurance Corporation. http://salvageartinstitute.org/

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3. The Mobility of Facts

Summary

My objective is to explore how embodied encounters with sculptural artworks could become newly pertinent in an increasingly abstract, digital world. In chapter 1, I considered how the legacy of Conceptual Art practices of the 1960s led to the bifurcation of art into autonomous depictive practices, on one hand, and heteronomous post-conceptual practices, on the other. Jeff Wall argues that the depictive arts are now limited to self-affirmation – "this is the price paid for autonomy" – whilst, "pseudo-heteronomous" practices will likely have "some way to go as the form of the new" (Wall 2006: 28). Peter Osborne takes a more decisive view: "contemporary art is post-conceptual art". Both art and digital media are conditioned by the same forms of social exchange. For Osborne, the digital image could be thought of as the meta-medium of contemporary art, because he sees the "radical disjunction" and "distributive unity" of both digital images and post-conceptual art as reflecting the commodity form of global capital. From Osborne's Marxist perspective, both art and the digital are screens upon which we project the anxieties of high capitalism. An historically autonomous art form such as Sculpture, by this account, can only exist critically as a reappearance within post-conceptual art, otherwise it would be an uncritical (and therefore invalid) return to formalism.

An examination of Alex Pott's notion of a sculptural imaginary suggested that there is a vital depth of aesthetic experience that has been lost to the more discursive heteronomous practices of post-conceptual art and their tendency to reduce sculptures to conceptual props. The challenge this research proposes is therefore how to reintroduce a depth of perceptual (optical and haptic) experience into the post-conceptual field of contemporary art, without losing a self-reflective dimension that critically engages with the social conditions of production. Can the digital play a critical role in a reimagining of the sculptural?

Chapter 2, established that the popular idea of the digital's immateriality is misleading. The trope of immateriality is a fiction. Digital media are both built on a material substrate and materially determined by social structure. If the digital were really able to put a spanner in the works of the sculptural, it would not be because it is immaterial, but rather because it's interface is intangible. However, digital media do radically displace their basis in material substance and they also conceal its presence within the design of their interfaces – a tendency that reduces interaction with the digital to the fixed pre-coded rules of conceptual representation. It is more helpful to think of the digital in terms of the virtual, because this distinguishes its real but intangible existence from the (unreal) abstract and the (real) concrete. The radical discontinuity of digital abstraction is the leap from virtual to actual, which has no direct analogue because digital data has no 'form'. Digital actualisation always

involves a creative element in order to flesh out the vectors. The digital qua virtual cannot be encountered of perceived and requires a representation or technique of the virtual to be actualised. The more concrete the transformation the more creative invention is required.

The sculptural, by contrast, always requires tangible matter. Although, as Alex Potts highlights, it is never just the concrete, but a dialectical relation between conceptual representation and perceived material that produces the sculptural imaginary. Chapter 2 also considered recent theories of 'creative thinging' and 'thing-power' in terms of production and reception (apprehension). It considered the non-discursive ways in which material things can communicate or affect people both physically and psychologically, outside of the conceptual identity of these things as (art) objects. In terms of the means applied to production, Lambros Malafouris considers the throwing of clay pots to suggest that working materials with hands involves a process of material engagement where matter and mind become one. He describes material engagement as a mode of enactive cognition that is in direct opposition to the conceptual representations of "computational thinking". Materials guide our senses by moving and constraining our bodies. Malafouris also argues that the physical properties of representation affect the semiotic process so that "material signs do not represent, but they enact; they do not stand for reality, they bring reality forth" (Malafouris 2013: 118).

In terms of reception, Jane Bennett promotes more attentive encounters between "people-materialities and thing-materialities" in order to "acknowledge a force that, though quite real and powerful, is intrinsically resistant to representation" (Bennett 2010: xvi). Her examination of an archive of damaged art considered the ways in which the human mind-body is susceptible to the affections endeavoured by things" (Bennett 2014: 6). In Bennett's view, one of the effects of the transfer of energy between people and things is the emergence of meaning. In their quest to experience how human engagement with materials and things can generate meaning, both Malafouris and Bennett are resistant to human representation, which is why it is easier to discern in material that is either "not yet objectified" as with the potter's clay, or "no longer" a cultural object, as with the demoted/damaged artwork. To feel the object's presence, one is required to look outside its concept, and that requires a suspension of judgement. In such a state of "methodological fetishizing" (Malafouris) or "sensuous enchantment" (Bennett), the thing's power can elicit a thrill or uncanny feeling. However, perception at the cost of conception precludes criticality, again bringing in the danger of formalist regression.

Philosophy has no choice but to use concepts. In his trademark method of using the concept to reach beyond the concept, Theodor Adorno pointed to Freud's preoccupation with "the dregs of the phenomenal world" to argue that the posited Other or "Not-I" is actually a mirror of the repressed self. There is a conflict between two materialisms then: historical materialism that insists

that any expression of material agency is an effect of culture, and vital materialism, that argues that such a position obscures the agency intrinsic to matter. Fortunately, I do not need to resolve this philosophical conflict here because I am concerned with sculptural artworks and not philosophy. Theory can only use concepts and is therefore unable to paste the non-conceptual into the text. Art, on the other hand, has been pasting material reality into pictures since Picasso glued a tasselled fringe onto a still life construction in 1914.

Collaging the literal into the pictorial brings 'thing-power' directly into the frame. But as Adorno pointed out: "Object in art and the object in empirical reality are entirely distinct" (Adorno 1997: 259). This point was made acute by Duchamp's readymades, where their superimposition produces a temporal oscillation between states – when does it become art? Time and again we arrive at the same dialectic of non-identity between thing and concept, literalism and stylisation, not-art and art, raw matter and schema. One side always negatively implicated by the other. There is a crucial, tangible difference between a literal collage of actual material and the cut-n-paste of digital representations that has become so ubiquitous in digital imagery in and outside art. Perhaps the distinction between collage and cut-n-paste could be seen to encapsulate the tension between the digital and the sculptural.

As Malafouris's notion of enactive signification makes clear, material signs substantiate themselves while simultaneously representing themselves, or something else. The sculptures described by Mike Kelley in relation to the uncanny reflect this duplicity. By foregrounding material tensions between stylisation and naturalism, generality and particularity, they tap into a collective unconscious and generate affective charge.

Flatness and depth

The aim of my thesis is to rethink the sculptural in light of the digital. It is important to clarify that I am not proposing a return to the historical genre of Sculpture. One of the ways in which we have seen that the digital reflects globalisation is that global processes tend towards homogeneity. Conceptual art, and its relation to dissolving genres, mirrors this tendency towards homogeneity, which is why Osborne sees the digital image as the meta-medium of post-conceptual art. This homogeneity, which conceals all sorts of tensions and contradictions, is now beginning to reveal those contradictions. Culturally, this is revealed as a demand for authenticity - the demand for reality (in recent politics, the denial of expertise is an example of this). When the most important commodities are virtual or intellectual properties such as images and ideas, a revitalised interest in substantial reality and things emerges, perhaps, as a compensatory reaction to the sense of de-realisation produced by Cyberspace and virtuality. If, as Osborne suggests, post-conceptual art is like

globalisation (in its homogenous distributive unity), then the sovereign state is like a genre in art. If the current tendency towards the real manifests itself as a tendency towards sovereignty, then it is also a tendency towards genres. In this respect, a return to art disciplines is rather like the re-emerging national populism of the state. My objective is not to turn my back on digital media and post-conceptual art and replace them with unconditional, authentic modernity. It is not enough to simply offer a deeper level of qualitative experience. Rather, what I am interested in is the critical relation between two kinds of experience (sculptural and digital) and a reconnection of sensuousness and critical awareness.

It is not just the way that Instagram flattens sculptural space and the alienating effect of what Francis Bacon called "our screened existence", but that the digital has made all aesthetic experience the same. The principle aim of digital media is distraction (click bait to sell us commodities or simply harvest our personal data as a commodity), and the quality of digital experience is boredom – a distracted, bored, fascination. This digital mode of thought has now become so internalised that digital experience just is experience in general. The digital is reality. The categorical imperative of digital images is simply to succeed as images. This is the aesthetic autonomy of image commodities that constitutes the new background of consumerism discussed in chapter 1. This research uses the digital and the sculptural to reconnect aesthetic experience with self-conscious reflection on the conditions of that experience. My project is to ask how the interface of digital data and aesthetics could play a part in this synthesis.

Towards a flexible procedure

One of the challenges of this research, in its concern with non-discursive qualities pertaining to the sculptural, is how to allow artworks to develop both autonomously as sculpture and as heteronomous research. It's a structural challenge that reflects my objective to combine the sculptural with the digital and the sensuous with the critical. How to operate within clearly defined limits and undertake a rigorous and objective procedure that would respect the autonomy of the phenomenon being investigated. My approach has been to adopt a method not dissimilar to a scientific experiment, in the sense of testing in the laboratory:

1. Find existing material things from the everyday world and isolate them.
2. Use digital processes to combine and transform them.
3. Observe and use the properties of matter to reconstitute them.

By undertaking a number of experiments using disparate objects and a range of computational techniques (digital scanning, 3D modelling, CAD drawing,) and materials (metal, resin, wood, plastic), I materially examine my research questions in the following way: firstly, digitise a found object; secondly, subject it to algorithmic transformations in the virtual space of a computational representation; and thirdly, reconstitute it into tangible materials for an embodied encounter by means of analogue casting and manual tooling. The procedure can be simply described as the trans-mediation: found object – digital object – sculptural object. In this way I have generated a constellation of objects that instantiate different potentialities within my central theme by making the transitions between these distinct phases visible as tangible traces. This work has been conducted with an empirical attitude predicated on not knowing precisely what was going to happen as an outcome. Since I was not trying to demonstrate a theory, the finished works would suggest a hypothesis retrospectively – art making as a form of experimental knowledge. There is a heuristic advantage to this approach, because however the sculptures might manifest, they would necessarily suggest new insights pertinent to my research question. By using the digital to reflect critically on sculptural production, I sought to learn in what ways the digital could play a critical role in a reimagining of the sculptural. One way or another the form of the work would stem directly from the interface between the digital and the sculptural so that each might reveal something about the other. In pedagogy, this approach is known as "constructive alignment", whereby the intended learning outcome is embedded in the learning activity and the learner constructs meaning from what they do to learn (Biggs 2003). On the face of it, my procedure is regressive and conventional because it seeks to develop sculptures through a self-conscious reflection on medium – the Modernist agenda par excellence. The critical difference is that with my research the digital media employed are understood as antithetical to sculptural experience per se, as I have argued in chapters 1 and 2. Nevertheless their complementarity to the final outcome is a key element of the sculpture's material presence. It is through the critical tension between the mathematically pre-coded transformations of digital media, and the haptic, concrete experience of the sculptural, that I seek to grasp a relation that the philosopher and affect theorist Brian Massumi has described as "the self-disjunctive coincidence of a thing's immediacy to its own variation" (Massumi 2002: 8).

Found objects

I needed to establish the criteria for selecting the existing things that would be subjected to my flexible procedure. I required some kind of objective critical logic if my research were to avoid the quick sands of naive subjectivity. It was important that my chosen objects should invoke some quality not entirely reducible to material culture. In terms of perception, Jane Bennett recommends adopting

"a more open-minded comportment" to enable "a certain anticipatory readiness . . . a perceptual style open to the appearance of thing-power" (Bennett 2010: 5). In terms of conception, on the other hand, Theodor Adorno prescribed a more intellectual approach, because "he who wants to know it [a thing itself] must think more, not less" (Adorno 1973, 2007: 189). Adorno's dictum "to use the concept in order to reach beyond the concept" is an invitation to go beyond the point where one's thinking is supported by facts and becomes speculative. The antagonism between these two philosophical approaches: perceptual and conceptual, intuitive and analytical would inform my apprehension and reflection on potential objects, but these philosophies didn't help me to refine my selection criteria. So, I decided to return to art for a precedent, and who better than the progenitor of western collage Picasso: "I don't seek, I find".

"Everyone knows that there are just two criteria for a found object", writes art historian WJT Mitchell, "it must be ordinary, unimportant, neglected, and overlooked" and "its finding must be accidental, not deliberate or planned" (Mitchell 2005: 112). Mitchell explains that like the thing-in-itself, the secret of the found object is intractable, but as surrealist practices demonstrated, it can become foundational. Approaching the question antithetically, Mitchell then asks: "what is not a found object?" and answers: "the sought object" and also "the desired object, the sublime object or beautiful object, the valued object, the aesthetic object . . ." The psychology of the found object, according to Mitchell, clearly has much in common with Bennett's 'demoted object', or Freud's 'uncanny'. Found objects are the antithesis of "the objects we care about in advance, the objects we are looking for, the objects of theory". They are "the indifferent objects, the 'poor things' that are all around us, the objects that provoke 'idle curiosity at best' (Mitchell 2005: 116). In other words, found objects are objects prior to fetishisation, aestheticisation, commodification, or after they become broken, devalued, forgotten. In short, found objects could be identified as 'things'.

In order that I could work with found objects, I was therefore in the paradoxical situation of not looking for them, but waiting for them to suggest themselves to me. To help me achieve "a certain anticipatory readiness" and "think more, not less" about the sculptural and the digital, I co-curated, commissioned and produced a series of five exhibitions called Physical Information at Bloomberg, exploring "the possibilities of concrete sculpture in an increasingly abstract world" (Coleman & Norfolk 2016). These exhibitions afforded me the opportunity to reflect critically on different modes of the sculptural in the immediate context of a digital media network. For instance, Eva Grubinger's exhibition *Five Problems*, involved the mimetic reproduction of existing objects and their transposition into other materials, at different scales; Jim Issermann's *Constituent Components*, involved three-dimensional extrusion and modular construction from a two-dimensional abstract pattern designed on a computer; Florian Roithmayr's *ir re par sur*, generated and tracked changes in

materials in an attempt to register the consequences of one surface or material yielding another through capturing the unexpected gestures that occur in the gap between mould and cast; and The *Mobility of Facts*, brought together three highly idiosyncratic objects by Siobhán Hapaska, Guiseppe Gaballone and Charlotte Posenenske that challenge the conventional notion of sculpture as immobile. The sculptures of each artist in this last exhibition embraced temporality and contingency in a unique way, whilst emphatically engaging the viewer physically and psychologically. Researching, producing and installing these sculptures, along with my exchanges with the artists or their estates, yielded insights that I have used to inflect my practical experiments. Some of these insights will be explicit in the following chapters, whist others will remain implicit. [1]

I also organised and chaired a symposium that sought to approach my research questions tangentially, through fields outside contemporary art, with papers from art historian Alex Potts about *Temporality in Sculpture*; anthropologist Haidy Geismar *How digitization effects the experience of objects and collections*; and novelist Tom McCarthy, who read an extract from a new manuscript: *And Down We Went*. Not only did these papers instigate much of the theoretical discourse covered here in chapter 1, but the discourse and debate in the panel discussions that followed generated insights and prompted questions that will emerge as pertinent in the chapters that follow. [2]

Meta-art

Each of the five chapters that follow corresponds to a different sculptural project and they can be thought of as case studies for the same flexible procedure. In each case found objects have been transformed and brought into new relations using digital media, before being reconstituted in tangible materials to allow a sculptural encounter. My procedure has been experimental and playful, allowing technologies, materials and processes to self-reflectively determine the development of the final forms. In each case these new artworks instantiate a synthesis of digital and sculptural media, to be experienced aesthetically. Aesthetic apprehension is of course the knowledge form of a sensual art experience. However, because the knowledge that art produces is aesthetic and not epistemic, it inevitably eschews analysis and remains inarticulable and therefore inscrutable. Art's inarticulability presents a difficulty for any attempt to write about art objectively. It's a problem that conceptual artist and philosopher Adrian Piper understood very well: "…although we can have an aesthetic experience by making and looking at art, we can't thereby know anything in the conceptual or discursive sense; I have argued that it is in the nature of the aesthetic that we can't. Further, I have argued that any attempt to unpack the object through conceptual analysis will be at the least problematic and ultimately unsuccessful. If we want to articulate anything, it must be by appeal to our epistemological abilities, and not to the aesthetic experience." (Piper 1996: 21). Rather than

attempt to rationalise physical artworks themselves – a strategy doomed to failure, Piper suggests that artists should take a different tack and focus on the process by which one realizes the work. She calls this reflective activity *meta-art.* "By 'meta-art' I mean the activity of making explicit the thought processes, procedures and presuppositions of making whatever kind of art we make." (Piper 1996: 17)

The five case studies documented in the appendices instantiate and encapsulate my practice led research. However, it is important to stress that the written accounts in the following chapters are in no way attempts to articulate, explain, interpret or justify the artworks themselves. They remain as opaque to me as to any other viewer and it is not my place to evaluate them as art. Rather I offer the following chapters in the spirit of 'meta-art', because they aim to elucidate as fully as possible the processes, procedures and presuppositions that determined the artworks. Piper explains that "Generally what is required in meta-art is that we stand off and view our role of artist reflectively; that we see the fact of our art making as itself a discrete state or process with interesting implications worthy of pursuit; that we articulate and present these implications to an audience (…) for comment, evaluation or feedback. (Piper 1996: 18). In the preceding chapters I have sought to articulate and critically reflect on the presuppositions underpinning my procedure, namely 'the digital' and 'the sculptural', their attendant tropes of immateriality and fixed facticity, and their ramifications in relation to the material culture of global capitalism. In the following chapters I will focus on the digital, analogue and manual processes that I have used in undertaking my procedure: how I came by the objects I've used, the materials I have employed and what kinds of decisions I have made concerning them. In short, I will articulate what I have *done* to realise the work as compared and contrasted with how and what I thought.

Making

Making, for the purposes of this research, is a reinvestment in the power of the imagination. Making has political utility as a way of investigating new tropes and concepts. Because making is always contingent upon the resistance of its materials, this friction frequently brings unforeseen developments. Whether or not we can frame material resistance as 'agency' is a contested point, as I have demonstrated above. Nevertheless, I see the back-and-forth dance between material and maker as pivotal to the production process. Many of the insights that follow will hinge on the specific qualities of resistance exerted by digital media in contrast to more conventional sculptural media. My articulation of the productive processes that brought the artworks into being will entail reflection on the generative currents of the materials used as well as my own sensory awareness. The temporal aspect of the creative process is crucial, because I aim to make explicit the ways that these sculptures

and my consciousness of them reciprocally took shape without preconceptions. Chapter 2 showed how cognitive archaeologist Lambros Malafouris proposed a *hylonoetic* model of creativity, in which mind and matter become intertwined, against the dominant *hylomorphic* or computational model, whereby practitioners are thought to impose conceptual representations on the material stuff supplied by nature. Against this *hylomorphic* model, anthropologist Tim Ingold proposes an alternative *morphogenetic* model of creativity based on the insight that the form-generating processes of creativity are more akin to a process of growth: "Suffice it to say, at this point, that even if the maker has a form in mind, it is not this form that creates the work. It is the engagement with materials" (Ingold 2013: 22).

Ingold suggests a crucial difference between anthropology and ethnography: "anthropology is studying with and learning from" whereas "ethnography is a study of learning about". He compares the relationship between anthropology and ethnography with that of art and art history. Ethnography and art history are preoccupied by a static relation between conscious image and material object, whilst anthropology and art move with a speculative, experimental and open-ended character – a "prospective dynamic". In foregrounding processes of human perception in his morphogenetic theory of creativity, Ingold also questions the privileging of visual apprehension over other aspects of embodied cognition:

> With regard to perception, it underpins the distinction between an optical and a haptic relation to the world . . ., showing that the optical relation is by no means limited to a perception mediated by the eye (nor is the haptic relation limited to the hands). With regard to creativity, it distinguishes the improvisatory creativity of labour that works things out as it goes along from the attribution of creativity to the novelty of determinate ends conceived in advance.
> (Ingold 2013: 20)

Ingold's critique of hylomorphic creativity implies a critique of *material culture* "a phrase that perfectly captures this theory of making as the unification of stuff supplied by nature with the conceptual representations of a received cultural tradition" (Ingold 2013: 20). The following accounts of my case studies share Ingold's morphogenetic notion of making as a process of growth, improvisation and material engagement. At the same time, they take seriously the hylomorphic role played by computational representations at the heart of my procedure. My empirical and phenomenological research into media is thus characterised by the antagonism between hylomorphism and morphogenetics. Each project presents a different synthesis of digital image and sculptural object.

Notes

(1) See appendix 1

(2) See appendix 1

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4. Playground

Garden Toys

I first encountered these objects in the garden of an Airbnb apartment in northern Spain, where I was on holiday with my family. On arrival, my one-and-a-half-year-old son alerted me to their presence with a squeal of glee. I looked at the dirty, neglected garden toys with scepticism. They were covered with a thick layer of grime that seemed neither hygienic nor inviting. The following morning, we awoke to the resounding raw of a water jet on hollow plastic. The apartment owner, who had noticed we had a toddler, was thoughtfully hosing down the slide, Wendy house, seesaw, swings and car, so that our little boy could play with them (figs 2.1 & 2.2).

On inspection, we found that the thorough pressure-wash had done an excellent job of removing the dirt and revealed the extent to which the years of coastal spray and sunshine had bleached the material underneath. These generic toys that are commonly associated with colour-blocked primaries, were now faded and practically transparent in places. The morning sun penetrated their hollow plastic forms, exposing the rain and hose water trapped inside. Any interaction provoked ripples that threw dancing shadows through the surfaces. Objects that had first seemed dull and forgotten now appeared iridescent and strangely vibrant.

Over the course of that week, I had plenty of opportunity to contemplate these assorted objects as I watched over my son playing. They were not the kind of things that usually invite much consideration because they are not aimed at adults. It occurred to me that attempting to empathise with a child's view of the world was the perfect excuse to practice a little naïve realism (the sin of critical theory). So, I tried to see things from my son's perspective, as he explored the plastic mise-en-scène. He was not yet able to walk unsupported – in fact he took his first tentative steps among these items – so he was almost always touching their surfaces with his hands. He felt his way around textures and shapes that simulated other material surfaces, such as tongue-and-groove panels, stone blocks, castle crenulations, and tyre treads. Materially they were all very similar, but the relief imprinted on their surfaces depicted a stylised world of miniature adult things. These tactile qualities and visual aspects seemed mutually stimulating. It was a haptic zone made for a child's imagination.

Garden toys are often made of plastic for two very good reasons: cheapness and longevity. As I had learned first-hand from the production of Jim Isermann's sculptures [1], roto-moulding is a process that requires an expensive steel tool used as a mould, but it can produce a huge number of plastic modular forms that are almost indestructible, at a very low unit cost. That is why it is the process used to produce street furniture such as traffic cones and crowd barriers as well as outdoor playthings. The

qualities of affordability and durability have made this kind of toy ubiquitous in gardens and nurseries. Common, generic, cheap and familiar, plastic outdoor playthings would rank low in a hierarchy of cultural value, and yet their relation to childhood makes them curiously archetypal.

What really fascinated me about these objects, however, was not their material thingness, but the way they induced my son to behave. These playthings were not just toys, but were designed with the developmental purpose to elicit role-play. Watching my son go in and out of the Wendy house door, apparently to wash imaginary dishes in its little sink, I found them to be quite effective in this function. In-and-out, in-and-out through the little hinged door he went. The more he repeated the same movements – pulling the door one way, as he moved the other, using the windowsill to pivot before approaching the task from the opposite direction – the smoother his actions appeared and the more confident he became. His balance and coordination were becoming attuned to the task and it gradually required less conscious effort. It dawned on me that another sense was at play here beyond sight and touch: *proprioception*.

> There is in fact a sixth sense directly attuned to the movement of the body: proprioception. It involves specialized sensors in the muscles and joints. Proprioception is a self-referential sense, in that what it most directly registers are displacements of the parts of the body relative to each other. (Massumi 2002: 179)

In chapter 2, I considered Brian Massumi's argument that the digital is not, in fact, virtual at all, but merely a codification of the possible - "pure systemic possibility". If there is openness at play, it is in the translation of the digital to the analogue. "Equating the digital with the virtual confuses the really apparitional with the artificial. It reduces it to a simulation." (Massumi 2002: 137). Proprioception, by contrast, is quintessentially virtual for Massumi. He explains that tactility concerns the skin as the sensible interface between perceiving subject and perceived object. Proprioception involves the muscles and ligaments registering these qualities as conditions of movement – muscle memory. "At the same time as proprioception folds tactility in, it draws out the subject's reactions to the qualities of the objects it perceives through all five senses, bringing them into the motor realm of externalizable response." (Massumi 2002: 59). In chapter 1, I argued that the sculptural is intrinsically kinaesthetic – sculpture makes you move. Alex Potts supports this view when he states that "sculpture is about existence in time as well as space" (Potts 2017). Proprioception is an embodied mode of self-referential experience that privileges the temporal over the spatial. As the perception of self-variation, it is as pertinent to the sculptural as the visual or the tactile. The garden toys my son discovered are designed to foster bodily self-awareness and balance. Ladders and slides, swings and seesaws, wheels and hinged doors provide an object lesson in Newtonian physics. The imaginative and proprioceptive potential of these objects is activated through physical, embodied interaction, and

it seemed pertinent to transpose these qualities into the disembodied, quantitative realm of the digital.

As I recalled my son's behaviour among these things, I wondered whether he or I would later be able to look back and remember this formative interactive experience. In his extended essay on *Matter and Memory*, the philosopher Henri Bergson argued that pure (virtual) memory always had to be actualised anew in bodily perceptions of the material world. "The phenomena of memory", he wrote, "are at the point of contact between consciousness and matter." (Bergson 1912, 2007: 81) [2].

> Our perceptions are undoubtedly interlaced with memories, and inversely, a memory, as we shall show later, only becomes actual by borrowing the body of some perception into which it slips. These two acts, perception and recollection, always interpenetrate each other, are always exchanging something of their substance by a process of endosmosis. (Bergson 1912, 2007: 72)

My attempts to recreate memory images of that particular group of objects always resulted in interpenetrating fragments - the superimposition of distinct perspectives somehow overlaid and interlocked. I wondered if I could use digital media to materially re-construct these moments to infer or reveal the intersection of virtual image and material substance. The playthings that I had encountered in northern Spain began to suggest themselves as potential objects for my research procedure because of their contradictory qualities: their relation to the body, touch, gravity and proprioception; their homogenous, stylised, scaled, representations of other things; their relation to the naïve subjectivity of a child's imagination and the virtuality of memory. Most importantly, the fundamentally embodied modality of experience they figure and the disembodied limitations of digital media.

Compenatration

My first practical experiment was to download pre-existing 3D digital models of playground objects into the digital space of Google Sketchup (fig 2.3). Sketchup represents a classical Euclidean space with triple-axis Cartesian coordinates, into which geometrical forms can be plotted and configured. It is a space of pure measurement that renders the dynamic space of reality static. Brian Massumi describes Euclidean space in terms that resemble Lambros Malafouris's likening of representational cognition to a computational fiction (see chapter 2 above): "The cognitive model assumes that visual cues are somehow used to calculate distances, as if our brains were computers preprogrammed in inches and feet. . . The computational fiction is a natural outgrowth of the assumption that we effectively move through and live in a static, metric or quantitative, Euclidean space" (Massumi 2002: 181). In the dynamic non-Euclidean space in which we actually exist, it is the

synaesthetic fusion of all our senses – especially the visual, tactile and proprioceptive – that forms our image of the world. Massumi argues that the reductive abstraction of Euclidean space is not like the world we experience at all because it precludes our naturally synaesthetic sense of awareness. "It is the encompassing reality of what we really experience in a spatial way that gets lost if we try to limit our understanding of space too narrowly to vision in its exoreferential single-sense functioning and the associated Euclidean geometry of form-in-configuration" (Massumi 2002: 182-3). The task of my experiment was to transpose my memories of the objects as I experienced them in non-Euclidean space, into the Euclidean space of the computer according to its Cartesian coordinate system, and then to re-materialise this representation to afford a synaesthetic encounter.

Importing models of a swing-set, seesaw, Wendy house and car into Sketchup, I couldn't find anything that closely resembled the particular objects that I had encountered. Most of the model toys were clunky and geometric, rather than rounded and cartoonish. However, as I dragged these assorted objects into Sketchup to approximately recreate the remembered scene, something unexpected happened: the objects started passing into and through one another. This mutual interfusion, or compenetration, of objects was immediately striking because it is obviously not possible for physical objects to interact like this in physical (that is spatiotemporal) reality. Solid things cannot simultaneously coexist in precisely the same place. The experience seemed emblematic of the impression of atemporality given by the digital model. The frictionlessness with which the objects passed through one another made them appear ghostly and unreal. It reminded me a little of the jumble of images that jostle for attention in my mind's eye when I try to remember the original objects. The digital image offered some equivalence to my own imaginary recollection, but on reflection seemed different in its key aspects. Compenetration, as displayed on the computer screen acted as a paradox, a supposed echo of something that we know cannot exist. A (false) trope of immateriality we know to be numerically driven and therefore, as shown in chapters 1 & 2, not even a ghost of its own processes of construction. In this way, digital compenetration both figured the interpenetration of perception and recollection described by Bergson, and revealed the disconnection between digital abstraction and concrete reality.

Unsatisfied by the 3D models I'd managed to find online, I began googling for actual outdoor playthings manufactured by the same companies as the objects I'd seen in Spain. I soon discovered that similar objects were widely available second-hand on ebay, at a small fraction of the recommended retail price. I purchased a Wendy house and slide identical to the ones in Spain and set out in my car to collect them. I found the Wendy house leaning in parts against a hedge. It was almost as bleached as its duplicate in Spain and was also quite battered and bent out of shape. It had obviously been kicking around neglected for some time. The owners confirmed that their kids had

grown up now, but they were noticeably emotional as they handed it to me in exchange for £16. The owners of the slide had taken the trouble to clean its component parts, which were also bleached but in better condition. I had paid just £8 for it, but we also exchanged memories and expectations when they told me about their son and asked me about mine. I had not expected these unwanted things – barely commodities at all – to hold such a palpable sentimental value.

I took the Wendy House and slide to the RCA's Rapidform digital facility in order to digitally scan their constituent components. Before I could do this, I had to clean them and spray-paint them with white chalk, since the sheen off the plastic surfaces would deflect and confuse the light beams of the scanner (fig. 2.4). Scanning was a slow process that involved covering the components with a mesh net that provides the scanner with fixed registration points. Multiple passes with the scanner are aligned with reference to these registration points in order to build up a complete object. The Rapidform technician worked with specialist software to 'stitch together' the components to produce a complete topology. Once the components were reassembled digitally (a process that involves filling the gaps), they could be brought together in simulated space (figs. 2.5 & 2.6). The scanning process was costly and I wasn't able to scan further objects, so I continued my search for existing 3D digital models for a little car, table and chairs, seesaw and a 'castle' swing-set, on commercial 3D model sites. I managed to purchase and download a car that felt consistent with the style of the Wendy House and slide, along with a table and chair, and a funny looking seesaw, which didn't really fit since its form suggested steel tubing rather than moulded plastic, but it was the best I could find. Unable to find a 'castle' swing-set, I drew a very basic schematic model to stand in as a proxy. Grouped together, they formed a plausible grouping of objects isolated in a mathematical zone quite removed from concrete reality.

Circumstances

Since digital space isn't really a space and therefore doesn't have limits, any delimitation at this stage would have been arbitrary. The digital models that I'd acquired so far didn't have scale either. As abstract datasets they could be resized according to any measurements attributed to them, but scale, of course, is relative. The most immediate benchmark for scale is one's own body – a measure that varies from child to adult. I measured the 'real' Wendy house and slide that I'd acquired and attributed the correct measurements to the digital models at a scale of 1:10. I checked the measurements of the kid's furniture from a catalogue and for the remaining objects, I estimated their relative sizes by eye, by scaling them up and down until they looked right.

Then an open call for a public art competition was brought to my attention [3]. The prize included production a budget and the opportunity to install a new sculpture in an outdoor public

location – both resources that I needed in order to realise this project. I applied and was shortlisted. Shortlisted artists were invited to produce a scale 1:10 maquette for their proposed public sculpture, and so I set about reworking my digital model. The brief was crucial because it determined the maximum dimensions according to the sculpture terrace and I transposed these given parameters into the digital model. This real context for the public sculpture brought other constraints to the digital model. For example, the site was in front of a gallery adjacent to a busy London street. The street introduced directionality to the project – vectors of approach; the gallery façade suggested a front and back; gravel on the sculpture terrace would provide the interface of artwork to ground. All these material factors had to be projected into the model. There were practical considerations such as health and safety: would it be climbed on? And sculptural concerns: how might it be encountered by an accidental audience not looking for art? All of these factors had to be projected into the model, where no such physical constraints previously existed. They would help suggest what the sculpture could be, by determining what it could not be. As I worked on the digital model, these physical constraints remain constant, while the physical solidity of the objects was suspended. A peculiar dance ensued, in which my decision-making was triangulated between the material constraints of the physical world and the physically impossible relations afforded by the digital.

I was interested in the possibility that the group of outdoor playthings might at first glance appear to be genuine. As if an assortment of garden toys were indeed installed on the sculpture terrace. As if it were not a gallery but a nursery school. Only on closer inspection, would the physical anomalies become apparent. By setting up a potential double take, I was interested in introducing a temporality to the sculptural encounter. A temporal tension that would be accentuated by the contrast between the continuous flow of traffic and the static mise-en-scène. The perimeter of the sculpture terrace became the frame within which the plan was developed (figs. 2.7-2.12). The intersection of objects became a means to cut through and obstruct access and movement: the wheels could not roll, the seesaw could not pivot, the swings could not pendulum, ladders could not be climbed nor slides slid. The original childhood uses of physical learning in a kinaesthetic manner are held in abeyance in the sculpture, replaced by the kinaesthetic circulation of the viewer's haptic attention as it follows the contours of the continuous surface and its visually disjunctive but materially homogenous conjunctions.

I printed the scale 1:10 maquette using the most cost-effective rapid prototyping process available to me at the time. By laying down micro-thin layers of gypsum that are fixed with an adhesive, one after the other, a subtly striated plaster model is built invisibly within a volume of off-white powder. The homogenising effect of the uniform material lent the resulting model an unreal, ghostly quality that was reminiscent of the on-screen digital rendering. Meanwhile the palpably brittle

and delicate detailing emphasised its very real fragility (fig. 2.13-2.14). Along with the maquette, I also produced digital renderings to help visualise how the work would be encountered in context (figs. 2.15-2.16). The maquette and renderings suggested a number of issues. Firstly, the homogeneity of the material highlighted the incongruity of the seesaw's (metal) form in relation to the other (plastic) objects, disrupting the impression that they might all be made from the same material. The effect of merging all these objects together was to produce a topologically complete entity. The simulated variations in the plastic surfaces described above did not jar with this, because they were all worked to the same level of detail; the same soft, almost graphic form. Secondly, I realised that I had scaled the 'castle' swing-set much too small in relation to the other objects and that this would be absurd in direct relation to a child or adult body (fig. 2.17). Curiously, this had not been evident to me on screen, but even at scale 1:10, I immediately recognised that it was quite out of proportion when viewed in the round. Thirdly, the homogeneity of the rapid prototype's material resembled the homogeneity of the digital model. This was also salient in the digital renderings, where the sculpture was depicted in a uniform, default grey, in stark contrast to the red brick and green foliage of the surroundings. Here the incongruity seemed pertinent. I had originally envisaged a polychrome sculpture that would represent the original objects more naturalistically. But I understood now that this might come over as too much of an illusion or a technical trick. The tension between the distinct objects that had been merged and the continuous topological surface of the maquette produced a disjunctive unity that encapsulated the interface between the digital and the sculptural. None of these insights had been obvious to me from the digital model. It was only when I could move around in relation to the three-dimensional maquette that I intuitively recognised these incongruities, and crucially, I understood when they were pertinent and when they were not.

Facture

I was fortunate to be selected as winner of the award, because it afforded me the resources to develop my digital model, renderings and maquette into a full-size public artwork. At this stage I had arrived at what cognitive archaeologist Lambros Malafouris and anthropologist Tim Ingold call a *hylomorphic* model – a representation of what I had proposed to materialise. As described above, this representation was already developed through a triangulation between the affordances of the software and the constraints of material site. Now I had to figure out how to build it. No longer an abstract hypothesis, all sorts of concrete factors immediately came into play: strength, durability, weight, transport, health and safety, vandalism, cost, the weather. One approach that I had been investigating was to use a robot to machine the forms out of polystyrene foam directly from the digital data of my 3D model. The machined foam could then be given a fibreglass shell that would

make it durable. This would have been the consummation of the hylomorphic model, because the robot could reproduce very complex forms very accurately, and the only real deformation would arise from connecting the parts and applying the fibreglass coating. However, initial enquiries revealed that the machining alone would be prohibitively expensive.

Given the affordability of the second-hand playthings on ebay, my next thought was to work directly with the original objects. This appealed to me because it would involve literally cutting-and-pasting the actual things into an enormous collage. I soon discovered another quality of roto-moulded plastic used to make these objects – almost nothing sticks to it. The strongest possible bonding would be a plastic welding. So, I acquired a plastic welder and, following online tutorials, I taught myself to plastic weld (fig. 2.19-2.20). The undisguised appearance of the plastic weld was actually quite pleasing, and I toyed with the idea of working only with this process. The idea of a crudely patched together assemblage of tired old playthings had a very different appeal. I was quickly disabused of this idea when I discovered that the different playthings that I wanted to work with were made from different plastics like polypropylene, polyethylene and polyurethane, which cannot be welded together – you can only weld like-for-like materials. On top of that, I could not source a swing-set or seesaw that suited my requirements. Even if I could, it would be impossible to cut and weld the complex intersections I had in mind with anywhere near enough accuracy. I had to find a way to seamlessly combine different media into a disjunctive unity and this would necessarily entail digressing from the digital grid.

Working with a production company, the solution involved a return to the digital model. From photographic references, computer designer Nathan Roberts and I drew a 'castle' swig-set according to the possible dimensions of laminated (exterior grade) MDF (fig. 2.18). We also re-drew the seesaw in a similar manner. By introducing routed radiuses to every edge, the MDF could be made to appear like the moulded plastic forms of the castle. MDF mimicking plastic mimicking stone. This process had the satisfying aesthetic effect of producing a form that was consistent with the other objects, but even more emphatically geometric and cartoony. It also had the practical effect of providing a rigid armature to hold all the other objects in place. The MDF 'castle' could be fabricated around the existing plastic objects, allowing for more complex intersections. Once the swing-set was scaled up to the appropriate size, it became too long for the sculpture terrace and would have spread the density of the composition too openly. However, the virtual topology of the digital model allowed me to simply compress the crossbar until all the objects came into contact with one another within the available footprint for the final sculpture.

Once the revised model was complete, construction began on the MDF parts and I acquired multiple second-hand playthings to afford the gradual working-out of connections by trial and error.

In practice, many of these intersections had to be figured out and improvised as the insipient artwork evolved. A mistake in one place suggested an alteration in another. The requirement for strength and stability determined how a chair sliced through the seesaw so that a steel armature could hold the two in place. It took several attempts to merge the car with a small slide and it emerged that the swing-set leg felt especially violent piercing the very middle of the large slide. Elsewhere, the positioning was more playful. The legs of another upturned chair punctured the little climbing wall to create an accidental composition of circles and squares. The ship's wheel of the 'castle' hung over the roof of the Wendy house like a little sun. All of this is to make explicit that through negotiation with the affordances and constraints of tangible materials, the form of the project diverged from the digital model. While the digital objects could be positioned on a grid, the real objects found their relations progressively through a series of knock-on effects. No placement or detail was ever fully intentional. The differences were subtle but palpable, because the moments of compenetration were no longer abstract and arbitrary, but had been adapted according to the requirements and limitations of the materials used. It is important to clarify that these concessions to material agency were pragmatic and not ideological. There was no subtext of 'truth to materials' since my objective was to use tangible materials to reconstruct an intangible digital phenomenon, rather than a form suggested by inherent material properties. In other words, my production process was working against tangible materiality, bending, breaking and reinforcing materials in order to suggest a digitally determined, seemingly immaterial structure, rather than a materially determined physical structure. In this way the hylomorphic blueprint ceded to a hands-on, improvised morphogenetic process. I couldn't have conceived of the composition without the digital model, but the final form derived as much from the judgements, necessities and contingencies of my enactive engagement with affordances and constraints of tangible materials.

Surface

Having committed to a production process that would combine original objects made from incompatible plastics, with fabricated MDF components reinforced with steel armature and epoxy expanding foam, the challenge now would be how to achieve a uniform coating that would lend the artwork homogeneous unity and durable finish. My research led me to a new coating technology called polyurea [4]. Numerous demonstrations on Youtube evidence polyurea's near indestructible resilience and adhesion to diverse surfaces and its elastic capacity to retain its shape – qualities that make it suitable for heavy industrial and military applications. After speaking with a number of UK suppliers, I found myself among a group of shipping containers outside an industrial estate just north of Swansea. I had taken along two of my plastic welding tests to be coated using polyurea. I observed

from a safe distance as the objects were sprayed inside one of the containers. The container was filled with a fog of grey, out of which the technician emerged with my coated objects. The two-part mixture had cured immediately. The entire surface was coated in a seamless plastic skin, which I was assured would protect the joints from any movement, as well as weather, vandalism or bullets (figs. 2.21-2.22). The appearance was a disaster though. The material is viscous during application and so, due to the relatively complex forms, there was a great deal of overspray in high relief. The cured surface emitted fumes so pungent that I had to drove back to London with the all the windows open. Back in the studio, it was possible to sand back the gloppy texture caused by the overspray. Once sprayed with primer, the objects acquired a pleasingly soft-contoured continuous surface. However, it was evident that this would require an enormous amount of labour, and on that scale, there were very real concerns that a material with such a terrifying molecular structure would likely be highly poisonous or carcinogenic. A Polyurea coating would have provided a durable homogeneous coating to visually and haptically unite the otherwise disjunctive forms with a continuous topological surface. However, the associated costs and health risks meant that this was a material dead end.

It would be necessary to employ a material technique that was much more familiar to me: a build-up of two-part epoxy filler primer. In order to do this, however, I would need to figure out how to get the epoxy to stick to the plastic substrate. My research revealed the adhesion problem to be caused by oils released from the plastics. As part of the roto-moulding process, an excess of oil is used in the mix of the plastic to facilitate rapid de-moulding. If the plastic is oily, objects pop out of the mould quickly and cleanly, speeding up the process to make way for the next pour. It turns out that it is possible to remove this excess oil by using a blowtorch to heat the plastic so that it sweats out the excess oil and then acetone can be used to remove the oil with rags. Once a plastic substrate has been thoroughly prepared in this way, and the surface has been lightly keyed with sandpaper, a primer coat will adhere very well. By building up the primer coats (eight layers), it was possible to reach a surface finish whereby differences in texture between polypropylene, polyethylene and polyurethane and laminated MDF, could be suppressed to leave a unified surface that varied only according to form. The complexity of transition between digital image and material actualisation could thus be completely withheld from the viewer's physical experience of the sculpture. In Chapter 1, I discussed how Alex Potts foregrounds the role of materials in the constellation of a sculpture's meaning. By concealing Playground's material substrate – a veritable dog's breakfast of constituent components cut-and-pasted together – the artwork's painted surface effaces the traces of its own making and highlights its own artifice as an illusion of frictionless immateriality. The seen surface is ordered, homogenous, continuous and seamless so as to simulate the imaginary perfection of a digital model. Beneath the surface is a chaotic, fragmented, textured and multi-coloured jumble

where multiple materials have been welded, bolted and glued – in a word forced – together. The on-screen digital trope of compenetration shows digital objects glancing across and through one another. The sculptural equivalent was a hard-won assemblage replete with filled holes, fudged joints, and concealed seams and MDF masquerading as plastic.

Synaesthesia

Having established that the whole thing would need to be uniformly painted with epoxy primer, I was faced with the question of what colour to finish it with. Primer grey might appear too fashionably 'industrial'. A bold colour would identify with the cheerful arbitrariness of Caro's high-Modernism. Some viewers of the scale 1:10 plaster maquette had suggested that the homogeneous off-white of the model had a ghostly quality [5]. It seemed to me that a ghostly appearance might not be misplaced, given the apparitional qualities associated with the digital processes I had employed. But to paint it white (or off-white) seemed too literal and symbolic. I decided that in order to remain internally coherent, the colour had to come from the sculpture itself. But this rationale was moderated by my intuition, or instinct, that the colour should be a pale dull blue, like a cool equivalent of sepia. I had somehow come to envisage it in a colourless blue. It just happened that some of the original objects – the four chairs and little table – had been cast from pale greyish blue plastic with a subdued matt finish. I liked the idea that through their interfusion with the other playthings, the diminutive furniture might have infected the other objects with their melancholy tint. Thinking of this muted shade also reminded me of a passage in Valdamir Nabakov's novel *Ada, or Ardor: A Family Chronicle* (1969), in which the protagonist, Van, thinks of memories as seeming bluish-grey. I looked up the passage: "Does the colouration of a recollected object (or anything else about its visual effect) differ from date to date? Could I tell by its tint if it comes earlier or later, lower or higher, in the stratigraphy of my past? Is there any mental uranium whose dream-delta decay might be used to measure the age of a recollection?" (Nabakov 1969: 428). Nabakov's radioactive metaphor lends memory a material agency that reinforces his protagonist's thesis that "Pure Time, Perceptual time, Tangible Time. . ." has a half-life that is motionless. Van continues:

> We have suggested earlier that the dim intervals between the dark beats have the feel of the texture of Time. The same, more vaguely, applies to the impressions received from perceiving gaps of unremembered or 'neutral' time between vivid events. I happen to remember in terms of colour (grayish blue, purple, reddish gray) my three farewell lectures – public lectures – on Mr Bergson's Time at a great university a few months ago. (Nabakov 1969: 430)

The coincidence of Nabakov's "grayish blue" memory with the colour of my toy chairs and table and "Mr Bergson's Time" was sufficient to settle my choice for the colour of the entire surface. Li*ke*

his protagonist, Nabakov famously experienced clinical synaesthesia. Synaesthesia is an example of (bodily) affectivity preceding (generating) visual perception. Brian Massumi has something to say about synaesthesia. In his view, an interoceptive sense like proprioception always works synaesthetically in relation to exteroceptive senses like touch and vision. "Synaesthesia is considered the norm for infantile perception. The theory is that it becomes so habitual as to fall out of perception in the "normal" course of growing up. It is thought to persist as a nonconscious underpinning of all subsequent perception . . . Synaesthetes are "normal" people who are abnormally aware of their habits of perception". Massumi continues to explain that for clinical synesthetes (like Nabakov) "Vision is typically used as a plane of general cross-reference. It is on the abstract surface of color that everything fuses . . . All the other senses, and any and every "higher" form [numbers, letters, words], are gathered into color, together with the three dimensions of space and time," (Massumi 2002: 188-9). Massumi shows that synaesthetic perception is primary over abstract conception and not the other way around. Considered in light of synaesthesia's fusion of the senses, colour is no longer a secondary, decorative or subjective quality, but is inseparable from form. The colouration of my sculpture would have the dual function of concealing the disjunctive conjunctions to produce a homogeneous unity reminiscent of the digital simulation, but it might also synaesthetically evoke the real abstraction (virtuality) of memory.

Le temps

In one of his *Conversations on Science, Culture and Time* (2011, 1995: 60-61) with philosopher, anthropologist and sociologist Bruno Latour, the philosopher Michel Serres recalls that "The French language in its wisdom uses the same word for weather and time, le temps. At a profound level they are the same thing" . . . "Everything depends on the way you understand the passage of time" (Serres/Latour 1995: 60 - 62). One of the demands of a public artwork installed outdoors is that it can endure the contingencies of weather. During the course of its installation outside the Royal Society of Sculptors in London, Playground was subjected to weather conditions that were extreme by any standards. Between February and March 2018, the UK was hit by winter storms the 'Beast from the East' and Storm Emma, which brought unusually low temperatures and heavy snowfall to London. Then the weather transitioned dramatically to the hottest April day since 1949 and then the warmest May since records began. The sculpture withstood this extreme weather admirably, but it still required maintenance and superficial repairs. Underneath its homogeneous epoxy surface was a dog's breakfast of different materials that each responded to the changing conditions in different ways: the exterior grade MDF absorbed some moisture, which was not an issue in itself, but when the temperature soared, the water tried to evaporate and produced enough pressure to split the epoxy

surface at its weakest points; the different materials (wood, metal, epoxy and various plastics) subtly expanded and contracted at different rates, to occasionally produce visible cracks at their connections; the epoxy foam reinforcing the interface of ball and table-leg, oozed slightly along the join and then expanded and solidified on contact with the air.

None of these material reactions posed great practical problems, since they could be easily touched up with flexible filler and paint, so as to maintain the illusion of a unified form. But the extreme weather revealed the intrinsic instability of tangible materials: the slow but very real movement that belies the apparent inertia of 'inanimate' objects. This "vibrant matter" exposed the extent to which the uniformly painted surface covered over what lay beneath like a static mask. With the relative expansion and contraction of the various media, the static image upheld by the formal configuration began to disintegrate. The compulsion (necessity) I felt to maintain the appearance (static illusion) made me reflect upon what was at stake in the artwork. It all hinged on a tension between the static reductive abstraction of the digital representation and the dynamic haptic immediacy of the embodied encounter. This tension is what generated the incongruity. As soon as the cracks made the concrete materiality salient, the abstract image dissolved. The sculpture, it turned out, was not at all static, while the digital representation of my memory was. In order for the two to coexist, I had to intervene. To maintain the connection between conceptual representation and concrete object exposed to the weather/time (le temps) required energy (labour). If neglected, it would fall apart according to the law of entropy. The image determined by a closed computer system was incompatible with an open weather system. I had to concede that like Danto's analysis of Malevich's black square (discussed in chapter 2), the appearance of surface cracks was not part of the artwork. The cracks did not add to the artwork's constellation of meaning, but they pointed to a crucial tension for my research.

Conclusion

This project recasts the antagonism between hylomorphic and morphogenetic models of creativity in terms of the spatiotemporality of synaesthetic perception. The digital model represents a classical Euclidean space. It quantitatively limits perception to a single visual sense (via the screen) isolated from bodily movement and even bi-optic vision. The remaining senses – smell, hearing, touch – are attuned elsewhere, to non-Euclidean space, the dynamic space in which one exists while watching the screen. In sculptural space, the subject's kinaesthetic relation to the object synaesthetically fuses all the senses. Exoreferential senses such the visual and the tactile synesthetically triangulate to produce what Deleuze termed the haptic [6], which is simultaneously fused with our self-referential sixth sense of proprioception as we move around the object. All the

other senses – sound and smell - are at play too, and were made more acute in the context of an outdoor public artwork, where: the roar of traffic, the constantly changing weather, the fumes from the petrol station next door, all "confounded" (meaning 'found together') in the encounter. *Playground* sought to transpose the Euclidean stasis of the disembodied digital model into the non-Euclidean dynamism of a busy high street. The homogeneous greyish blue coating not only unified the configuration of disjunctive conjunctions, but also synaesthetically coloured one's haptic and proprioceptive experience of the work, making it subtly incongruous with the vividly varicoloured world around it. This would account for the feedback that recognised the work to have been digitally produced and frequently assumed that it had also been digitally rendered. At the same time, I observed visitors moving around the work and using their hands (just inches away) to follow its topological contours. The tension between the graphic simulation of Euclidean space and the contingencies of spatiotemporal non-Euclidean space was never more salient as when the surface was covered in rain, or snow, or when the residue of dirt congealed in the trough at the base of the slide. Interference on the surface activated the tension, interference in the surface undermined it.

A major achievement of this work was to transpose the digital trope of compenetration into the concrete reality of an outdoor public space. The physical battle required to materially construct this digital illusion and dissimulate its literal materials, mirrored the material self-effacement required by the digital to uphold its false trope of immateriality. From the standpoint of the viewer, this work is all surface. It has no inside (this was evident from the uncertainty, curiosity and questions it elicited from viewers). The complex interrelation of tangible and unstable materials remains hidden from view and therefore out of mind. There was no way for the viewer to recapitulate the work's construction and so this did not factor in its constellation of meaning. On the other hand, the dissonance between this static representation and the emphatic dynamism of the public context and contingent weather posited an incongruous juxtaposition.

Reflecting on this project, I was bothered by the artwork's lack of interior. The particulars of its material construction had been merely a means to an end. Although the production process had revealed significant insights about the relation between sculptural object and digital image, these insights were not made manifest in the final work itself, but rendered conspicuous by their absence. This observation motivated me to find new ways to manifest and activate the specific materiality and construction of subsequent projects for this thesis.

Notes

(1) Jim Issermann *Constituent Components* (2017) was the second exhibition we commissioned for the Physical Information exhibition programme at Bloomberg Space, London. See Appendix 1.2.

(2) The phrase is borrowed from Sherry Turkle's *Evocative Objects*: *Things We Think With* (2011). "These essays reveal objects as emotional and intellectual companions that anchor memory, sustain relationships, and provoke new ideas. These days, scholars show new interest in the importance of the concrete. This volume's contribution is its focus on everyday riches: the simplest of objects—an apple, a datebook, a laptop computer—are shown to bring philosophy down to earth. The poet William Carlos Williams contends, "No ideas but in things" (1927). The notion of evocative objects goes further: objects carry both ideas and passions. In our relations to things, thought and feeling are inseparable."

(3) This Bergsonian relation of the virtual to memory has been highlighted by Shields, Levy, Massumi, Hanson. For a comprehensive account of Bergson's theory of memory and perception, see Suzanne Guerlac's excellent introduction to Henri Bergson Thinking in Time (2006)

(4) The First@108 Public Art Award 2017 at the Royal Society of Sculptors.

(5) Polyurea is a type of elastomer that is derived from the reaction product of an isocyanate component and a synthetic resin blend component through step-growth polymerization. It is created by the chemical reaction (polyaddition) between a di-isocyanate (NCO-R-NCO) and a polyamine (NH_2-R-NH_2), without the aid of a catalyst or an additional cross linker. It is usually applied using a spray coating system in a 1:1 mix ratio. https://www.polyurea-world.com/artikel-article.articleid-232-t-Polyurea_Technologie-sel_lang-english.htm

(6) I gave an artist talk at the Royal Society of Sculptors during the exhibition of shortlisted maquettes. During the audience questions, several people noted a resemblance to the phenomenon of 'ghost bikes' that are common in London. Bicycles painted entirely white are sometimes chained to the site of a fatal bicycle accident.

(7) In AThousand Plateux Deleuze and Guitari distinguish haptic space from optical space and in contrast to its common usage as a synonym for "tactile": "haptic" space, as distinguished from optical space." Haptic is a better word than "tactile" since it does not establish an opposition between two sense organs but rather invites the assumption that the eye itself may fulfil this nonoptical function." (492 [through 499])

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5. Gate/Fragment

Captivation

Out running on my usual route from my flat in Brixton to the river at Battersea, I was enjoying the relative lack of effort and concentration required when jogging downhill. The rhythms of my breathing and my gait had somehow aligned without conscious effort and I was thinking of nothing at all. That is, until I was stopped in my tracks by an iron gate. The curious fact was that this gate was not physically obstructing my route, as one might expect. It was the side gate of a suburban end-of-terrace house that I had presumably passed many times before. On this occasion, however, it had been opened 180 degrees to overlap a second, similar gate. These typical side gates presented symmetrical geometric designs consisting of a flat bar frame, square or round rod bars, and slender strips that have been wrought into decorative scrolls. The surprising effect of encountering two of these designs overlaid, but slightly out of alignment, generated an exponentially more complicated asymmetrical pattern that was momentarily confusing because I did not initially read it as two regular gates, but rather mistook it for one irregular gate. Perhaps this experience captivated me because the misconstrual chimed with my research into the compenatrating tendency of digital models. However, here the illusionary effect appeared strangely two-dimensional and at the same time the complex abstraction of the design seemed emphatically at odds with the material tangibility of iron, or in fact steel, as it turned out to be. As far as I could tell, it would be impossible to wrought steel with the fragmented complexity that I was observing. The confusion did not last, but by then I was standing still, close to, and engaged. Narrowing my eyes, it did not take much imagination to re-envisage the two gates merged as one and to re-experience the strangeness of the tangled grids and spirals.

For Alfred Gell, whose anthropological theory of art was rooted not in semiology nor aesthetics but agency, *captivation* is "the primordial kind of artistic agency" (Gell 1998: 69). He explains "every artifact is a 'performance' in that it motivates the abduction of its coming-into-being in the world. Any object that one encounters in the world invites the question 'how did this thing get to be here?" (Gell 1998: 67). This is why Gell identifies making as a particularly salient feature of artistic agency. In Gell's analysis, captivation occurs when there is incongruence between the spectator's experience of agency and the agency originating from an object. He initially illustrates this by describing how his limited experience of the possibilities of painting as a Sunday painter, are confounded when confronted by the incomprehensible virtuoso paintwork of Vermeer. But to really make his argument understood as a critique of conventional western aesthetics, Gell revisits his earlier account of the hand-carved Trobriand prow-boards [1]. The richly carved and painted panels on the prows of Trobriand canoes are the first thing that their overseas exchange-partners get to see when their

flotilla arrives to trade kula. Gell describes them as "psychological weapons" because the purpose of the ornate carvings is to demoralize the opposition, diminishing their capacity to negotiate. "A prow-board is an index of superior artistic agency, and it demoralizes the opposition because they cannot mentally encompass the process of origination, just as I cannot mentally encompass the origination of a Vermeer." (Gell 1998: 70-71). "Artistic agency", Gell argues, "is socially efficacious because it establishes an inequality between the agency responsible for production of the work of art, and the spectators; in the Trobriands this inequality is attributed to superior magic; in the West, to artistic inspiration or genius." (Gell 1998: 71).

Captivation or fascination – the demoralization produced by the spectacle of unimaginable virtuosity – ensues from the spectator becoming trapped within the index because the index embodies agency which is essentially indecipherable. Partly this comes from the spectator's inability mentally to rehearse the origination of the index from the point of view of the originator, the artist. The 'blockage' in cognition arises at the point when the spectator cannot follow the sequence of steps in the artist's 'performance' (the 'performance' which is objectively congealed in the finished work). The raw material of the work (wood) can be inferred from the finished product, and the basic technical steps – carving and painting; but not the critical path of specific technical processes along the way which actually effect the transformation from raw material to finished product. In other words, it is the complexity of the artistic decision-making process (generate and test) which defeats spectatorial recapitulation. (Gell 1998: 71-71)

Pausing halfway down the hill in Battersea, "trapped within the index" of two unremarkable suburban gates that I misconstrued as one, I was reminded of Gell's account of the Trobriand carvings. Gell's enquiry into captivation prompted me to ask the question: what if the "superior agency" was not the effect of magic or genius, but digital technology? Could I use the superior processing power of a computer to produce "extraordinary effects by means which do not articulate to the agent's 'normal' sense of self, embodiedness, agency, and being in the world."? (Gell 1998: 71). This question seemed pertinent to my research because the primary purposes of most digital media are either to elicit sales or to captivate the user long enough for their valuable data to be extracted. The Trobriand's use of artistic virtuosity and the capitalist deployment of digitally enhanced imagery are connected because they are both intended to captivate users in order to create advantage in the marketplace – an external purpose rather than an immanent meaning. I decided to try to objectively congeal the performance of the digital within a representation of generic suburban gates; to use computational complexity to defeat spectatorial recapitulation.

I had the initial idea to digitally superimpose a number of generic gates so that their frames, bars and scrolls became inextricably entangled. I wanted to cast this abstract proposition into solid iron and then allow it to rust. I envisaged the interfusion of the gates to appear graphic and simultaneous due to the inhuman precision of the digital process and at the same time the irregular, powdery corrosion of the iron to express material weight and duration, as if something from the

future had got trapped in the past. The gate's literal function to physically obstruct the human body might be played out through abstract captivation. In fact, Gell explains that the cognitive resistance produced by surface decoration such as Celtic knotwork, accounts for their application at thresholds. This is the 'apotropaic' function of patterns as protective devices, defensive screens or obstacles impeding passage. "Apotropaic patterns are demon-traps, in effect, demonic fly-paper, in which demons become hopelessly stuck, and are thus rendered harmless." (Gell 1998: 84).

Reverse engineering

My first experiments were with two-dimensional drawings. I made simple line drawings of common gate designs using the vector software program Adobe Illustrator. I then experimented with overlaying these drawings to varying degrees of complexity (figs. 3.7-3.9). These experiments evidenced one of the traits of the digital that I have discussed in chapter 1: the infinite potential for differentiation. In other words, I could go on and on producing infinite combinations of overlaid gates. I was going to have to establish a preference. At first, I was captivated by one of the busiest combinations of multiple gates (nine) that I had produced. The combination was so busy that it was absolutely impossible to distinguish individual gates, although the unique character of one dominant gate was salient because it had a recognizably Art Deco design that was much more ornate than the other more generic examples. The complexity of the combined pattern was beguiling because it was beyond comprehension. In fact, it was barely a pattern at all, because I had overlaid the gates slightly out of register, so that although repetition and symmetry were evident, they were not pronounced. The density of the tangle was claustrophobic and this was somehow emphasized by the dominant circle motif that bored a hole clean through its centre. This design seemed to offer a level of complexity that could only have been computer generated and was certainly captivating in its "superior agency". I decided to extrapolate it into an object, a scaled down maquette to test the effects of materialisation (fig. 3.10).

The most efficient way of doing this was to laser cut MDF directly from the vector files. In order to render the object as truly three dimensional, I decided to allocate a different depth to each element of the gates: scrolls, bars, and frame would be cut first from 3mm MDF, then I cut two further 3mm layers of the bars and frames without the scrolls, and finally two further layers including just the nine frames. By gluing layers 2 and 3 to either side of layer 1, the frame elements of each gate were rendered 15mm thick, the bars 9mm thick and the scrolls just 3mm thick. In this way I built up a very shallow object that was a little more three-dimensional than a single cutout form. The nine gates were aligned out of register vertically and laterally, but their equal depths were aligned symmetrically around a common midpoint, so that although the two-dimensional view was highly complicated (nine

objects), its profile was very simple (three depths). I spray painted this object with an off-the-shelf primer that was approximately 'rust' colored, to unify the surface and disguise the blackened laser cut edges. Although the finished object was certainly captivating up to a point, it was also surprisingly disappointing. The simplicity of its depth belied the complexity of its face. It was incomprehensibly complex, but to the point that it wasn't worth trying to mentally encompass the process of origination because it was obviously computer generated. It was also barely an object and functioned more like a patterned surface. Perhaps this was because, as Gell puts it, "complicated patterns lie on the borderline between visual 'textures' and 'shapes'". (Gell 1998: 79). In this respect my test sculpture lacked 'thingness' and was all abstract decoration. "Sheer complexity, involution, and the simultaneous suggestion of a great many formal relationships between motifs is a characteristic of decorative art in general. One cannot understand decorative art by generalising from simple, easily interpreted, examples, because the telos of decorative art lies in the opposite direction, towards the complex, the ambiguous, and the multitudinous." (Gell 1998: 79). This first three-dimensional extrapolation helped me to recognize that while excessive complexity certainly emphasizes abstraction, it can also overwhelm material substance, resulting in a lack of tension. My prototype did not present itself as multiple objects in the same space, but as a singular decorative object. I understood that I would need to shift the bias away from mathematical complexity and back towards "generalizing from simple, easily interpreted, examples".

There was another practical material factor in my thinking here. I took my first prototype to a foundry that specializes in sandcasting iron gates and railings. The technicians there explained to me that my pattern was far too complex to be cast into iron. Part of the issue was that the style of gate I was working with was 'wrought', whereby the decorative scrolls were produced by heating and bending thin material around an anvil, whereas cast iron gates are made using molds that have detailed surfaces, but relatively voluminous forms. The complexity of my gate was an issue because molten iron or steel has a viscosity that would prevent it from flowing around a mold that is two narrow or convoluted. It would cool and set too soon, blocking the remaining material from filling the mold. The foundry technicians advised me of the minimum gauge that could be cast and also indicated the maximum complexity of form. It was clear that the design of my superimposed gates would need to be radically simplified and also cast in small sections that would need to be welded together after casting. This advice came with the caveat that welding cast iron is very difficult, but not impossible.

Revisiting my initial line drawings, I settled on a combination of three gates that were all similar in ornamental design, but which had contrasting outlines – two with curved arches and a one more pointed 'gothic' arch. Combined, the arches lent the design a vaguely ecclesiastical tone, whilst the

spare interaction of the different frames, bars and scrolls offered coincidental areas of complexity and areas of simplicity. I played around with their respective placement and found that if they were all too directly overlaid, the individual gates could not quite be determined. However, if they were too spread apart so that they only partially overlapped, they clearly appeared as three distinct gates intersecting like a Venn diagram. Through experimentation, I managed to find an ambiguous midpoint where the individual gates were just readable, but were sufficiently entangled to muddle the eye. Given the relative simplicity of the front view, I considered how I might complicate the profile. The most obvious solution was to arrange each gate out of register in depth as well as breadth and height. Because I was still thinking to sandcast my MDF object, I had to bear in mind that no undercuts would be possible. Sandcasting involves pressing one half of the form into fine compressed sand and then repeating with the other side. Any undercuts would be lost because they would be destroyed when the pattern was retracted from the sand. This meant that there had to be a central layer consisting of all the other layers and that the profiles would need to be perfectly perpendicular to the face. Instead of rendering the three elements (frame, bar and scroll) of nine gates in five layers, I decided to render the three elements of the three gates in fifteen layers (figs. 3.11-3.15). Building up a complex depth of object layer-by-layer in this way would be like a very crude approximation of 3D printing or rapid prototyping, which also works by laying down a layer at a time, but usually by micromillimeter increments.

To add to the complexity, I decided that each element of each gate would have unique in gauge. In other words, the frame, bars and scrolls from one gate would be of different dimensions to the frame, bars and scrolls of the others. The complexity of the design was such that it was often difficult to tell which gate a specific element actually belonged to. By allotting each gate with subtly different set of dimensions, these differences might become almost subliminally palpable, even if they could not be easily observed. I walked around my neighborhood measuring the three different elements of the gates I found there. They were fairly consistent, but subtly varied from gate to gate. I used these dimensions for an initial reference when I was allotting thicknesses to the elements of my vector drawing. I was conscious that my rationale was becoming completely abstract and mathematical. Just as my layering process was crudely mimicking a 3D printer, my schematic calculations felt like I was mimicking a design program. However, I was about to discover the materiality of my project reassert itself in an unexpected way. The minimum gauge that the foundry technicians had recommended was much thicker than the profile of any of the gates I had measured. Widening the narrowest element to correspond to the minimum threshold for molten iron and therefore widening all the other elements in proportion, made the design appear chunky. The next challenge was to convert these facial plane dimensions into plausible depths that corresponded to

combinations of the available thicknesses of stock MDF: 2mm, 3mm, 4mm, 6mm. It took quite some working out to arrange these standardized thicknesses of MDF so that they represented fifteen different gauges of material, in three misaligned relations (fig. 3.16). I then realized that three thicknesses of each of the vertical bars for each gate needed to be square in section, so that their width and depth were equal. So, I had to return to the face view and adjust the width of those bar elements to correspond to the depths I had calibrated according to the feasible MDF layers. This to-and-fro negotiation between measurement and material is the process that ultimately governed the final design, and the result bore very little resemblance to the real measurements I had collected from actual steel gates. My final design was cartoonishly thick and extended in depth. This unnaturalistic exaggeration of graphic and three-dimensional aspects implied a representation that had been stylized through mediation.

I produced a further scale 1:1 test section of the new design to get a feel for how it would look and feel (fig. 3.14). Laminating the MDF was especially challenging and I found myself unable to stack and glue the layers neatly and with even pressure, leaving the profile angled awkwardly off-perpendicular to create a mild undercut that would cause problems with sandcasting. I realized that I would need to add registration holes so that the layers could be aligned accurately using dowels. Another problematic material factor was that the laser cutter does not actually cut at precisely 90 degrees to the material surface. The laser beam widens ever so slightly as it moves away from the laser and therefore cuts through the material at a very slight angle. This angle is barely perceptible to the eye, but when layers of very thin material are stacked up fifteen times, the repeated cut angles can be clearly felt as angled steps, like a saw-tooth roof. These tiny undercuts would also cause problems for sandcasting, because the saw-tooth steps would act like barbs, dislodging sand when the pattern was withdrawn from the mold.

I tried using a range of fillers to smooth over the saw-tooth profile before painting. Although I managed to do this with some success, it was extremely time consuming due to the level if intricate detail and would be utterly impractical for the entire life-size object. I took this test section back to the sandcasting foundry, only to be informed that even if I managed to glue all the layers perfectly aligned and then smooth off the saw-tooth effect caused by the laser cutting, my new design was now so exaggerated in depth that it would not be possible to sandcast unless I was able to add 'draft angles' to every profile. A draft angle is basically a mild taper so that the extremity of the form is always thinner than the midpoint, like an acute triangle with the top chopped off. This would ensure that pulling it out of the mold would not dislodge any sand. Unfortunately, there was no way of building a draft angle into such a low-tech fabrication process using laser cut MDF. I was forced to give up on my plan to sandcast my life-sized representation of three superimposed gates.

Digital rendering

I decided that at the very least I could produce a 3D digital rendering of the sculpture I had designed, so that I could share a visualization of the artwork I envisaged. I emailed my two-dimensional vector drawings to an architect friend, Priscila Fiszman. The file was divided into layers that represented each layer of MDF and each layer was allocated a thickness. With this information Priscilla was able to quickly produce a three-dimensional digital model that could be imported into a 3D rendering program, furnished with simulated materiality, and subjected to different simulated lighting conditions. I asked her to give it a 'rust' finish and to hang it on a white wall above a neutral floor – the default conditions of a 'white cube' contemporary art gallery (fig. 3.23). It was interesting to note how the simulated shadows that this cast on the wall behind the sculpture both compounded the complexity of the visual effect and literally threw the object into relief, embedding it in the simulated gallery space. At the same time, the stark white wall placed the pattern into silhouette, which had the effect of flattening the proposition and highlighting the abstract pattern. This seemed to shift the bias from representational object towards to abstract decoration.

To counter this flattening, decorative aspect and reassert a physical proposition in relation to the body, I tried installing the simulated artwork as a literal gate, obstructing passage between two simulated walls (fig. 3.24). Although this seemed like a more interesting concept, the images didn't help me to understand how it might feel to encounter at all. I wanted to render the tension between abstract design and concrete fact palpable, rather than readable. As a digital rendering it was just an image – an abstract representation – that conveyed no sense of weight, scale, materiality, or time. The impoverishment of these digital renderings made me even more determined to resolve the project sculpturally one way or another.

By focusing on a geometric abstraction, I sensed that I was too uncritically adopting an hylomorphic logic of imposing form and structure on matter. In order to proceed, I would need to return to the materials and let their affordances and constraints lead the way. "Follow the materials", Tim Ingold would suggest: "The living work of art, however, is not an object but a thing, and the role of the artist is not to give effect to a preconceived idea but to follow the forces and flows of material that bring the work into being." (Ingold 2013: 96). Developing his ideas from philosopher Gilbert Simondon's notion of individuation, that holds that the generation of things should be understood as a process of morphogenesis in which form is ever emergent rather than given in advance (2.), Ingold highlights the "continuous modulation that goes on in the midst of form-taking activity, in the becoming of things." (Ingold 2013: 25). To illustrate the central role of "continuous modulation" in morphogenetic process, Ingold turns to Gilles Deleuze and Felix Guattari's critique of the matter-form

model. Assuming 'a fixed form and a matter deemed homogeneous' fails to acknowledge the variability of matter – its tension and elasticities, lines of flow and resistances – and the "confrontations and deformations to which these modulations give rise" (Ingold 2013: 25). As Deleuze and Guattari put it "it is matter in movement, in flux, in variation" and "this matter-flow can only be followed" (Deleuze & Guattari 1996: 450-451). Deleuze and Guattari provide the example of metallurgy to highlight the insufficiency of the hylomorphic model that reduces technical operations to discrete steps: "Matter and form have never seemed more rigid than in metallurgy . . . yet the succession of forms tends to be replaced by the matter of a continuous variation" (Deleuze & Guattari 1996: 453). "Even iron flows", summarises Ingold, "and the smith has to follow it". (Ingold 2013: 26).

Fragment

I now turned my attention from the geometric abstraction of the computer renderings to the "matter-flow" of metallurgy. Since I wished to see the effect of casting the compenetrating gates into rigid iron and my MDF pattern would not afford sandcasting, my only option was to try investment casting, otherwise known as the 'lost wax' method. Since foundries (including the university foundry) that specialize in sculpture rarely work with ferrous metals because the carbon would contaminate non-ferrous alloys such as aluminium or bronze, I had to find an industrial foundry that worked with ferrous metals like steel and iron. Sculptures and architecture bearing rusty patina tend to be made from weathering steel or 'Corten' steel, a stable steel alloy that forms a superficial rust-like appearance over time. However, I was determined to work with simply 'cast iron' because of its symbolic engineering value as the material of strength, weight and rigidity and I therefore wanted to be able to list 'cast iron' as the single material used. I was also attracted to the fact that cast iron is intrinsically unstable and would naturally corrode over time. Since most irons are actually quite brittle and weak in tension, I settled on 'ductile iron', or SG iron, which has spheroidal graphite added to the iron, transforming its molecular structure into an alloy that is stronger than steel.

To make a rubber mold of the life-sized merged gates, as I envisaged, would be prohibitively expensive. However, since I would need to cast the object in smaller sections anyway, due to the viscous "matter-flow" of molten iron, I decided to make one test section as a case study and proof of concept. I selected an area of my digital design approximately 50cm x 30cm, that included perhaps the most complex interfusion of pattern on from the whole design. Having laser cut the fifteen layers of this fragment, I used a vacuum bag press to apply atmospheric pressure evenly across the whole object during the laminating process. I had to do this in two halves that were then glued together and clamped. I used a backing sheet of MDF to make sure that the halves remained completely flat while the glue was drying in the press and it was at this point that I noticed the peculiar effect of the MDF

pattern emerging from the MDF surface (fig. 3.17) (I will return to this insight in due course). I then filled and sanded the profiles to remove the saw-tooth effect that revealed the laminated layers until I had a produced smooth, primed and lacquered 'pattern' ready for mold making; a continuous topological surface.

Once a one-piece rubber mold had been made and the pattern removed, it was time to cast the form into wax. It was at this stage that I ran into an unexpected challenge – the contingency of weather. It was an especially hot summer. Soaring temperatures made the foundry environment even hotter than usual. Most of the casting produced at this industrial foundry involved mass-produced objects – propellers, for example. Mass produced objects require rigid steel molds (rather than soft rubber molds) into which an especially hard wax can be pumped at high pressure. This means that the hard wax is very stable and retains its precise form until it is encased in ludo (a plaster and sand mix) for the burn-out. However, I could only pour a much softer wax into my rubber mold and that meant that it was quite unstable and prone to the heat variance between de-molding and encasing (fig. 3.19). The first iron cast that came out looked okay from a distance, but on close inspection its straight frame and bars could be seen to be warped and wobbly (fig. 3.21). It looked a bit like it had been modeled out of clay rather than constructed from rigid iron because the wax pattern has softened and distorted in the heat. After several attempts we finally managed to get a cast that was nearly perfect. Nearly, because I could still detect a very subtle wandering of its 'straight lines', but this subtly soft irregularity undermined the otherwise digitally precise interfusion of forms afforded by the design program in a way that left the object, to my eyes, feeling curiously charged and unsettled. Not only had the specifications of the design (gauge, simplicity, size) been determined by the requirements of flowing metal, but the instability of the soft wax had also produced deformations resulting from the flux and flow of "matter in movement".

Once I had left this cast-iron fragment outdoors for a few weeks it took on a rich rusted texture that was more naturally varied than the superficial decorative effect that Corten produces. Rain pooling on the horizontal faces rusted more quickly than the undersides and vertical edges. In places where drips ran down, the surface stained unevenly (fig. 3.20). These variations in tone and color belied any conception of homogenous matter. The fragment was also very heavy and it made me realize how ridiculously heavy the entire artwork would be if I ever managed to produce it in iron. However, I also realized that I didn't have to complete it now because the cast iron fragment was more sculpturally resolved than I had anticipated. The discontinuous pattern of the part pointed elliptically to a whole that wasn't there. Devoid of a clear external referent, the object seemed to turn inwards on itself and the most pertinent relations became internal. The abstraction of the proposition was now more emphatic due to the absence of specific figuration, whilst the suburban character of

the generic decorative motifs still articulated its roots in domestic social structure. Particularly compelling, for me, was the incongruence between the wrought iron process that was figured and the cast iron process that had occurred, and of course the digital mediation that had bound these processes together. Abstracted from the recognizable size and shape of complete gates, the vertical, horizontal and spiral elements at different depths now suggested an object lesson in geometry, revealing golden sections, fractal tangents and other archetypes of mathematical form. The surprise for me was that the combination of these various effects produced what Gell called "a certain cognitive indecipherability", and yet I was the agent responsible, along with the digital software, the contingent weather and all the other material factors that had co-authored it with me. I had set out to represent a gate, or rather three gates inextricably entangled. Having lost the outline of the gates along the way, I had arrived at a representation of inextricable entanglement. In other words, I had made a kind of cast iron knot.

Knot theory

Riffing off Alfred Gell's discussion of knotted patterns, anthropologist Susanne Küchler's essay on Knot theory, *Why Knot?* (2001), describes how topology emerged as a new branch of mathematics developed using computer modeling as imaging technology (Küchler 2001: 61). Knot theory provided the mathematical tool for tracing the behavior of solids in shifting reference systems. Küchler describes how the intertwined pattern of a knot, "its embeddedness in the mundane and relational texture of the everyday" lends it the capacity to become the "object of affect-driven thought" (Küchler 2001: 64). The crux of Küchler's analysis of knots is the significance of the surface or space around the knot. "The space around the knot is everything but the knot, with the knot lying within or beneath the surfaces which make it visible to the eye." What emerges from this simple insight, that knots involve a dialectical relation between what is there and what is not there, is that they suggest a binding of sculptural form and virtual space:

> As the knot is contained within the negative space created by patterned surfaces, it lends itself to be applied to the conceptualization of sculptural form. And, as it is prone to retaining its geometric properties under deformations, the sculpted knot enables intellectual economies to unfold around a polity of images. (Küchler 2001: 65-66)

And yet at the same time:

> The space thus created is strictly self-referential in that it does not represent spaces of imaginary or past experience. As virtual space, the knot-spanning surface acts synthetically in bringing together, like the mathematical formula or the architectural plan, experiences from a number of domains; rather than just articulating already existing knowledge, the knot as

artefact is thus capable of creating something 'new' – a momentary integration of distinct domains of experience which may be a reason for the symptomatic use of the knot as a contractual object. (Küchler 2001: 68)

Küchler's argument that the topology of knotted patterns creates a new "momentary integration of distinct domains of experience", namely sculptural form and virtual space, offers an interesting approach to thinking about the origin story of my cast iron Fragment. Gell's theory of 'abduction' entails a combining of affective and cognitive processes. Against the notion of art as the object of discursive thought, Gell asked how art could be "thought-like". By emphasizing the linking of material and mental processes, Küchler shows how "The knot epitomizes what levenson (1991) called 'knowledge technology' responsible for externalising non-spatial, logical problems in a distinctly spatial manner. Associative or inferential thought provoked by the knot may thus condition spatial cognition because of the textured and deformative properties of the knot." (Küchler 2001: 71)

MDF

There were moments during the convoluted fabrication process of the cast iron *Fragment* that had surprised me. I will return now to the striking effect of the MDF pattern emerging from the MDF surface during the laminating process with the vacuum bag press. The effect was especially remarkable because I dislike MDF as a material and it rarely suggests any redeeming features in and of itself, except for its convenience as a cheap and easily worked material. After I had glued the two sides of the MDF fragment together to make the pattern for the rubber mold, I remember feeling distinctly disappointed with the freestanding result in contrast to the kind of bas-relief that I had been holding moments before. I thought about the emphasis that Küchler had placed on the embeddedness of a knot in its surface and felt that this effect was worth revisiting. I also felt an urge to materialize the complete design of three compenetrating gates, that had evolved though a negotiation between abstract calculation and the physical properties of MDF. I resolved to produce the complete design as an MDF pattern emerging from an MDF surface. Rather than effacing the production process to produce a mysterious object that could not be easily recapitulated by the spectator, this object would lay its means of production bare.

I divided the fifteen layers into fifteen further sub-sections that were labeled alphabetically A – O, to produce 225 laser cut parts (fig. 3.26). I also liberally riddled the design with 6mm registration holes wherever I thought they would be useful, so that I could use dowels to align the details during the laminating process. Laminating with the vacuum bag-press involved carefully rolling extra-slow-drying wood glue over one layer of one section, applying the next layer using the dowels to align the two, and then repeating this process for three further layers. I would then use an air compressor to fix

the layers in alignment with headless pins, before sliding the section into the vacuum bag where it would remain evenly clamped under atmospheric pressure for several hours until the glue had irreversibly grabbed. Even with the extended drying time of the retarded glue, this was a hurried procedure and despite the registration dowels, it was really the act of running my fingers around the edges of the sections that determined whether the layers were sufficiently aligned to be pinned in place. The point here is that my sense of touch was more pertinent than my vision, because I could quickly feel all around the object and manipulate it in real time to correct displacement without even thinking, whereas it was very hard to judge the precise alignment by viewing from different angles. Finally, I went to the trouble of laser cutting the 12mm backboard so that this would leave the same characteristic charring as all the other edges, integrating it fully with the rest of the work. The color and tone of the scorched laser cuts varied according to thickness and even particular MDF stock, producing a varied stratification of honey-to-dark brown stripes across the depth of every profile.

The completed work was really a surprise to me, primarily because it was no longer a gate. It led nowhere – indeed it could not be separated from its ground – and also it was made of MDF. The spiraling scrolls that were suspended just a centimeter or two away from the MDF ground appeared emphatically fragile. There was a strange tension between the lines produced by the cut edges of the sub-sections, and those that delineated a contour or one of the gates. The artwork presented not only three gates as one, but two hundred and twenty-five pieces of MDF as a single entity. The numerous registration dowels took on an almost expressive punctuation that highlighted their unsystematic arrangement. Above all, the stratified precision engineering of the MDF had no logical relation to the wrought shaping of rigid steel that are the source for the forms. Sculptural form and virtual space had colluded to produce something unexpected. I realized that the bias between material and mental process had shifted and now there was absolutely nothing mysterious about the artwork's construction. The mystery wasn't the process of its making, but in the thinking of its making: "How did this thing get to be here?" The artwork bore no resemblance to the one I had set out to make. I had simply returned to my vector drawings, and this had opened up a more complex process as I divided it into parts and assembled them using MDF. The vector drawing had been extruded in the most mundane material imaginable. Yet the human scale and direct proximity to my body lent the object a presence that felt a bit like confronting another figure. Emerging from its surface, the shallow gap between geometric pattern and material ground produced a strangely abstract space. A tortuous excess of digitally calculated MDF, the sculptural form of Gate suggested a portal to a digital space that I was physically barred from entering.

Conclusion

This project began with a chance encounter with two overlapping gates while I was out running. Like the glove, rat and bottle cap that Jane Bennett encountered in a Baltimore storm drain, the gates commanded my attention in their own right "as existents in excess of their association with human meanings, habits or projects" (Bennett 2010: 4). They provoked affects in me through their "thing power", through the particulars of their material and construction and also through their chance assemblage as if superimposed. By using digital processing to literally superimpose gates that had been reduced to vectors, I had intensified the inextricable entanglement and problematized cognitive recapitulation. In this way digital mediation afforded the intensification of what Gell identified to be the apotropaic function of knotted patterns, producing geometric abstraction "cognitive snare".

While Bennett's encounter prompted a theoretical disquisition, my own encounter prompted a material one. It was in the relay of analogue processes used to reconstitute this digital representation in concrete form that exposed the agency of vibrant materials. The vitality of unstable wax, viscous metal and variable corrosion all served to highlight the primacy of processes of becoming over the states of being through which they passed. These processes were morphogenetic rather than *hylomorphic* because the final form of *Fragment* was not imposed on inert matter, but emerged from the tensions and elasticities, lines of flow and resistances of: laser cut MDF and glue, rubber mould and wax pattern, ludo case and ductile iron, rain and rust. These were Ingold's "forces and flows of material" that brought the work into being. Not a succession of distinct steps, but modulations in continuous variation. Mounted on the wall like a picture and seen from close to, *Fragment* exhibits a complexity and precision of geometry that implies computation. However, *Fragment* is also an indeterminate form wavering between the processes of hammering and casting. Its rusted crystalline structure exhibits what Bennett called "a metallic vitality, an (impersonal) life, [that] can be seen in the quivering of these free atoms at the edges between the grains of the polycrystalline edifice." (Bennett 2010: 59).

A second work, the unanticipated MDF bas-relief that resulted in *Gate*, rehearses the threshold between digital and analogue processes. On one hand, the theoretically *hylomorphic* imposition of abstract geometric form laser cut from passive MDF. On the other hand, the manual lamination of the MDF using glue and atmospheric pressure, which turned out to be more *morphogenetic* than I expected. Gate makes a virtue of its imperfections and adjustments. In his classic book *The Nature and Art of Workmanship* (1968) the industrial designer and craftsman David Pye distinguished between what he calls 'workmanship of certainty' and 'workmanship of risk'. Fully automated processes of mass production are regulated to produce certain results, whereas the contingencies of

one-off craftsmanship are open to risk. According to Pye, "it must be remembered that, where construction is involved in the making of something, then although the components may be made by the workmanship of certainty, they will still nearly always have been assembled by the workmanship of risk." (Pye 1968: 34). The tensions between the precise regulation of the laser cutting and the imprecision of hand lamination (irregular edges, misaligned connections, drips of glue and protruding panel pins) epitomized the modes of craftsmanship described by Pye. What was unexpected was how this tension is activated by the viewer's changing relationship to the work:

> In nature, and in all good design, the diversity in scale of the formal elements is such that at any range, in any light, some elements are on or very near the threshold of visibility: or one should say, more exactly, of distinguishability as elements. As the observer approaches the object, new elements, previously indistinguishable, successively appear and come into play aesthetically. Equally and inevitably, the larger elements drop out and become ineffective as you approach. But new incidents appear at every step until finally your eye gets too close to be focused. (Pye 1968: 62)

Much as Pye describes here, *Gate* reveals its contradictory aspects at different degrees of proximity. At first sight, it presents an entanglement of MDF gate profiles emerging from an MDF ground. The closer the viewer approaches, the more its complexity is revealed and the initial gestalt gives way to abstract details. Every stage of the making process is gradually revealed, from the hallmark scorched edges of the laser cutter, to the irregular thicknesses of MDF, the seeping glue, the etched numbers and the doweled joints. In sculptural terms, it elicits the opposite response to the concealed materiality of Playground. Unlike the Trobriand prow boards, or digital images (as commodities), the internal material details of *Gate* invite cognitive recapitulation of the making process, which is neverthele4ss at odds with the form it suggests. The unexpected mystery of Gate is the incongruity between its form and materiality, activated by the kinaesthetic embodied encounter of the viewer. Responding to the vital power of a found gate, it's trans-mediation from thing/digital/sculptural generated an unexpected artwork that re-asserts the power of attentiveness to sculpture through a tension between the digitally derived image that it projects and its pronounced material facticity.

Notes

(1)   Gell first gave an account of the Trobriand summarized her in his earlier publication *The Technology of Enchantment and the Enchantment of Technology* (1992)

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6. Tree

Thinking through material

For a number of years, I have been running a seminar with BA Fine Art students that I call *Thinking Through Material*. The two-session small group round-tables involve rigorous scrutiny and shared discussion about objects chosen and brought along by each individual student. The first session involves sustained engagement with a disparate range of items: trinkets, artifacts, heirlooms, tools, stationary and occasionally bits of rubbish. The group considers the objects from aesthetic and semiotic standpoints, as well as trying to understand the agency of how and why the things were made as they have been. In the second session the students select and bring along examples of their own sculptural work, finished or otherwise. Together we apply the same level of examination, analysis and speculation that we had generated when looking at the non-art objects. The seminar removes the stigma that can associate with interpreting artworks and helps to uncover the ways things can generate meaning indirectly through their materials and construction, as well as engendering dialogue and idea exchange in the studio. To help get the first sessions going, I always bring something along to put on the table too.

Leaving my flat on a day when I would be holding one of these seminars, I remembered I needed to bring something and glancing around the kitchen, my eyes settled on a funny little Christmas ornament that I had been given a few years before, and which had been sitting on a book shelf in plain view ever since (fig.4.1). I hadn't really given it much thought, but I liked that for most of the year it was an anachronism, except in late December. In the seminar I put it on the table along with: a blue watering can, an antique watch, biscuit tin, a locket and a couple of other objects I don't recall. Naturally everybody recognized that it was a stylized little Christmas tree made of colored glass. The 'pot' was dark translucent blue, the 'tree' was a translucent mid -green, and the 'baubles' at the end of each branch had been dipped in opaque scarlet enamel. Somebody suggested the red enamel looked a bit like nail varnish, and the comment immediately made the object seem quite dainty. There was some debate as to whether it could be quite valuable like an example of Venetian colored glass. But then it also could have been quite cheap, as though it had come from an up-market Christmas cracker. There was something about the way that each 'branch' drooped in the middle, as if the heat required to weld it to the 'trunk' had caused the 'branch to soften and melt slightly. However, it was this droop that somehow emulated the way that the branches of a fur tree bow under the weight of snow, before turning up towards the tips. In this way the factory fabrication and the natural growth it mimicked converged pleasingly. We talked about the notion of 'kitsch' and the idea of cultural hierarchy. This object seemed very difficult to place on any scale of value. It was noted

that the 'trunk' emerged from the 'pot' slightly off-center, and in fact there was a general wonkiness to it that seemed to belie any suggestion that it was the result of fine craftsmanship. At the same time, it was also noted that the bottom section of the 'pot' was surprisingly straight with a regular taper. In fact, it was the straightness of the 'pot' that made the 'tree' seem especially wonky. Then it dawned on us: the 'pot' must have been precisely machined for a reason – to fit into something. This little tree was in fact a bottle-stop and the 'pot' was effectively the cork. The little tree was not merely an ornament, but it had a function. Handling this awkward little object, everyone agreed that they would never want to use it for that purpose, but that considered as a mere ornament it retained a curious charm.

Quantum entanglement

That evening at home, I returned the little tree to its place on the bookshelf. I looked at it differently now. It had been given a great deal of attention and had prompted some interesting debate, but ultimately it had resisted comprehensive explanation. Now I saw it not as an ornament, or a bottle stop, but as a useless yet intriguing *thing*. Sometime later, following a postgraduate research presentation about my *Playground* project, I was reflecting on feedback I'd received about that sculpture's uniform finish. Everybody had wanted to know what was underneath the painted surface that covered over the nuts and bolts of the material reconstruction. "What's on the inside?" someone had asked. When I had heard this, I immediately pictured a transparent sculpture, but I couldn't begin to think about how I might produce one. I thought about Charles Ray's description of a transparent Donald Judd sculpture: "Looking at the beautiful Judd I am privileged to see its internal and external structures simultaneously. Like a being from any dimension this sculpture is totally and completely embedded in the space of its existence. I am reminded of Aristotle's disbelief in the fourth dimension: his proof of its nonexistence was that he could not point in its direction." (Ray 2006: 19). When I had been experimenting digitally with the compenetrating objects for *Playground,* I had often switched the software to 'X-ray' view because it revealed that what otherwise looked like two objects merging to form one object, was in fact mutual interfusion, whereby each object could be seen to penetrate the other. It occurred to me that this was why the moment of interfusion was so interesting. What would happen to physical matter in such a contrived situation?

In his unfinished story, *The Great Dark*, Mark Twain uses the microscopic contemplation of a drop of water as a fictional device to launch the imagination on a fantastical voyage where reality and dream become fused. Intriguingly, this tale also features a description of two transparent figures superimposed:

… and before I could interfere he sat down in the Superintendent of Dreams' lap! - no, sat down through him… [The] Superintendent of Dreams' head was larger than Turner's, and surrounded it, and was a transparent spirit-head fronted with a transparent spirit-face; and this latter smiled at me as much as to say give myself no uneasiness, it is all right. Turner was smiling comfort and contentment at me at the same time, and the double result was very curious, but I could tell the smiles apart without any trouble. (Twain, 1938, p. 279)

Reflecting on Twain's fictional compenetration and Ray's invocation of the fourth dimension after witnessing internal and external structures simultaneously, I decided to develop a transparent artwork digitally and I knew exactly which existing object I wanted to work with. The first challenge was to find a way to digitize the little glass tree. After some initial enquiry, I discovered that it would be difficult to digitally scan the tree unless I painted it white, which I didn't want to do. 3D scanners measure objects by projecting structured light onto the object and then measuring its distortion. A transparent object would reflect, refract and magnify the structured light in manner that would not allow it to identify the contours of the object. It was suggested that the tree wouldn't be very complicated form to model, and so I employed a 3D modeler to generate a 3D model based on my photograph of the object from different angles, and precise measurements taken from the object with calipers. The resulting 3D model when rendered was a good likeness to the original (fig.4.2).

I didn't really have a plan with what I would do with the digital tree, other than that it would involve compenetration – the trope that was emerging as a driver of much of my research. I was interested in the possibility of combining mutual interfusion with transparency. Even though the tree was colored, the original object had enough transparency to see through its coloured sections and I had thought to replicate this sculpturally in some way. As an initial experiment I simply duplicated the tree and then intersected it with itself. And that, it turned out, was all that was required (fig. 4.3-4.4). This procedure seemed simple and immediate enough, but it would be unthinkable outside of the digital domain. To date, I had only used the glitch of compenetration to interfuse different objects. Now the effect of an object compenetrating itself was rather different. My previous research projects had suggested that multiple objects (plastic toys and iron gates) were simultaneously coexisting in the same space. The duplicated tree, by contrast, suggested that the same object was occupying two places at the same time – another proposition entirely [1]. I experimented with the proximity of the trees (fig. 4.3-4.4). to find that if they were too close, they read as a single distorted tree. If they were too distant, the tension was lost and it was just two trees overlapping a bit. There was an optimal distance when they seemed to be converging or diverging, like an amoeba reproducing by binary fission. They appeared now as though with double vision – an effect of the eyes rather than the objects, whereby for one reason or another the eyes fail to converge at the required depth of field. I enjoyed the absurd association between Christmas and a drunken tree. From another standpoint still, the trees together retained a surprisingly figurative character, with the top bauble becoming head-

like, and the suggestion that two trees were dancing together, locked in one another's branches. Despite these and other associations evoked through the doubling and their affective proximity, my principle concern of determining the degree of interfusion was to investigate digital compenetration from the inside. In other words, I wanted sufficient physical overlap to render the internal merging transparent. The perspective that was most helpful establishing this was the view from above (fig. 4.13). From this angle, the proximity of the doubling transformed a relatively simple object into a complex mathematical form, with the relative positions of the twinned 'baubles' serving to articulate the repetition like suspended registration points. An initial 15cm 3D print allowed me to inspect my digital model 'in the round' and even at this scale the doubling and affective proximity had an uncanny effect (fig. 4.7).

How small can a tree be?

Having established the work's form using the digital model, I now needed to establish its size. The original object was just 6cm tall. My thought was to enlarge it to the credible size of a small Christmas tree. I used the digital file to produce an 80cm high foam maquette using a Zund digital cutting system (fig. 4.8). This was the smallest size that I thought I could get away with if I were to exhibit the artwork on the floor, which was my preference. Christmas trees smaller than this tend to be placed on a tabletop and assume a status closer to a houseplant or vase of flowers rather than a tree. I liked this scale because it allowed the object to stand in the same 'literal' space as the viewer (on the same floor), rather than in the 'aesthetic' art-space suggested by a plinth. It also afforded the opportunity to look down on the object from above and appreciate the mathematical complexity of its plan view. Situated on the floor, the artwork's scale would be more directly related to the viewer's body:

> I think the sense of scale that a piece has is always in relation between your body and the object that's external to it. I mean, that is where scale comes in, it seems to me: you relate it to yourself. And so I am very aware that these pieces create this kind of situation in which one is aware of one's body at the same time that one is aware of the piece, because I think that is the term that gives its meaning or gives it its measure in some sense. (Morris 1971)

Robert Morris's object sculptures of the 1960s famously sought to expunge cultural representation or illusion, in order to highlight the phenomenological relation between viewer and artwork. I was interested in how such a phenomenological relation could affect the reading of a cultural representation and the digital model afforded the possibility to reproduce my doubled tree at any size at all, in principle. The reality, however, was that material reproduction comes at a cost. I was fortunate to be awarded two grants specifically for the development and production of this project

proposal [2]. My plan was to 3D print the digital file, make a rubber mold and then cast it into pigmented transparent resin. Initial cost estimates for this process were prohibitively expensive. The option of commissioning an expert epoxy technician to produce the artwork was completely beyond reach and so I resolved to produce the entire process myself, allowing material constraints (my limited technical experience and fixed budget) to become collaborative agents in the making process. I knew that I would have to back-into-the-value of the funds at my disposal, so I began with the material costs and then worked towards a plan.

The cheapest rapid prototyping process currently available is CJP. It uses a plaster-based powder material, bonded with liquid binders. The significant expense with CJP is the cost of the material itself. In order to reduce costs, I made the object hollow and with the minimum feasible wall thickness, so that I would be using the least material possible. From my hollowed digital model, it was possible to calculate the maximum affordable size of 50cm high. Further calculations based on the 4700 cubic cm volume of the 50cm model indicated that the cost of rubber (for the molds) and epoxy (for the casting) would be just affordable, if I were to do all the labour myself – little did I know quite how much labour that would turn out to be. At 50cm high, the artwork would not be best exhibited directly on the floor as I had planned, because I wished to present the transparent compenetration close enough to eye level to bear careful scrutiny. However, I reasoned that because smaller Christmas trees are frequently presented on tables or other supports to raise them off the ground, this need not overwrite the sense of literalness that I sought to retain. If anything, it would shift the association away from any suggestion of a tree growing in the ground as in 'nature', and situate the artwork firmly in a 'domestic' social scale.

Wrestling with matter

Now began the complex process of applying a preconceived form to matter. In order to 3D print my digital model at 50cm high in plaster, I had to negotiate the first literal constraint: the print envelope (figs. 4.9-4.11). The print envelope is the maximum size at which any part can be printed and my double tree exceeded this by quite some way. I would need to divide the object vertically into at least five parts and I would also need to print the ends of the longest four/eight branches separately. This is not unusual for 3D printing and the technician at the print workshop was able to help me to do this. It was suggested that I add a simple locating socket to each joint to facilitate alignment and attachment of the parts once printed (fig. 4.12). At the same time that I was consulting the digital 3D print technician, I also sought the advice of a casting technician in order to think through making the mould. Although I have made plenty of rubber moulds before, I had never tried to cast something anywhere near as complicated as this object. To attempt to cast it all in one go

would require a mould consisting of multiple parts, all of which would increase the likelihood of problems with the casting process exponentially. In addition to this, it would be extremely challenging to get a clean cast from a mould of such complexity and any problems I encountered would write-off the whole cast (a considerable investment in costly resin). So, I decided that the most pragmatic course of action would be to cast the object in parts that could then be assembled. Following my experience with the MDF *Gate*, I thought I could make this modular construction (a common trope of the digital discussed in chapter 2) a virtue, by building it into the design rather than attempting to conceal it.

To emphasise that this modulation was a creative decision, rather than an undesirable imperfection, I decided that the parts should be of equal height. The regular cuts would then function like a superimposed grid of vectored sections slicing through the otherwise organic and fluid form. Further to this, I anticipated the final assembly and reasoned that some sort of connecting pin would allow the parts to be stacked without adhesive. What interested me about this line of thought was the fact that these necessary connections would be clearly visible through the transparent material. Experimenting with the digital model, I found a way to include two vertical lines of pins and sockets, one plumb down the centre of each slightly off-vertical 'trunk'. I also played with these pins until each pin and the spaces between them were of equal distance. The visual effect of these pins on my transparent (X-ray view) model was of two dashed lines such as are commonly used in digital plans to indicate an internal detail not a visible from the outside, like an armature for instance. I was quite satisfied with this contrivance whereby a structural necessity would double as a self-expressive fiction (figs. 4.16 & 4.31).

On receipt of my 50cm rapid prototype parts, I was alerted to how extremely fragile the 1.5mm plaster walls were. There was no way that I could make a rubber mould around them as they were, because they were sure to break and I could not afford to reprint them. I would need to reinforce the parts with something. I was concerned that even the pressure exerted by expanding foam could be sufficient to destroy the fragile 3D prints and so I decided that the safest way to proceed would be to fill them with plaster bit by bit (figs. 4.20-4.21). I researched and used a special LX plaster, a low expansion formula so stable that it ought not to jeopardise the 3D prints when curing. However, as it turned out, the specific material and environmental conditions of this project would assert their vitality in an unexpected way. In order to pour the plaster through relatively small holes and into narrow forms, I had to use a plaster mix that was slightly wetter than ideal. The forms themselves were then entirely closed except for the small holes through which the plaster was poured and air escaped. The weather was once again hot and of course the excess water wanted to evaporate and return to the atmosphere. I watched nervously as for days the precision printed forms subtly changed

shape. The plaster and its plasticised binder were surprisingly elastic and areas would sometime swell and sometimes shrunk. The sections bearing the 'branches' finally seemed to settle down, a little distorted, but more or less as they should be. The top of the 'pot' however, swelled to become even more mushroom-like than it had originally been. Then, to my horror, the lower section of the 'pot' split open completely (fig. 4.15). I was left with no choice but to peel off all of the lower 'pot' section of 3D print material to reveal the crude plaster filling within, which was finally allowed sufficient air to cure. It took nearly a week to fill and smooth this lower pot section and blend it with the top section before it was ready to cast. The lower section had reduced about 6mm in diameter, whereas the top section had bloated. What I had now, no longer resembled an accurate analogue of the original digital model (fig. 4.26).

The next phase was to smooth the entire surface of the now reinforced, but still brittle parts. The CJP process leaves a striated surface of 0.2mm lines corresponding to each layer of plaster as it was laid down and then 'fixed' by the binding agent. I did not want to remove this in order to efface the digital process but because if the epoxy cast were to be as transparent as glass, the surface would need to be as smooth as glass. If I took my mould from the striated surface it would not produce a transparent surface. Smoothing epoxy from that state was not practical, so the smoothing had to happen as far as possible in the plaster, before the moulds were made. I worked on the parts by building up layers of spayed filler primer and then working back with sanding 'contour pads' and gradually working down to finer and finer grits until 2500 grit cloths that felt like kitchen cloths (figs. 4.22-4.24). Throughout this process it was my fingers and ears rather than my eyes that determined how smooth a finish I had achieved. I could hear when a sanding pad was biting and when it had done its work and I could feel, by running my finger tip or nail over the surface whether the print on my finger snagged on any pronounced texture. It was only in the final analysis that I sprayed the objects with lacquer to produce a gloss finish, that the judgement became visual again, since the clarity of the reflection confirmed a smooth finish and any clouding suggested more work was required. Even at this stage I was not safe from the contingency of the weather (le temps). I had made a makeshift spray booth in my garden from a large cardboard box, some weights, a modelling turntable and a plastic sheet to shield from the rain. On one occasion a sudden squall hit hard enough to shake the box and dislodge the upturned pot so that it toppled and cracked the top section and chipped the side. It was too late in the process to go back and repair the damage comprehensively, so I resolved to allow these battle scars to exist and manifest themselves as they might through the remains of the process.

The most expedient approach to mould-making was to make a single rubber block mould for each part (fig. 4.27). I then used a scalpel to cut open each mould and release the plaster original.

Unavoidably, the fragile plaster original was completely destroyed during the extremely physical process of removal (fig. 4.29). All that I had now was the empty voids in the rubber mould and it was time to fill them with epoxy resin. Although at this point, it was still my intention to cast the double tree in transparent resin tinted with coloured pigment to mimic the original blue and green object, I decided that the first cast ought to be clear. This first cast would be inevitably flawed and I reasoned that a clear cast would give me a better sense of what was going on. I rented a vacuum chamber to extract the air bubbles that inevitably fill the epoxy when the two parts are mixed. This was crucial since the transparent material would expose any bubbles that remained in the mix.

One particular constraint with epoxy resin is that it can only be poured and cured in depths of up to 50mm at a time. This is because epoxy resin cures exothermically and the heat it generates can cause shrinkage and discoloration. The recommended procedure is to pour 50mm, allow it to cure completely (3 days), and then pour the next 50mm layer. However, this does leave fine lines between the layers, although they are only visible if one views the layers from side on. I was advised that this issue might be avoided if the re-pouring is done when the resin is at the 'gel-phase' of curing. When the gel-phase happens depends on external factors such as temperature. After several tests I established that it was at around 8 hours. Since I had to pour at least five layers for the pot, this meant pouring layers at some very inconvenient hours of the night. Despite this marathon pouring session, the results were not fantastic. Although I didn't get clean lines, it was impossible to pour onto the gel-phase without causing bubbles that could not escape. Accidental displacement of the half-cured gel-phase also caused strange clouding and distortion of the cured resin. I tried again, but this time following the factory instructions and sure enough, although the cast was otherwise good, the horizontal lines were an unwelcome and irregular intrusion into the otherwise clear volume of the 'pot'. There was one last wild-card approach that was worth a try. Since the issue was the overheating of the exothermic resin during curing, perhaps this could be mitigated, or at least minimised by keeping it cold. I was going to try to pour the whole pot it in one go. So, I borrowed a large freezer box and packed it with ice. I also put the rubber mould in a sealable plastic bag (epoxy does not like moisture). Then I filled the 'pot' mould with epoxy resin in one pour, sealed the bag, covered it with ice and closed the lid. The full curing time was four days and when I opened the freezer box and de-moulded the resin 'pot', I was delighted to find that it was a pretty faultless pour, other than a few air bubbles that had not escaped. However, there was some mild discoloration that was most obvious in relation to the crystal clear 'branches' and 'trunk'. A vague yellowish-brown tone like a nicotine infused mist. It was not very Christmassy. In fact, the whole colourless cast was not very Christmassy. By taking out the blue ('pot') green ('tree') and red ('baubles'), the now colourless object has also lost much of its festive association. The jump from blue to green that had defined the junction between

'pot' and 'tree' while their forms merged fluidly, had given way to a jump between a subtle yellowish tinge and crystal-clear transparency.

I assembled the first cast in the manner I had planned. Except that because it had not been possible to cast such a subtle detail as the sockets for the pin joints, I had to drill the sockets and use pins cut from clear acrylic rod. These pin and socket joints, the literal armature holding the sculpture together, did resemble a dashed line as I had anticipated, but they were also a little irregular, because it was difficult to drill the sockets in perfect alignment (fig. 4.32). It also dawned on me that I could just as easily glue the parts together using clear epoxy, which made the pins redundant. It seemed to me now that the conceit of the socket-and-pin joints was over-thought and introduced an unnecessary distraction from my principle concern, which was to make materially visible the inside of digital compenetration.

Transparent things

For the next iteration, I used crystal clear epoxy as glue and filler to connect the parts. Micro-bubbles in the adhesive make the connections visible as white or translucent facets within the object. I applied and removed epoxy to certain details as though it were clay or plaster and as I did so I realised this had become sculpting in the most literal and conventional sense of the term – adding and removing material to refine the shape of a three-dimensional form. I had left the 3D print far behind now, working on the object without an external reference in order to make its form as internally coherent as possible. This form would not have been possible without the digital antecedent, but the process now was entirely one of manual manipulation. I laboured to improve the finish of the acrylic resin, once again working down from higher grit pads to remove the casting seams and risers, to fine grit pads and then finally to polishing compound. Although I didn't set out to fetishize the finish, the smoother I made the surface, the more transparent the sculpture became. Using crystal clear epoxy to glue the parts together also made for much cleaner connections than the pins and sockets, helping to reduce the overall visual noise. Paradoxically, the more transparent the surface became, the more visible the surface imperfections, close inspection revealed a gossamer web of fine lines. However, the labour was worth it because another quality emerged that the first unfinished iteration lacked. The more registration of marks on the surface disappeared, the more the volume of transparent material became palpable. The transparency of my digital 3D model was effectively an X-ray view allowing an unimpaired view if the interior of the other side of the object. The transparency of my epoxy resin doubled tree, although perfectly clear, did not provide an unimpaired view of the interior of its far side. Beyond the inevitable imperfections, three physical effects completely disrupted a clear view of the interior of the other side of the object: reflection,

refraction and magnification. Each clear 'bauble' functioned like a little crystal ball. The volume of the 'pot' was like a bucket of water held in shape without the bucket, containing one or two tiny suspended bubbles. These and other traces of the making process: the connections between the parts; the damage caused by the 'pot' falling in the squall; the ghostly geometry of the digital model, imperceptible until now, was subtly detectable around the top of the 'pot' as the light caught the rounded angles; areas that couldn't be smoothed as well had also slightly lost their transparency. Yet all of these material and digital traces were constantly interrupted and animated by the shifting tones and colours of whatever was behind the object and the surface it was sitting on.

The insight that all this optical confusion makes apparent is that there is a difference between digital transparency and sculptural transparency (figs. 4.35 & 4.36). In his book *The Transparent Society*, philosopher and cultural theorist, Byung-Chul Han describes transparency as the ideology of digital society and he links it to the trope of immateriality:

> Transparency is a neoliberal dispositive. It forces everything inward in order to transform it into pure information. Under today's immaterial relations of production, more information and communication mean more productivity and acceleration. In contrast, secrecy, foreignness, and otherness represent obstacles for communication without borders. They are to be dismantled in the name of transparency. (Han 2012, 2015: viii)

For Han, "matters prove transparent when they shed all negativity" (Han 2012, 201: 1) and "hypercommunication is free of the negativity of Otherness" (Han 2012, 2015: 12) This negativity, as I discussed in chapter 2 in relation to Adorno's negative dialectics, is that which does not positively identify concept or ideology. In other words, the alterity, the foreignness, the negative other that digital transparency cannot exhibit, is typified by "the thing, as Heidegger defines it" (Han 2012, 2015: 12). The transparent digital model of the doubled tree simultaneously exhibits all of its information with perfect predetermined clarity. The transparent resin cast of my doubled tree remains mysterious, impenetrable, flawed, unknowable and somehow other. Digital transparency exhibits its total information all at once in a vacuum of Euclidean space. Sculptural transparency is contingent upon everything going on around it; inseparable from whatever is refracted and magnified through it, reflected off it, or obscured by it.

Conclusion

The final decision in resolving Tree as an artwork was how to embed it in the world sculpturally. As I discussed above, it was too small to be placed directly on the floor without appearing awkward. Exhibiting it on plinth would situate it too much in the aesthetic space of 'art'. Placing it on a found table or shelf made it seem excessively literal, like a larger Christmas ornament. And yet its support

would always be intrinsic because the artwork is see-through and would magnify, reflect and refract whatever it is set upon. The solution I arrived at was to make a transparent resin table at a size that would suit a Christmas tree of this stature. In this way the placement would seem literal, and at the same time, a representation. The support would be not quite the same as the artwork (it would not be doubled), nor would it be an alien object such as a bespoke plinth or found table. On one hand, it would occupy the same space as the viewer and present a consistent phenomenological presence. On the other hand, it would extend and intensify the not-quite-there-ness of the transparent proposition.

Reflecting on the tree's protracted transformation, I was struck by what had been retained and what had changed. The first digital rendering had closely resembled the original object. It convincingly simulated the colours and transparency of the glass and the wonkiness of the tree in relation to the machined precision of the pot in which it sat. Once it had been cloned and compenetrated with its *doppelgänger*, it took on a peculiarly animated character that appeared to be merging, splitting or even dancing with itself. Although many of these traits were preserved in the final artwork, its sculptural actualisation transformed the digital realisation completely. For one thing its enlarged size meant that it has no practical association with bottles and its absence of colour made its festive associations much more tenuous. The decision to enlarge the object and remove its colour had resulted from my experience of zooming into and through the digital model in absolute clarity. And yet the process of materialisation turned out to be so precarious, labour intensive and materially determined that the final artwork presented a very different set of qualities. Contingencies such as weather, processes of curing resin, budgetary constraints, all had their effect on the outcome. Likewise, material constraints such as print envelope, mould complexity and air bubbles all made themselves manifest in the final artwork.

Looking at Tree, the primary qualities of what can be seen are its material imperfections. The object that had been so clearly rendered on screen in an 'X-ray view' of total disclosure, is absent. What catches the eye are reflections in the surface, scratches and scuffs on the surface, internal elements of the compenetration along with other external phenomena, visible through the surface. Where the surface is especially smooth, there are purely optical moments like looking through a lens. However, these moments tend to give way to: traces of sanding and polishing, areas of slight texture where the 3D printed plaster pattern had not been perfectly smoothed, bubbles trapped in the resin, texture and reflections at the joints of the components, a white patch where I had had to dig out some of the pink rubber of the mould. Where Playground had concealed the signs of its materiality and making and Gate had revealed its materiality and construction, Tree makes nothing visible except for its own substance and the traces of its facture. The work succeeds, in my view, because it remains coherent enough to hold itself together as a digitally derived form and at the same time it is just a

presentation of the material, contingent, and laborious processes of its analogue actualisation. After extensive polishing, the exothermic discoloration of the pot is still visible as a subtle yellowish tinge, but reflected around the rest of the object here and there it is harder to isolate. The on-screen digital mediation had simulated a perfectly transparent object. The finished work is rendered opaque by the density and temporality of its material substance, and the distorted reflections of the physical space in which it sits.

Notes

(1) There's the fact that two separated particles can interact instantaneously, a phenomenon called quantum entanglement. ... And there's another phenomenon called quantum superposition. This principle of quantum mechanics suggests that particles can exist in two separate locations at once. https://www.popularmechanics.com/science/a18756/atoms-exist-two-places-simultaneously/

(2) TECHNE Study Support and Work Placement grant 2018; Elephant Trust grant 2017.

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7.Coiled Pot

Objects and their mediations

The first of two panel discussions during my *Physical Information* symposium (2017) revealed a tension between the standpoints of art history and anthropology in relation to objects and their mediation [1]. Art historian Alex Potts had just delivered a paper on *Temporality and Sculpture* that had concluded with an account of Robert Smithson's *Spiral Jetty* (1970). Potts described how Smithson staged the relation between a material object anchored in the real world and the "cluster of mediations" that circulate around it, such as: film, essay, photographs and descriptions. Later, during the panel discussion, Potts suggested that the digital only intensifies such mediation. He argued: "The digital is an object, but it is also a mediation. It's an odd object because what it usually does is circulate around the object or situation it's representing. It's not itself the focus." (Potts, 2017).

Immediately following Pott's presentation, anthropologist Haidy Geismar delivered her paper *Digital Object Lessons for the Twenty first Century*, in which she sought to challenge how we think about the relationships between form and matter, meaning and knowledge by focusing on the digital. "What happens," she asked, "when digital media enter the conversation?" (Geismar 2017). Geismar's presentation highlighted the fact that most museum objects are already forms of mediation that have been taken out of their normal context in order to be seen as preserved artifacts, not as mere functional objects. At the same time the digital, which is so often reduced to notions of immaterial media, is worth examining as a material object: "The museum framing, which makes you focus on an object isn't really appropriate for most kinds of objects in the world. But equally, digital artifacts are not merely immaterial networks of information, but more like objects" (Geismar 2017).

On the one hand, Pott's argued that sculptures are often reduced to material objects but are really clusters of mediation. On the other hand, Geismar argued that digital artifacts tend to be reduced to forms of immaterial mediation, whereas they are in fact material objects that "hide all sorts of political problems and perspectives that are implied but that aren't recognized, because we are glamoured by new technology" (Geismar 2017). The antagonism between these contrasting positions emerged in discussion about Gesimar's example of a collaborative project with artist Caroline Wright. Wright had asked Gesimar to select an object from the UCL Ethnography Collection (curated by Geismar). Gesimar had selected a lantern-slide box – a "conceptually empty box, stripped of meaning and knowledge", since the slides had been removed and safely archived. Wright made a pencil drawing of the box, before dismantling and unpicking the box until all that remained were *Dust and Threads* (2015). In Geismar's account, it was only during and after the box was disintegrated, that its possible meaning and knowledge value emerged. The moral of Geismar's "object lesson" was that

the imperfect representation was not the same as the original object "a continued reminder that in every material form there is value, even if we cannot, at that moment, see it." (Gesimar 2018: 43). In the panel discussion, Potts referred back to Gesimar's example: "I wouldn't call it art, but you were staging a phenomenon with that. Part of the reality of the phenomenon is that it couldn't be perfectly staged." (Potts 2017) Pott's didn't qualify his rejection of this artist's project as 'art'. However, Gesimar suggested this might concern "the UCL Ethnography collection's natural science legacy to teach you something about the real world." (Geismar 2017). At the end of the discussion, Pott's lamented that many contemporary art projects that engage with social or political issues lack sufficient interest in the material itself: "Possibly nowadays the danger is less that they seem to be contentless and they are actually using political content as a form of self-promotion – aestheticized political content." (Potts 2017). Despite the seeming divergence of their arguments, this exchange also highlighted elements of convergence, because Potts and Geismar approached the same issue from different perspectives. What they held in common was that both digital and sculptural artifacts are at once objects and mediations. However, Geismar and Potts also reframed their common concerns concerning mediated art objects and objectified digital media in terms of the longstanding antagonism between art and science, aesthetics and knowledge. Their exchange revealed different interpretive procedures: sociology pursues questions about (external) causes; art ascribes plausible (immanent) meanings. The conflict recalls Jeff Wall's "bifurcation" between autonomous art and heteronomous art (discussed in chapter 1). I suspect that since Potts advocates autonomous art: "what matters is the existential density of a work" (Potts 2016), he might have felt indifferent to the sociological message of Wright's project, which is to say that it was too heteronomous.

To date, my research models had been informed by anthropology's theoretical approach to the digital and art history's theoretical account of the sculptural. The simultaneous divergence and convergence of these positions that played-out during this debate seemed to crystalize the tension and at the same time highlight how digital objects were no different from any other objects, including sculpture. Motivated by Haidy Geismar's analogy that the digital dissociates objects from their cultural mediations in much the same way that museums decontextualize their artifacts, I proposed to engage with the UCL Ethnography Collection myself as a means of advancing insights drawn from the symposium and my research to date. I wondered how my flexible approach to digital procedures might trans-mediate an artifact from the UCL Ethnography Collection and at the same time intensify its "existential density". I began to imagine a project that would focus both on the digital mediation of an object and on the digital as a material object. I mentioned my research methodologies to Haidy after the symposium and she kindly invited me to visit the collection.

Contextual Dissonance

It was only when I entered the basement space of the UCL Ethnography Collection that I realized what I had let myself in for. The room is filled wall-to-wall with glass display cabinets and draws containing a spectacular array of artifacts from around the world. In the few places where walls could be seen, they were densely hung with hand-carved spears, paddles and ceremonial staffs. The overwhelming impression was of things taken out of context. Objects robbed of their social and cultural meanings. For the most part the collection consists of artifacts that have been de-accessioned by other collections such as the Wellcome Collection, because they were either unwanted duplicates or damaged. Now they were tools for ethnographic research and learning, but the feeling that they did not belong here was palpable. Given the limited available space, the artifacts were grouped taxonomically according to their approximate shape and size, rather than place of origin or cultural use. They were literally removed from contexts and the arbitrary proximity of an Indonesian bow with a South African spear, for example, collapsed time and space to jarring effect. I wasn't sure that it would be possible for me to work with anything I could see here, precisely because I had no access to the social contexts that once gave meaning to these objects. It's not that these objects weren't fascinating, beautiful and even enchanting, but precisely because they were so, that made me wary. In an insightful reevaluation of the origins of Western avant-garde practices of the early twentieth century, artist Arthur Jafa has highlighted how when African art first came to the West "it created a profound re-composing of ideas of how you build imagery, space and time. Cubism came directly out of an apprehension of African artifacts, but it was Duchamp who realised that a lot of the power of these things came from contextual dissonance" (Jafa 2017). Jafa's insightful use of the term "contextual dissonance" is pertinent here because it reframes the conceptual transfiguration Duchamp achieved by placing 'readymade' things in the gallery space as a perceptual tension. The incongruence of encountering a thing out of context produces a sense of discord.

I was aware of contextual dissonance as I perused these objects with Haidy and it manifested as a feeling of disquiet. I wanted to steer clear of problematic concepts like the 'primitive' or the exotic. On the basis of her own research methods, Haidy was sensitive to this difficulty, pointing out that anything that had had a ceremonial, votive, magical, or religious purpose would be off-limits and that we should look for something mundane. As I pointed out one or two objects that I found particularly beguiling – a Congolese hair comb and a Melanesian paddle, Haidy explained that UCL had good relations with the Congolese and Melanesian communities in London and that I could potentially offer to involve them with the project. However, collaboration with a community would add complications to the methodology that remain outside the scope of this research. Remaining focused on the disembodied aspect of digital technology would allow me to review objects from the collection

consistently with my processes elsewhere in this research. In any case, these objects were already complex and compelling, without my involvement and I felt it would be exploitative to work with them. Finally, Haidy made a brilliant suggestion. She showed me four unfinished ceramic pots that had been fired at different stages of the fabrication process. The first pot had been petrified at the earliest stage of its coiled construction (fig. 5.2). Sausages of clay had been coiled around on top of one another to initiate the rounded form of a pot. Where the inside had been partially smoothed, finger marks were faintly visible. The second Pot was more refined, but the coils could still be discerned (fig. 5.3). The walls of the third pot had been thinned and completely smoothed (fig. 5.4) and to the forth, a decorative pattern had been initiated but not finished on the outer surface (fig.5.5). Haidy explained that these pots had been fired unfinished at the request of an anthropologist travelling in South Africa in order that the stages of the material process could be preserved and studied back in the UK. I was particularly drawn to the first pot because it was the most incomplete and therefore evidenced its materiality and construction most saliently. I had no qualms about working with this artifact because not only was it an essentially a generic quotidian pot, but it was unfinished, and therefore retained a 'thingly' quality of being not yet fully objectified. This suspended state equates it to the in-between status of a digitally generated 3D print within my own methodology. In this instance the pot is another example of technology, from a different place and time, but equivalent in its apparent neutrality. It wasn't an appropriated artifact, but a commissioned teaching aid. An object intended merely to articulate the process of its own making. As Taslim Martin, ceramics tutor at Camberwell College of Art, pointed out: 'it could have been made by anyone, anywhere on the planet, at any time in human history". He was right. Without the little ethnographic label identifying it vaguely as "Unfinished coiled pot, South Africa", it bore no culturally specific features at all (fig 5.6).

Digital and analogue

I was fortunate to enlist the assistance of Karleung Wai, Specialist Technical Instructor in Additive Manufacturing at Rapidform, RCA's 3D digital facility. Karl brought the RCA's new portable hi-res 3D digital scanner over to UCL's Ethnography Collection and scanned the coiled pot (fig. 5.7). Karl was also able to use specialist software to develop the scans into a topologically complete 3D model. Karl had told me about a piece of RCA equipment called the 'haptic arm'. A tool that apparently allowed you to feel a digital object and manipulate it using digital 'hand-tools'. Intrigued by the possibilities such contradictory sounding technology, especially in relation to my digital model of a crudely hand-made clay pot, I asked if I might be allowed access to experiment with it [2]. Meanwhile, I decided to experiment with the digital model using software already at my disposal.

The first action I took was to produce a 1:1 3D print of the pot using the cheapest available PLA (Polylactic Acid) printer at the University of the Arts London [3]. A PLA printer produces much more pronounced striations than the plaster printer that I had used for my previous Tree project. But the material cost is negligible by comparison and so I printed the pot just to see what it would feel like (fig 5.9). The plastic pot was anything but existentially dense. The plastic felt rigid, but very insubstantial due to the gridded reinforcement inside its hollow walls. The uniform grey finish made the textured object appear dull and lifeless. The only point of interest was the unforeseen relationship between the regular stratification of the PLA layers and the irregular coils of the original clay pot. The PLA printer had in fact produced the pot by gradually building up coils of plastic as the computer-controlled nozzle circulated round and around building the object. The simultaneous contrast and resemblance between these two processes was unexpectedly engaging. I thought about making a plaster mold from this PLA print in order to slip-cast the object back into clay and fire it. The circuitous tautology of this approach appealed to me. I then came across a material that combined PLA with stone dust, and which claimed "remarkable aesthetic features and a significant higher material density up to 37% higher than "normal" PLA . . . an extremely matte stone-like finish with unique natural gradient linings." (Formfutura 2018). I decided to try this product and at the same time enlarge the Pot to the largest size that could fit in print envelope. However, the result was very disappointing (fig. 5.10). Not only did it bear no resemblance to actual fired clay, much less the original pot, but also the stone dust in the PLA clogged up the printer nozzle and proved difficult to clean. There were legitimate technical concerns that the aggregate in the mixture might be abrasive and damage the precision engineering of the 3D printer, so I decided not to use this material again.

Meanwhile, I imported the 3D model, which was actually a 'wire mesh' into a CAD program (Rhino). Intended primarily for architects and engineers, this CAD program offers pre-set views (plan, front and side elevations) and allows you to modify existing 3D objects according to predetermined coordinates and transformations. When Alfred Gel wrote of the difference between 'mimesis' and 'abstract pattern', he explained that mimesis involves recognizing a resemblance between 'index' and 'prototype', whilst abstract pattern depends on registering repetitive congruence (Gell 1998). In this way both mimesis and abstract pattern hinge on the temporal progression of the index and therefore reflect the tracking of the recipient's memory. Gell explained that all abstract patterns are variations on only four "rigid motions in the plane", to which repeated motifs can be subjected: reflection, translation, rotation, and glide reflection. Further abstract qualities include complexity, involution, simultaneity and superimposition. With Gell's rules of abstraction in mind, I began experimenting by duplicating the digital pot and subjecting it to these four grid motions (figs. 5.11-5.13). More often than not, these transformations seemed too easily read. That is to say, despite the relatively

nondescript organic form I was working with, the new configurations could be quickly recapitulated as the result of mirroring, rotating and gliding and were of limited interest. They lacked what Gell called "cognitive stickiness". The most successful configurations were either excessively complex (fig. 5.14), or inextricably intertwined (fig. 5.15). In fact, this latter example seemed to coil around itself like a knot.

It was at this tentative stage of project development that I recalled Brian Masumi's *Parables of the Virtual* (2002). For Massumi "Nothing is more destructive for the thinking and imagining of the virtual than equating it with the digital." (Massumi 2002: 137). Massumi sees the digital as having a weak connection to the virtual because it relies on systematization of the possible and he insists on a distinction between the possible and the potential as an integral part of any thinking about the virtual. "Digital processing doesn't possibilize let alone virtualise. The digital is already exhaustively possibilistic" (Massumi 2002: 141). It was true that my unskilled experiments with the CAD program had depended on pure systematic possibility through the running of code-bound routines. However, Massumi's fascinating insight is that "Whatever inventiveness comes about, it is the result not of coding itself but of its detour into analog. *The processing may be digital – but the analog is the process.* The virtuality involved, and any new possibility that may arise, is entirely bound up with the potentializing relay. It is not contained in the code." [sic.] (Massumi 2002: 142). The crux of this argument is that digital and analogue should not be construed as mutually exclusive. "The challenge is to think (and act and sense and perceive) the co-operation of the digital and the analog, in self-varying continuity." (Massumi 2002: 143). Although the CAD transformations of the digital pot were determined by pre-coded possibilities, my responsive decision making with each transformation was instinctively analogue in its relation to the previous iterations. I looked at my knotted, superimposed, concentric, recursive, rotating digital pot and I returned to Massumi's text:

> Take the images by their virtual centers. Superpose them. You get an overimage of images of self-varying deformation: a unity of continuous separation from self. It is here that the virtual most literally, parabolically appears . . . This is to say that the virtual is best approached topologically. Topology is the science of self-varying deformation. (Massumi 2002: 134)

Massumi's point is that the paths of co-operation between digital and analogue – transformative integration, translation, and relay – are themselves analogue operations, so there is always a preponderance of the analogue over the digital. My digitally knotted pot, considered from the standpoint of Massumi's virtual parable, encapsulates the need to think the digital and the analogue together, and suggests that the relation between the digital and the sculptural is in fact bridged by the analogue operations of actualisation. Before I could 3D print my knotted digital pot, I had still to carry out one theoretically simple digital (possibilistic) operation: Boolean union. Although

my digital rendering had the appearance of one topological object, in fact it remained four interpenetrating iterations of the same pot at slightly different scales, orientations and positions. Boolean union basically allows you to intersect two or more objects, but it relies on the automatic program identifying the intersections. In my ignorance, I had merged four very high-resolution objects with complex mesh patterns. The Boolean operation could not identify the intersections of these multiple mesh patterns all at once. My laptop whirred, got very hot and then nothing. My digital model had vaporised and all that remained on screen were one or two fragments of errant geometry. It was like the virtual equivalent of a clay pot exploding in the kiln, and just as irreversible since in my enthusiasm, I had somehow failed to save the file. It was to take me a very long time to reconstruct a configuration with anything like the knotted self-varying relay of the previous model (fig. 5.16).

Digital Clay

I was fortunate to be granted access to use the RCA's haptic arm, but only for an afternoon as a one-off. I had only three hours to get to know the equipment and the programme and find out how it felt to 'touch' the digital. I took just two digital files with me: the 1:1 scan of the original pot, and my reconstructed pot knot. Once the digital file is loaded, a 3D rendering of the object can be viewed on screen. The haptic arm is a motorized device that applies force feedback on the user's hand, allowing them to feel virtual objects and producing "true-to-life" touch sensations as user manipulates on-screen 3D objects. It consists of a pen like tool, attached to a triple jointed articulated arm (fig. 5.17). There is a small button on the pen, which is used to activate whatever 'tool' has been selected. Without pressing the button, the pen can be used to feel around the virtual object and an image of the pen can be seen on the screen in relation to the object. I say 'virtual', because there is really nothing there physically. On screen it is a truly transparent object. The idea is that you look at the screen whilst you feel the invisible thing and it takes quite a while to get used to coordinating these two dissociated senses. In fact, I became quite distracted watching the 'nib' of the pen describing the form of the invisible pot in the air next to my head. As I stroked along the side of the invisible pot, the nib bounced over the perturbances of the virtual clay coils.

The software for this tool does not use vectors or a mesh, but translates the object into three-dimensional pixels. This is known as 'digital clay' and many of the tools in the drop-down menu are much like the tools that a potter would use to work clay. Selecting one of these tools, the user can then scrape, gouge, stamp, smooth the digital clay. However, whist this is very impressive, it hardly feels 'true-to-life'. For one thing, as you watch the tool on the screen push a deep dent into the digital clay, or scoop out a hollow of material, no digital clay is displaced, it just disappears to form the negative analogue of the tool selected. Push hard enough, and you find yourself on the inside of the

object, or stranger still, inside its hollow wall. Despite all these 'unreal' phenomena, there is no question that the haptic arm affords the user a means of working intuitively with an existing form. The pixelated geometry is very high resolution so that it does not appear to be geometry at all unless you zoom in very close. The 3D model responds instantly, or practically instantly, although I did sense a nano delay between action and reaction. At the same time, there was an odd uniformity to the traces of actions left on the surface of the 3D model, not least due to the lack of displaced material. Due to the limited timeframe, I worked quickly and uninhibited. I didn't have a plan at all and I didn't really have any expectations. I experimented with as many different tools as I could, and for the first time working on a computer, I felt the familiar sense of being able to try something quickly, and then respond to that effect immediately and so on (figs. 5.19-5.21). The experience actually felt more like drawing. Perhaps because of the pen-like tool, but also because the simulated manipulation felt very superficial. If it were real clay, I would have been concerned about it drying out or being to wet, for example, or the risk that it might collapse under its own weight. Not so the digital clay. Moreover, if I didn't like what I'd done, I could simply click the backwards arrow and revert to where I was a few moments before.

Initially most of the tools that I tried didn't seem to create much by the way of mark, surface or form differentiation to the model. I added regular concaved dips, dragged a spike around to create a scribble, and even smoothed the coils away with an effect that looked a bit like soft focus, but it just made it look as though the pot were more finished than before. It seemed to me as though my interventions were either too subtle (the blur that just looked like smoothed clay) or too obvious (the rounded craters or gestural scribbles). Then I came across a strange tool and it took me quite a while to figure out what it did. It behaved unlike any real-world sculpting tool. As the nib of the pen was moved towards the object and the button was pressed, then before the pen touched the object, the object distorted towards the pen as though it were magnetically attracted. Pulling the pen back away from the object continued to pull the digital clay away from the existing form. Done to an extreme, this action produced horrific long spikes that were immediately recognisable as digital distortions. However, done just slightly, the effect seemed stranger because while it still looked to precise in relation to the existing form to have been shaped from real clay, it was subtle enough to appear organic, like some bubbles or boils swelling under the surface. I enjoyed the counter-intuitive suction effect of this tool and proceeded to work my way around the knotted pot so that it was evenly covered with an array of curious bulges, but not so much as to obliterate the original coiled form, or block recognition of its self-varying iterations (figs. 5.22-5.23). When I returned to my studio and reviewed the screen grabs I had taken to document my experiments, there was no question in my mind that this last experiment was the most interesting and it was also more interesting than the

knotted pot as it had been achieved using the CAD programme alone. The rounded protuberances produced using the haptic arm were enough to block spectatorial recapitulation. It was really not clear where the hand modelling of the coils stopped and the digital manipulation began. The object was literally the result of a push-pull between digital and analogue and it seemed to refer to little other than itself. The determinate numerical precision of digital technology had generated a curiously indeterminate object.

Aluminium

Until this point, in the back of my mind was the logic of somehow returning my digitally manipulated coil pot back into clay and firing it. I knew that with a simple vessel, I could make a plaster mould and press cast the clay inside, remove the mould and fire the result. However, I realised that my knotted configuration of compenetrating, self-varying coil pots would be much to complicated for this fabrication process to work and I started to wonder how might make this particular digital rendering material and what that might imply within my methodology. Studying the digital renderings against the black void and grid references of virtual space (figs. 5.22-5.23), I noticed that the default render finish resembled aluminium, because the simulated highlights and shadows appeared to give the textured surface a cloudy reflection. I remembered reading that PLA could actually be used as a wax substitute for investment casting because it would burn out in the kiln to leave a clean negative form. So, I decided to print the object in PLA, increasing the size just a little to fill the available print envelope, and then cast it into aluminium at the Camberwell College of Art foundry.

Having eventually succeeded in Boolean uniting the four compenetrating coil pots in their self-varying deformation, I uploaded the final digital model to the 3D printer. The printer software calculated the volume of PLA material required and I scaled the now topologically complete entity to be as large as could be printed from one entire roll of PLA material, which was as large as that 3D printed model would allow (fig. 5.24). As it happened, this meant that the largest pot was just over scale 1:1 and the smallest was just under scale 1:1 to the original ethnographic artefact. The printer display announced that it would take 3 days 5 hours to print. After three days I went to check on it and was surprised to find that the display now suggested that 1 day and 8 hours remained (fig. 5.25). Apparently digital time did not quite correspond to GMT. In total it took a week for the computer-controlled nozzle to slowly build up the object from 0.5mm coils of plastic. The completed print included a great deal of excess material by way of structural supports calculated and designed by the printer's software to support the build-up of materials where there was an overhang, because it cannot print onto nothing. It subsequently required significant labour to remove this excess material without damaging the detailed surface of the printed object itself (fig. 5.26).

Essentially the lost wax process involves building up coating of ludo (a mixture of plaster, sand and recycled plaster) around the wax (or in this case PLA) object to form a thick hard shell. The PLA is then burned out in a kiln to leave a void, which is then filled with molten material – in this case aluminium. However, two particular elements of the process were to leave their mark on this object. First, there were two hollow details, where the interior of the pots is glimpsed, that required 'floating-cores'. The cores consist of the hardened Ludo that filled the hollow in order to mould the inner surfaces of the object. They are 'floating' because when the PLA is burned away, there is nothing to support them and so to keep the cores in place I drilled and inserted 'core pins' (essentially steel nails) right through the walls of the PLA object so that the ludo would have something to grip onto on either side of the PLA (fig. 5.27). Once the PLA is burned away, the pins keep the ludo on either side of the void in place. Second, as with all investment casting, 'runners and risers' were required. These are wax channels that provide a continuous flow of molten metal to eliminate shrinkage as solidification occurs during the casting process. Since aluminium is quite gassy, I also added further wax channels to act as 'airs', releasing gas from the mould during pouring (figs. 5.28-5.30). Carefully adding all these wax details was time consuming, and the ludo shell required a substantial volume of material that would also be cracked away and recycled at the end of the process (fig 5.33). It took just seconds to pour the aluminium into the mould, but the molten material continued to bubble and boil visibly in the mouth of the mould for nearly a minute after pouring. The appearance of the bubbles was uncannily similar to the digital protuberances I had generated using the haptic arm (figs. 5.31 & 5.32).

The next day I was very surprised to find how easily the aluminium cast emerged from its ludo shell and how it already had a milky lustre (figs. 5.33-5.36). Because aluminium is soft, it was relatively easy to remove the core pins and cut away the runners, risers and airs. I had to soak it in water to lessen the ludo stuck inside the hollows, but that soon came away with gentle brushing. To fill the holes left by the core pins, I shaped and inserted aluminium rod, snipped it away and then knocked it with the round end of a hammer. Initially, I intended to work this back with a detailing tool until they became invisible. However, the tiny round dots seemed oddly at home on this complex surface. Following this logic, I elected not to fettle back the stumps of the runners, risers and airs until they could no longer be identified – a process that would demand a degree of mimesis and artistic licence, but instead neatened them up, but retained the near circular trunks just proud of the surface.

Conclusion

The finished artwork *Coiled Pot* is unlike anything I could have imagined in advance. It is a palimpsest of five distinct processes: 1. hand-modelled coils of clay used to build up the original coil pot, 2. self-varying compenetration of the digitally duplicated pots, 3. surface deformation introduced by experimentation with the haptic arm, 4. pronounced stratification of the 3D printed layers of PLA

that now shimmer around the reflective surface as regular contour lines, and 5. tell-tale traces of investment casting aluminium that pock-mark the stratified surface. Unlike my previous research projects that had each, in their way, required a great deal of hand finishing and surface management, I had barely touched this object from start to finish. De-moulding any cast object is always a bit of a surprise because much of the laborious mould-making process is about setting up the right conditions for a material interaction to take place without you. However, looking at *Coiled Pot* I feel almost entirely disconnected from its facture. My hands were not responsible for the coiling or firing of the original clay pot, and I only handled it briefly wearing archival gloves. The scanning process does not require physical contact and nor did manipulation with the haptic arm. Although I was obviously responsible for the deformations this produced and I did 'feel' them through feedback forces exerted by the 'pen', the mysterious 'tool' that drew material towards me by some inexplicably magnetic algorithm, heightened the sense in which I was disconnected from the process. The CAD transformations had been developed through trial and error, but were largely the result of chance since I was unable to visualise the effects of the numerical operations I was instigating until they had happened. For more than five days the 3D printer steadily built up the new object from concentric coils of its own according to its own variable timeframe. It was only in the final stages of fettling the aluminium cast that I physically manipulated the object. And even then, I was merely tidying up details determined by the necessity of the process.

This project allowed me to interrogate an object and its materiality through partnership with the rigorous methodologies of a leading anthropological researcher, adding both critical distance to my choice of object as an artist and an intellectual foil unburdened by the tropes and fashions of contemporary art and common debates concerning the material or immaterial nature of contemporary sculpture in particular. By following Geismar's lead and focusing on the digital as a material object, the project evolved into a sculptural study of the digital transformation. At the same time following Pott's notion of sculpture as a constellation of mediations, the finished artwork presents nothing but a palimpsest of self-reflective mediations. The project clarified my methodology in terms of a unique three-way combination of an artists' experimental practice, a critique of materiality based in digital technology, and a deployment of anthropological research rooted in a critique of Western assumptions concerning notions of apprehending an object.

The completed artwork stems from the three previous iterations of my research procedure discussed above: my initial interest in the illusion of immateriality suggested by the digital compenetration and explored through the homogenised surface of *Playground* (chapter 4), the 'cognitive stickiness' elicited by the inextricable entanglements of knotted topologies in *Fragment* and *Gate* (chapter 6), and the intrinsic materiality and contingencies attendant to the material casting of

digital duplication in *Tree* (chapter 7). Crucially, my hands-on experience with the haptic arm allowed me to feel the material differences between 'digital clay' and actual (sculptural) clay. In his cognitive ecology of pottery, Lambros Malafouris explains how the physical process hinges on the potter's sense of the clay:

> In the time and space of pottery making, afferent sensory feedback (visual and proprioceptive/kinaesthetic information that tells that potter that he is moving) and efferent motor commands conflate and operate synergistically. The potter's sense of agency may be generated by efferent signals that send motor commands to the muscle system, but we should keep in mind that these efferent signals derive from the potter's sense of the clay. (Malafouris 2013: 225)

Malafouris's analysis is probably a fair description of the practiced manual work of the South African artisan responsible for producing the unfinished coil pot that I scanned in the UCL ethnography collection. By digitally simulating 'afferent sensory feedback', the haptic arm at the RCA promises a similarly proprioceptive/kinaesthetic relation to a 3D digital model. I was a novice, rather than a practiced artisan with this equipment and perhaps with practice, I would become accustomed to the behaviour of digital clay. And yet I noticed a palpable disjunction between my movements and their effects on the digital model. As I pulled the 'pen' away from the surface with the strange 'magnetic' tool, the digital object responded in subtle jerks and with a minute time delay that belied the 'true-to-life' feel claimed by the equipment. By repeating the operation, I became more familiar with the likely outcomes, but ironically involuntary wobbling of my hand prompted the algorithms into rapid sequences of recalculation in order to render the probable outcome in real time. It may be that future improvements in processing efficiency will allow kinaesthetic information to be translated into code and then feedback more efficiently. However, my sense of digital clay was still one of bodily disconnection rather than synergy, even though it was ostensibly manual. Despite the bodily disconnection that epitomised its means of production, the final form also intensifies the objects connection to the human hand. The finger-sized coils and palm-sized vessels both imply and invite handling. It's only on close scrutiny that the regular geometry of the machined contours that indicate the participation of non-human shaping. Pick the object up, and its heavy weight is strikingly at odds with its modest size and hollow form.

Coiled Pot encapsulates my research through its fusion of the digital and the sculptural. It posits an existentially dense, self-varying deformation that is both sensually and critically reflective. The resemblance between the original hand-made coils and the digitally machined coils left by the 3D printing process throw into relief the extent to which digital actualisation is bound by the same material constraints and contingencies as any analogue process. Even the digital time of the printer diverged from standardised clock time according to its mysterious contingencies. The final artwork

could only have been produced digitally, but these digital operations are so embedded in the material object that they have become inseparable from the analogue processes of their actualisation.

Notes

(1) The context and content of the Physical Information symposium are discussed in chapter 3 above (see also appendix 1.5).

(2) Although TECHNE studentship afforded me access to equipment at other institutions within the consortium (hence my access to the scanner), access to the haptic arm was apparently more restricted. Given its pertinence to my PhD research, I was eventually granted access for a brief time, which proved just sufficient to make a significant impact on this project.

(3) I teach at Camberwell College of Art, UAL, and have a good working relationship with the technicians there. The equipment at Camberwell. Since UAL is also part of the TECHNE consortium I was able to use facilities there to supplement my research.

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The Imponderable Bloom

> He broke off [fell silent], and she fancied that he looked sad. She could not be sure, for the [communication] Machine did not transmit nuances of expression. It only gave a general idea of people – an idea that was good enough for all practical purposes, Vashti thought. The imponderable bloom, declared by a discredited philosophy to be the actual essence of intercourse, was rightly ignored by the Machine, just as the imponderable bloom of the grape was ignored by the manufacturers of artificial fruit. Something "good enough" had long since been accepted by our race.
> E. M. Forster, *The Machine Stops* (1909)

This PhD research was motivated by an intuition that an essential aspect of human experience is lost through the machinations of the digital, and the hunch that sculptural encounters could help reconnect us to that experience. When I embarked on the research in 2014 (the year my son was born) it still seemed to make sense to speak of the digital as opposed to the real. Now in 2020, the digital simply is reality. The seductive grain of the digital grows ever finer and my now six-year-old son finds it difficult to distinguish between a CGI remake of The Lion King and an HD wildlife documentary narrated by David Attenborough – "Daddy, is this real?". Perhaps one day the sculptural artworks generated by this research might serve as 'object lessons' for my son, by embodying the tension between these simultaneous realities at the historical moment of their total integration. At the time of writing (July 2020), humans across the world are beginning to emerge from three months of physical isolation as a result of the global Covid-19 pandemic. The prohibition of direct physical contact and the complete pivot to digital communication has made questioning the reductive experience of digital media more pressing than ever.

In his science fiction short story, *The Machine Stops* (1909), E.M Forster imagined a future in which humans living in isolation have lost the desire to look directly at things. Only communicating remotely through mechanical representations, the protagonists have also lost their sense of space because "man is the measure", and "the essence of human intercourse" has been abstracted because "the Machine did not transmit nuances of expression". The conditions Forster describes are not unlike recent conditions during lockdown, which posed particular challenges for delivering and assessing a Fine Art degree course. There is no question that without digital technology the delivery of university learning and teaching would have been impossible between March and July 2020. The technology allowed students and staff isolated in different places and time zones to maintain discourse via a digital interface. In some instances, computers also enabled artworks that could no longer be physically realised to be digitally simulated and rendered. At the same time, digitally mediated videocall tutorials frequently felt stultified and resulted in tension and anxiety. Whilst final student presentations occasionally reflected leaps of speculative or conceptual imagination that probably

wouldn't have occurred in studios of workshops, the flattening effect of the PDF submission format made heterogenous student projects appear homogenous. There could be no accounting for the "imponderable bloom" of direct physical contact, and this was conspicuously absent in those more sculptural projects that sought to bring human scale and a full range of perception to bear on their objects and ideas. This thesis has sought to reassert the imponderable bloom of the sculptural by strategically employing the digital media that preclude it.

I began by questioning existing knowledge of the digital and the sculptural through immanent critiques that revealed their dialectical tensions (their necessary inner contradictions). On the one hand, I argued that digital objects entail a duel movement towards homogeneity and difference. On the other hand, I found that the sculptural imaginary stems from a tension between material facticity and imaginary projection. This line of enquiry led to the insight that the relation between digital and sculptural objects should not be considered as the common-sense binary digital/analogue, because they are both simultaneously concrete and abstract. However, I established that the digital and the sculptural elicit different orders of experience, because the digital relies upon representations, whereas the sculptural entails non-representational embodied knowledge. In order to consider how the digital might be applied to the sculptural, I analysed both digital photography and 3D digital replication of museum artefacts, and I identified an intrinsic rupture in digital reproductive processes. Namely, that there is no necessary indexical resemblance between digital data and the objects it purports to replicate. The non-indexical gap between digital data and its reconstruction is the cause of the tension and anxiety frequently associated with the digital, because it reflects a breakdown in comprehension. The lack of necessary resemblance is also why objects produced from the digital are always fictions that require creative activity in order to be actualised. I noted that digital technicians working on digital surrogates of museum artefacts tend to self-consciously hide traces of their necessarily creative interventions. By contrast, I argued that sculptural artworks can critically activate their autonomy (and thereby elicit a subtle shift in consciousness) by self-describing the material means of their fabrication.

I investigated the materiality of the digital and showed that whether it is considered from the standpoint of physical substance, or human judgement, the digital cannot be assumed to be immaterial. Furthermore, I exposed the digital industry's inclination to perpetuate the seductive ideological fiction of digital immateriality by coding digital media to self-efface evidence of its materiality, even at the cost of efficiency. Digital materiality was seen to exist in various forms, but its presence tends to be displaced from direct experience of the user interface, because material affordances and constraints are overwritten by the pre-coded rules of the programme. Having

established that digital materiality, though real, does not directly affect the experience of the user, I turned to ask how physical materiality can directly affect our experience of concrete things.

Addressing the notion that a 'thing' possesses qualities that elude instrumental reason, I examined two recent theories about how these qualities can affect human experience during the production and reception of objects. Cognitive archaeologist Lambros Malafouris critiqued the reductive computational model of human cognition to argue that the material world is actually a constitutive part of the human cognitive system: bodily experience was seen to be primary in structuring human conceptual processes; colour and texture affect human cognition through instantiation rather than symbolism; agency is the product of material interaction and not it's cause; and creativity derives from submission to vital materials rather than imposition onto inert materials. Meanwhile, political theorist and philosopher Jane Bennett suggested that when we encounter material things there are real forces that operate below the threshold of reflective attention: material effects in excess of the symbolic; affectations are a transfer of energy from which meaning can emerge. Bennett draws attention to our ability to sense that extra something provided by the presence of the thing.

Malafouris' and Bennett's projects underscore how the digital belongs to a representational order, whereby thought is experienced as a re-presentation of a stable model that exists in the world presented to us. By contrast the sculptural entails a non-representational order whereby objects emerge through the interaction of unstable processes characterised by creativity and contingency. The implication is that the digital and the sculptural have different ontologies. The digital is representational because it is founded on identity and is subordinated to a system of knowledge where differences emerge from negation (exclusion). On the other hand, sculptural qualities can be non-representational because they emerge through a process of change (self-difference) and are therefore grounded in affirmation. The conflict between negation and affirmation is reflected in my analysis of the tension between Bennett's affirmative theory of affect and Adorno's negative dialectics, which I characterise in terms of enchantment and disenchantment. This philosophical debate between negation and affirmation has further ramifications for art that correspond to debates around percept and concept, autonomy and heteronomy. I have suggested that autonomous art is affirmative, but that its criticality derives from its potential to resist the saturated backdrop of the commodity spectacle in order to elicit a subtle shift in consciousness through inward experience. There is a political aspect to the slow production of sculptural artworks that push back against more immediate forms of digital saturation. It is worth noting that despite their entailment of digital processes, the sculptural artworks produced during this research all evolved to be one-offs that cannot be mechanically reproduced. Heteronomous art, or course, deals with conceptual

representations of the external life world. For Peter Osborne, the digital is the meta-medium of conceptual (heteronomous) art precisely because it deals only in immediate representations that can be infinitely reproduced and distributed globally.

The methodological problem with Osborne's thesis that all contemporary art is conceptual art and that autonomous art can only exist as an instance of conceptual art, is that it privileges representational thinking. When conceptual representations are primary, the art experience is reduced to the abstractions of human thought. When a so-called sculpture is presented as an instance of (semi-autonomous) conceptual art, it appears as a representation of 'sculpture' – a prop or marker that is unable to affirm its own presence because it is subsumed by its conceptual identity. In Osborne's mechanistic formulation of contemporary art, the imponderable bloom - the essence of human intercourse - is lost. My project has been to strategically employ the digital meta-medium of conceptual art in order to re-imagine the sculptural after Osborne, and render the intangible palpable. My practical experiments have reversed Osborne's bias by taking unstable non-representational sculptural processes as primary and allowing digital representations to be transformed by them. I argue that it is the affective tone of a bodily encounter that motivates thought, more than the object of recognition. When the physical presence of an external thing and a subject's internal thingness resonate, the subject's experience of what it is to be human can be altered and recomposed. Just as our sensual experience of things exceeds our knowledge of them as 'objects', so our reciprocal bodily self-awareness as concrete persons, exceeds our abstract representation as 'subjects'. The imponderable bloom of direct experience is therefore critical, because it can reveal the material world to be constitutive of what we are and how we think, and at the same time it makes us aware (sense, feel) that we are not the centre of the material world, but merely things among things. The insights gleaned from this enquiry buttress my initial intuition as the central claim of this thesis: that something essentially human is lost through the abstractions of digital experience, and that sculptural experience could become newly critical in a world where digital experience is becoming experience in general. To test this claim, I will return to my initial research questions and draw upon my practical case studies to answer them.

What can digital media tell us about the nature of sculpture as an artform? The case studies that I have presented demonstrate how the digital can emphasise rather than undermine what is particular to sculpture. My practical experiments demonstrate that even when the process is ostensibly *hylomorphic* (because I was attempting to apply a preconceived computational representation to tangible materials), its sculptural evolution is *morphgenetic* due to the contingencies of dynamic material interaction. The mathematical precision of the computer provided the counterpoint of an unnatural order against the chance operations and contingent processes

required to reconstitute them in matter. Inhuman processing power intensified the difficulty with which the viewer might cognitively recapitulate the production process, whilst numerical modelling allowed me to pursue formal hypotheses that I could not have visualised without digital augmentation. However, the resulting formal knots were always profoundly inflected by the unforeseen qualities of material facture, such as: the midsummer heat that subtly slumped the investment wax, the misaligned lamination glued under atmospheric pressure, the structural instability of a wafer-thin 3D print as its internal plaster reinforcement dried, or the battle to keep resin cool during exothermic curing, all lent their unanticipated authorship to the ways that these artworks evolved and would be experienced. Accidents can contribute to the poetics of sculpture, but they violate the self-enclosed system of the computer. Any result reached by a closed digital system has been inscribed by the original data, whereas sculptural form can subsume the unpredictable within its internal structure. This is why digital representations always adhere to the either/or rule of binary negation – a logic of exclusion. Whereas non-representational sculptural qualities hinge upon the affirmative self-difference of becoming. The digital cannot create sculpture, but it can signpost the sculptural.

What is productive and distinctive about synthesising the reductive abstraction of the digital and the physical immediacy of the sculptural? The aim of my practical experiments has been to produce a structure of experience within the viewer that is equivalent to the coexisting processes incorporated formally within the artworks. The tension between digital representations and non-representational sculptural qualities as materially superimposed possibilities. My methodology's basic procedure is a kind of collage – cut-and-paste. Each of the techniques involved functions as a compositional element that is experienced in relation to the others. In each case it is direct physical experience of the non-representational sculptural qualities that throws the digital representations into relief and lends them a haptic voice. The works perform both representational and non-representational glitches that intrude upon one another. Yet these glitches go beyond a patina of fallible human imprecision and reach directly into the formal structure of the work. For example, *Fragment* fuses a glancing abstraction into rusted cast iron. *Gate* hinges upon the lame lack of weight and substance characteristic of MDF to undermine the emphatic entwinement of its cognitive snare. *Tree* only bears a tenuous resemblance to a tree and is, perhaps, more suggestive of an amorphous embryonic cell caught in the process of mitosis. However, its incompletely individuated form only really presents the clear material substance from which it has been made and that substance is only visible through its haptic, non-representational qualities: its nicotine tint and modular construction, and by the distortions it imposes on its (contingent) environment though reflection, refraction and magnification.

Two insights have been particularly pertinent to my making. First, I have argued above that digital technologies seek to uphold the ideological fiction of their purported immateriality by effacing evidence of their material construction. My first research project, *Playground*, sought to emulate this tendency by concealing its physical construction beneath a seamless topological surface. The resulting sculptural representation managed to appear incongruous and compelling largely due to its staging outdoors, where the a-temporality of the digital model was contrasted by the emphatic dynamism of the life-world on a busy high street. Its sculptural tension was therefore as much a consequence of external context as of the objects' identities inviting physical self-awareness. Nevertheless, I recognised that it remained more a representation of the digital than a non-representational transformation of the digital. Second, I identified how non-representational sculptural qualities frequently describe themselves in such a way as to intrude upon the representations that they nevertheless suggest. Throughout my practical research I have sought to play these two tendencies – digital self-effacement and sculptural self-description – off against one another. *Coil Pot* instantiates the coexistence of these digital and sculptural qualities in shimmering aluminium. The self-differentiating iterations of the digital object and the topological distortions produced using the haptic arm are as alienated from the coils of clay as the original pot was estranged from its origin in South Africa, stored behind glass in the UCL Ethnography Collection in Bloomsbury. The project was as much a product of my Physical Information symposium at Bloomberg as my engagement with RCA digital facility, or the UAL foundry. This small yet existentially dense object embodies tensions between representation and non-representation, sensuousness and critique, speculation and empiricism. Its scale and tactility invite handling, but it is much heavier than it looks.

This research suggests that it is the sensuousness of the embodied encounter that makes the abstract anomalies of digital operations so incongruous. I have sought to impart form to knowledge by sculpturally integrating distinct forms of experience. One of the reasons why digital artefacts conceal evidence of their own construction is that they want to be taken for objective facts. By calling attention to themselves as made things – digital artifices – the artworks produced in this research generate moments of ambivalence that oscillate between presentation and representation, cognition and recognition, when consciousness might take itself as its object. As concrete abstractions, they encapsulate how digital mediation alters the material fabric of the world. A world saturated by the global circulation of digital representations is a disenchanting prospect. This research proposes that sculptural encounters could reenchant critical objects with the imponderable bloom of direct physical experience.

Rupert NORFOLK

The Mobility of Facts

Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy, Kingston University London

January 2020

Appendices

Appendix 1.   Physical Information curated exhibition programme:

    1.1   Five Problems
    1.2   Constituent Components
    1.3   The Mobility of Facts
    1.4   ir re par sur
    1.5   Physical Information Talks Event

Appendix 2.   Playground (Chapter 4)

Appendix 3.   Gate/Fragment (Chapter 5)

Appendix 4.   Tree (Chapter 6)

Appendix 5.   Coiled Pot (Chapter 7)

Appendix 1

Physical Information
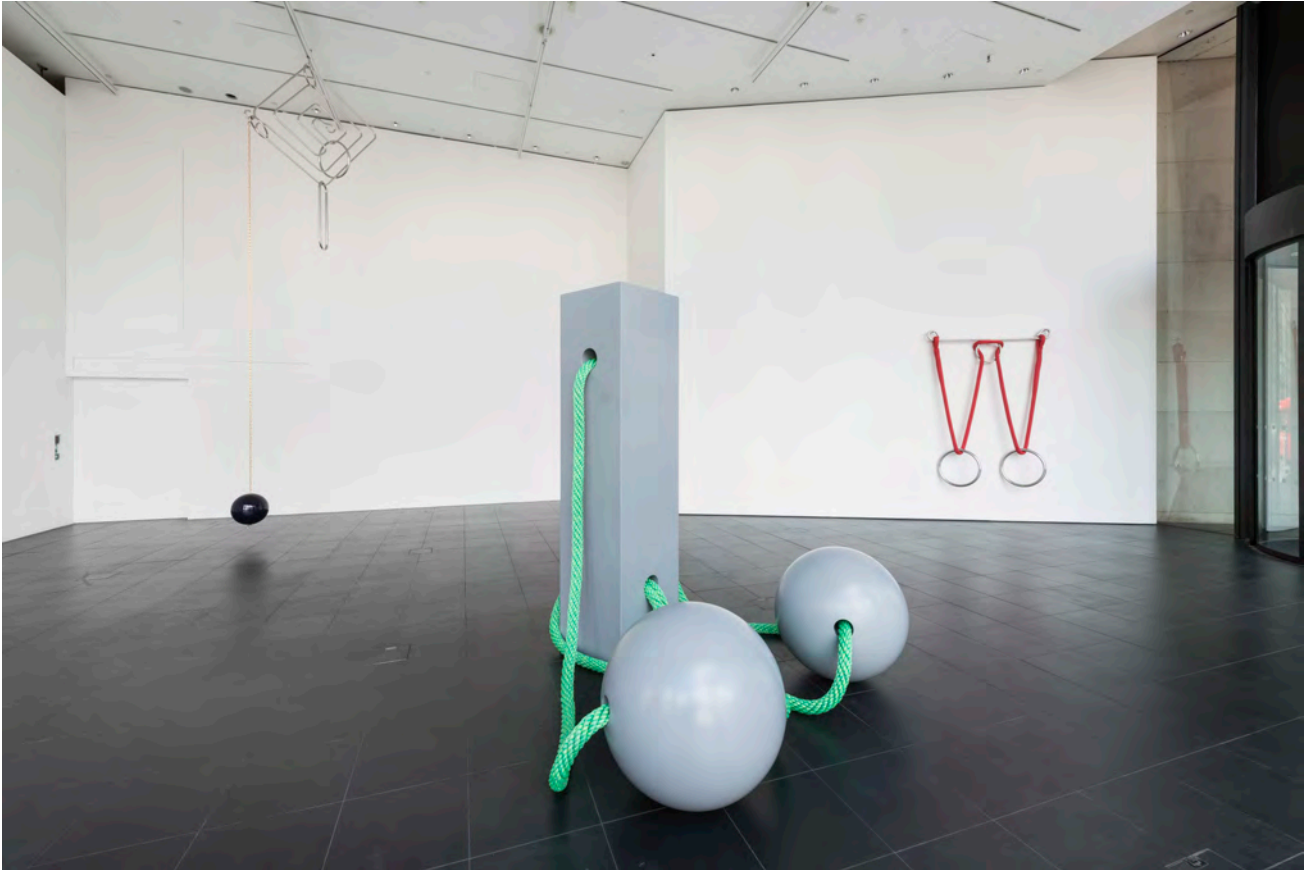
Eva Grubinger *Five Problems* 1 April – 28 May 2016

Jim Isermann *Constituent Components* 22 June – 10 September, 2016

Giuseppe Gabellone, Siobhán Hapaska & Charlotte Posenenske *The Mobility of Facts* 30 September – 17 December 2016

Florian Roithmayr *ir re par sur* 20 January – 22 April, 2017

Eva Grubinger
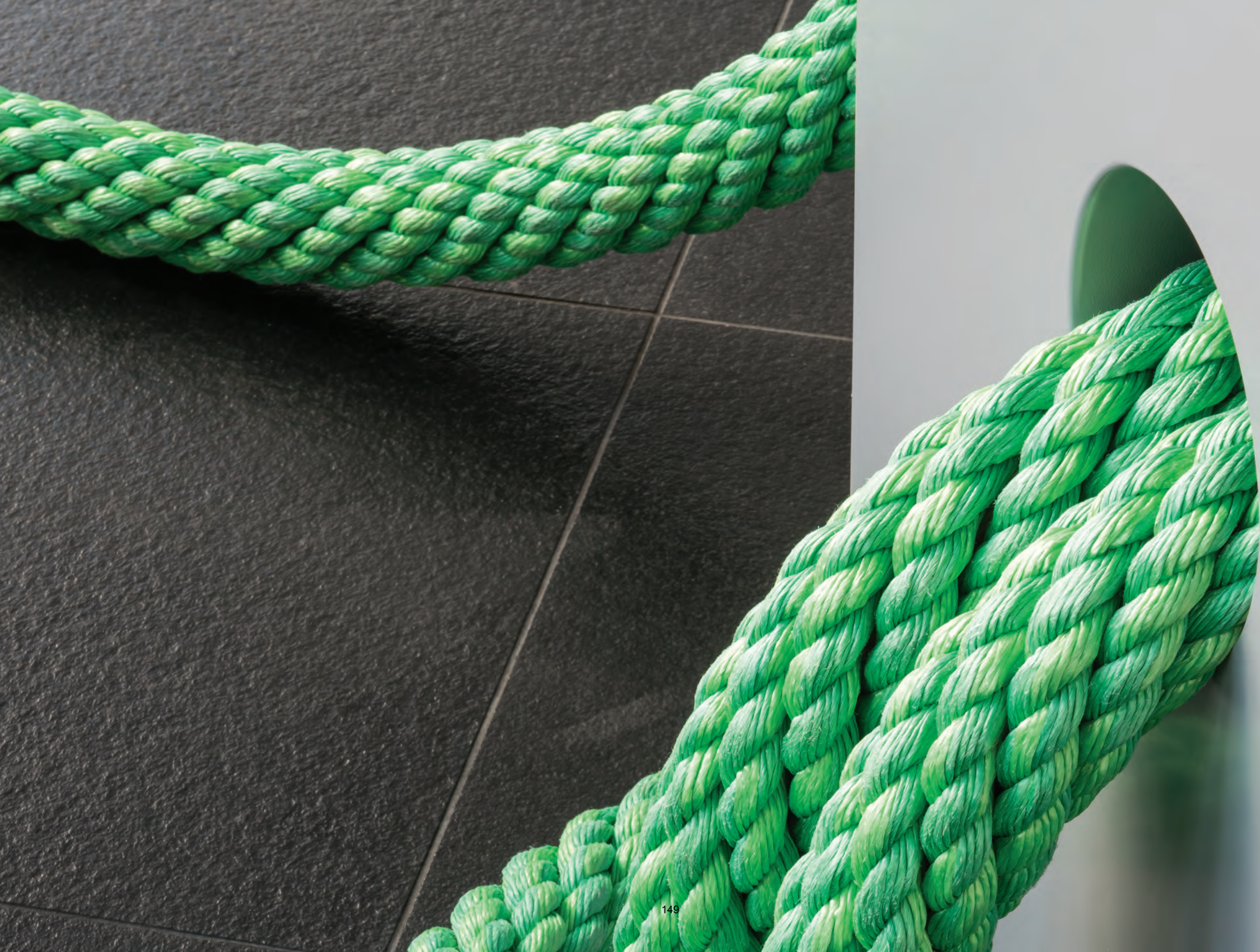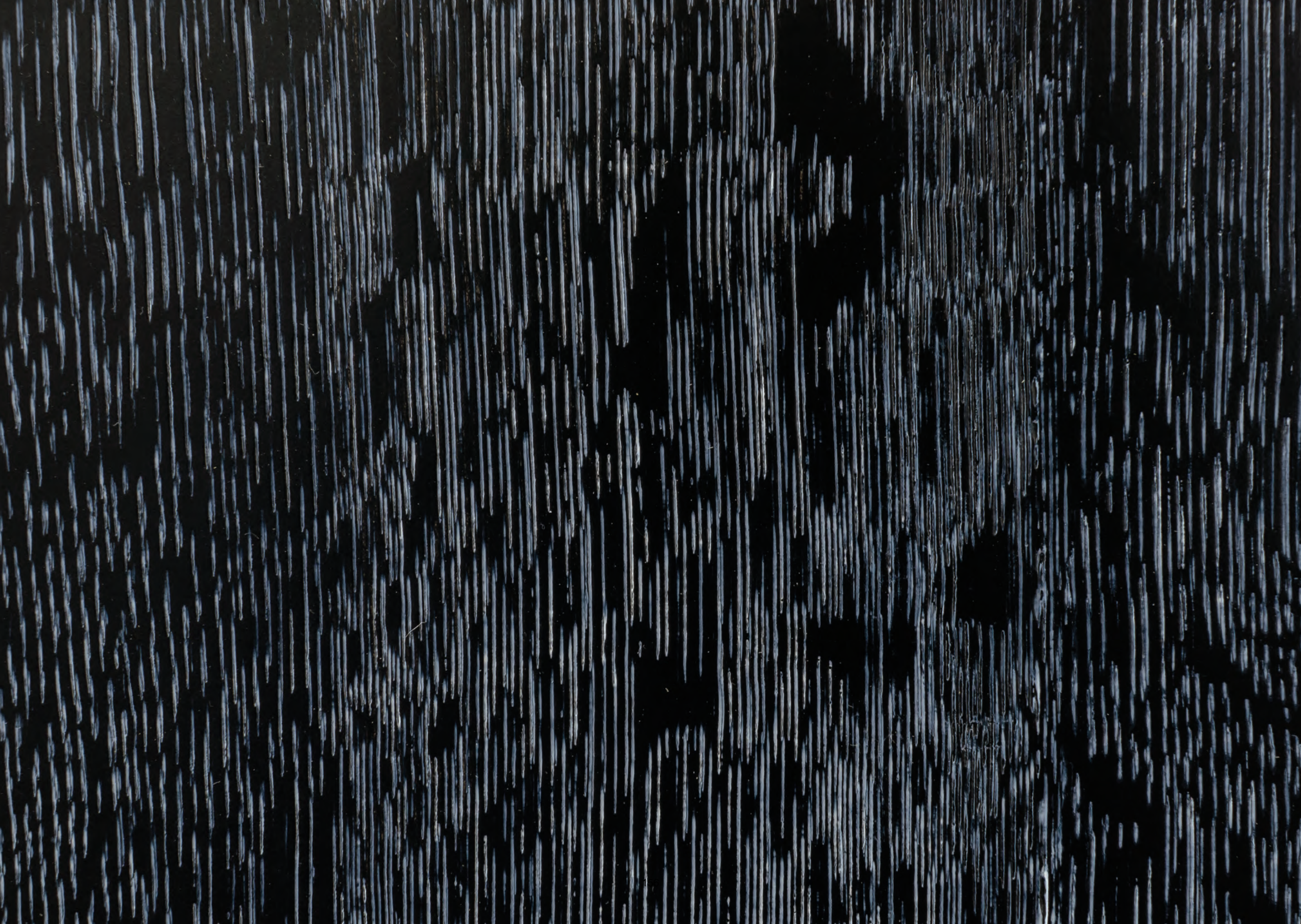
Untitled (No.1), 2016
Wood, fiberglass, paint, rope
250×60×60 cm; ⌀80 cm

Untitled (No.2), 2016
Stainless steel, braided rope
180×210 cm (ca.); ⌀50 cm

Untitled (No.3), 2016
Stainless steel
80×34×20 cm (ca.)
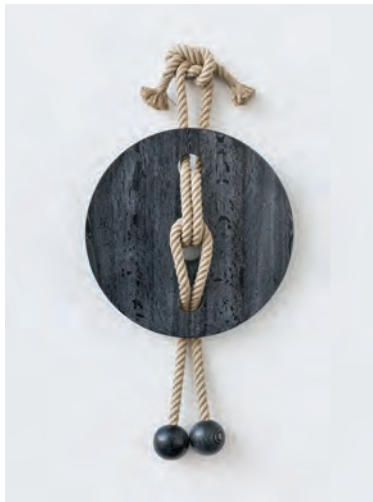
Untitled (No.4), 2016
Stained oak, chalk, enamel, hemp rope
⌀80×160×20 cm (ca.); ⌀14 cm

Untitled (No.5), 2016
Stainless steel, gold, carbon, enamel
120×113×2.5 cm;
96×13×3 cm ⌀25, 40, 63 cm

Five Problems is a series of sculptures that relate formally to Vexier (or disentanglement) puzzles, thought to originate in the 'wisdom games' of the Song Dynasty-era China. These conundrums, involving freeing and attaching puzzle parts, come in a variety of materials including string, metal and wood, with their appeal deriving from their apparent insolvability. In Five Problems, Eva Grubinger enlarges and reworks such brainteasers, locating them on the floor, walls and ceiling. Being too heavy to manipulate, the 'problems' become mental ones; callisthenics for the brain.

The sculptures refer to objects of Chinese, African and American origin. They encode mathematics, topological knot theory, logic and history, aspects that Grubinger's sculptures both emphasise and reconfigure. Where the original knots and string are substituted with rope, the works convey an ocean-going feel, reflecting Grubinger's long-standing interest in the maritime as metaphor, particularly as a focus for competition and imperial conquest. Other works have bodily overtones, suggesting that one intractable 'problem' being reflected here is gender relations. These highly technical, beautifully machined objects might also suggest luxury items in a showroom, though they are made grotesque by their size. Echoing commonplace objects such as the harnesses and safety materials that work in part as psychological security blankets during perilous sports, the sculptures also imply an aspect of the human psyche that desires risk, but on safe terms.

For centuries, disentanglement puzzles have been used as a kind of intelligence training. Elsewhere, purely mental techniques such as the 'memory palace' have been employed, where objects are distributed around an imagined space in order to aid recall. The near-abstract forms of Five Problems conflate both techniques to suggest a variety of knotty cultural problems across different scales and registers—with the implication that, despite their appearing unsolvable, we can at least try to think them through.

Eva Grubinger lives and works in Berlin. She has had solo shows at Museum of Contemporary Art Kiasma, Helsinki (2001); BALTIC Centre for Contemporary Art, Gateshead (2003); Berlinische Galerie, Berlin (2004); Schirn Kunsthalle, Frankfurt am Main (2007); Museum der Moderne, Salzburg (2009), Belvedere Palace and Museum, Vienna (2012); and Institute of Contemporary Arts, London (2015), among others. She has participated in group shows at Deichtorhallen, Hamburg (2002), Taipei Fine Arts Museum (2008), Krannert Art Museum, Illinois (2009), Marrakech Biennale (2012); Galeria Vermelho, São Paulo (2013); Witte de With Center for Contemporary Art, Rotterdam (2014); and Kunsthalle Wien, Vienna (2015), among others. She is currently a guest professor at Kunstakademie Dusseldorf.

Physical Information is a programme of five exhibitions co-curated by Henry Coleman and Rupert Norfolk, exploring how physical objects can generate alternative experiences in an increasingly abstract world. Three solo commissions and two curated shows investigate the potential of sculpture to activate public imagination and orientate social space, engaging the individual viewer physically and psychologically.

The Bloomberg SPACE commissioning programme reflects Bloomberg's philanthropic passion to support exciting talent and to commission new works. Since 2002, Bloomberg SPACE has worked with more than 470 artists and has commissioned over 130 new works.

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Jim Isermann
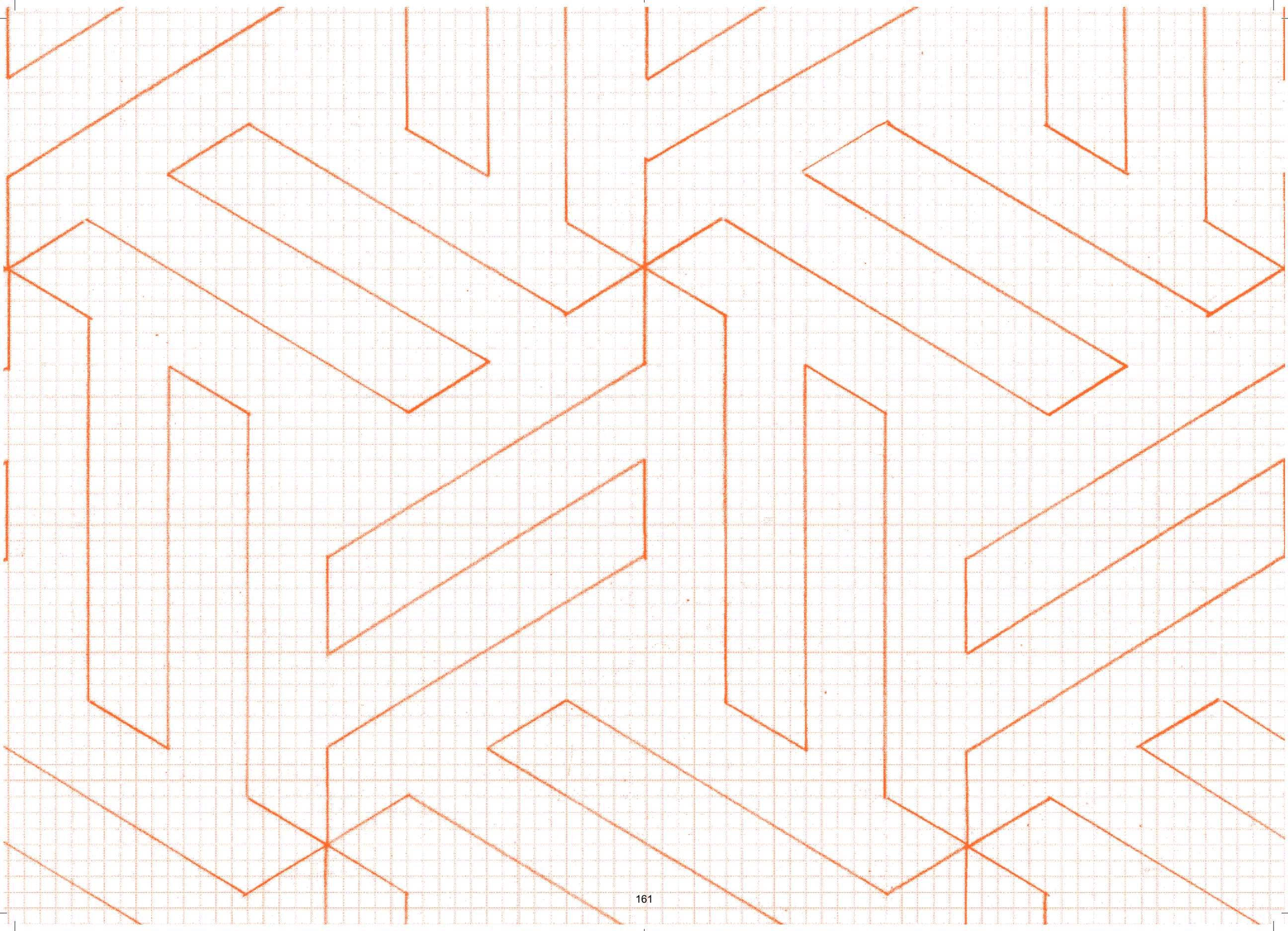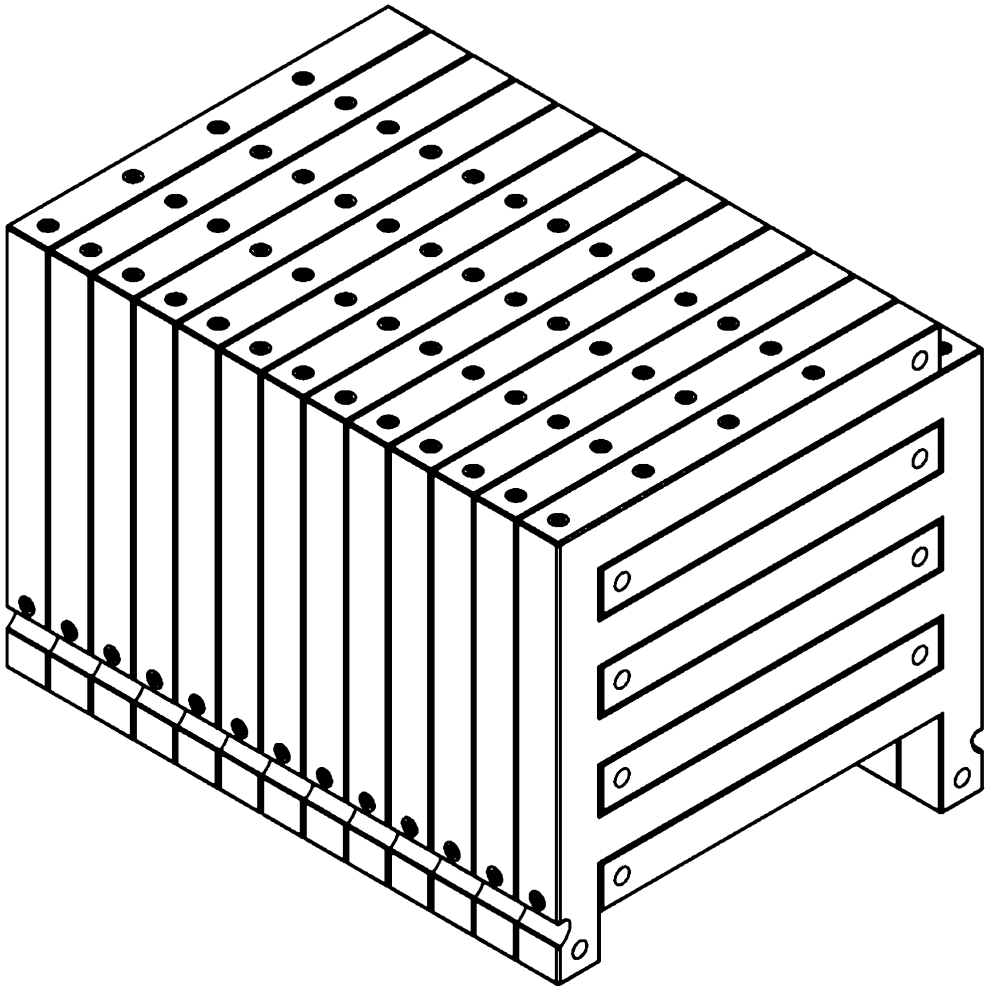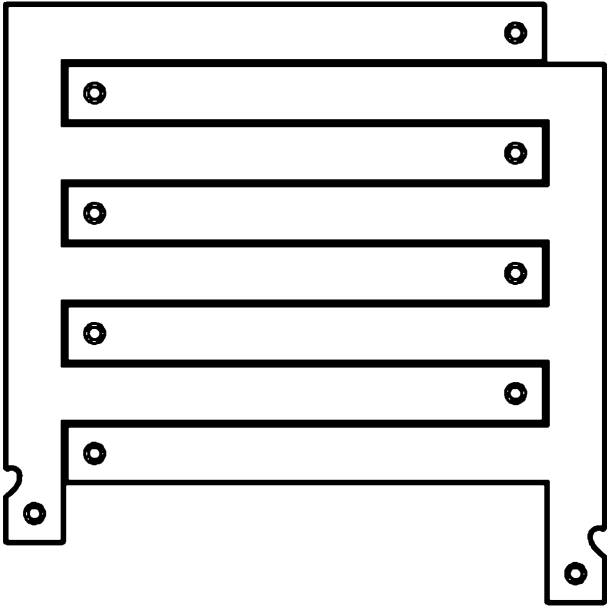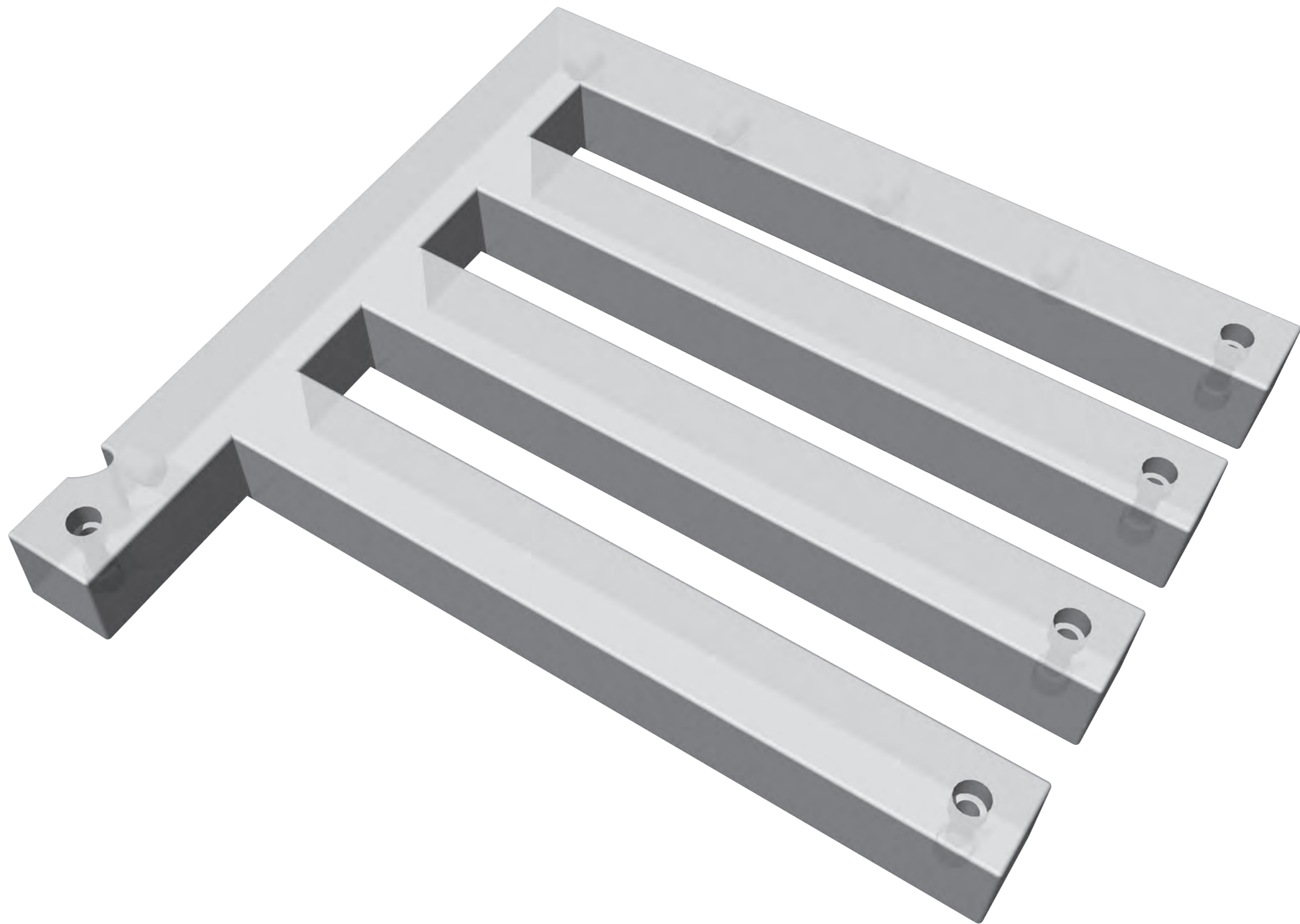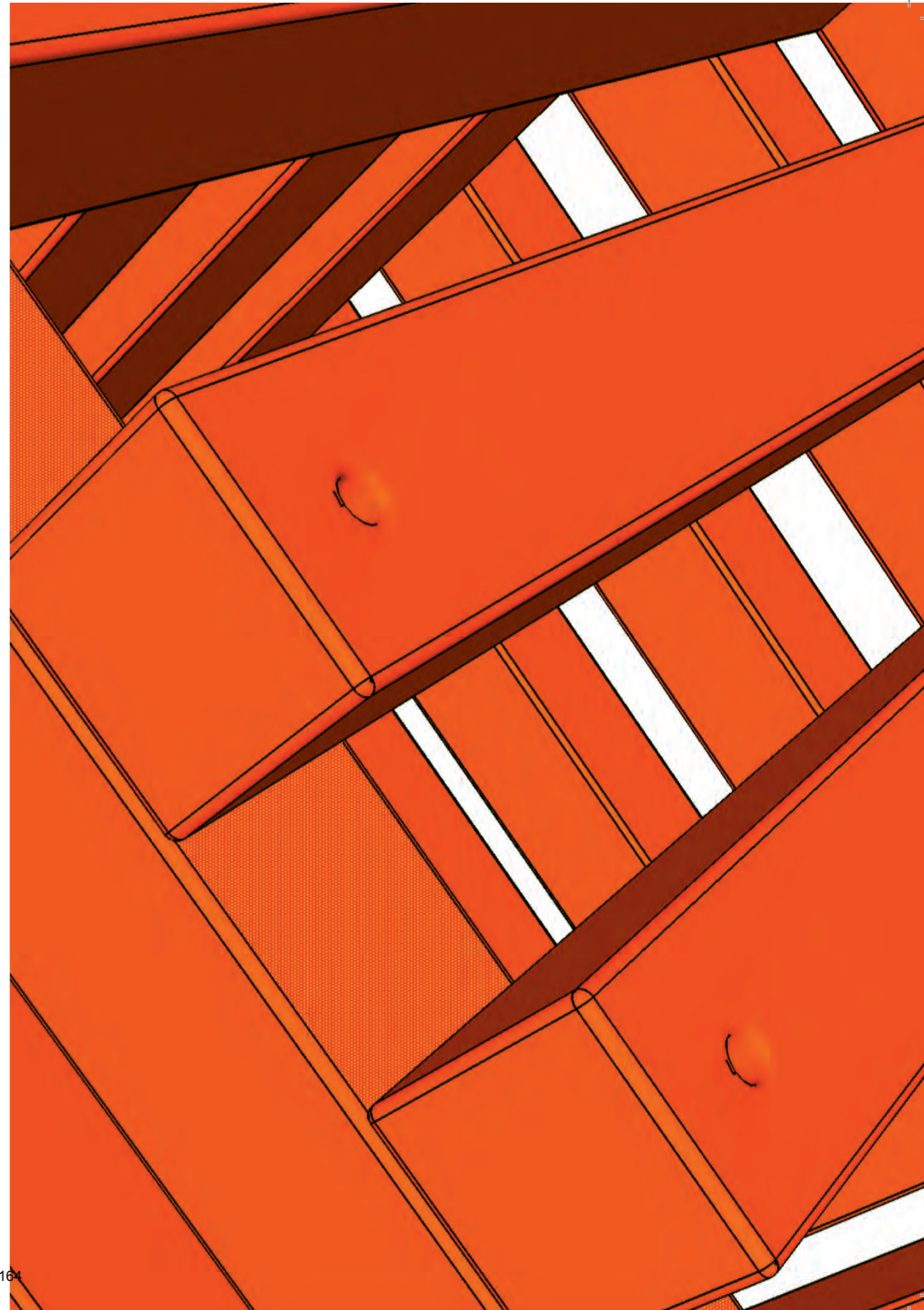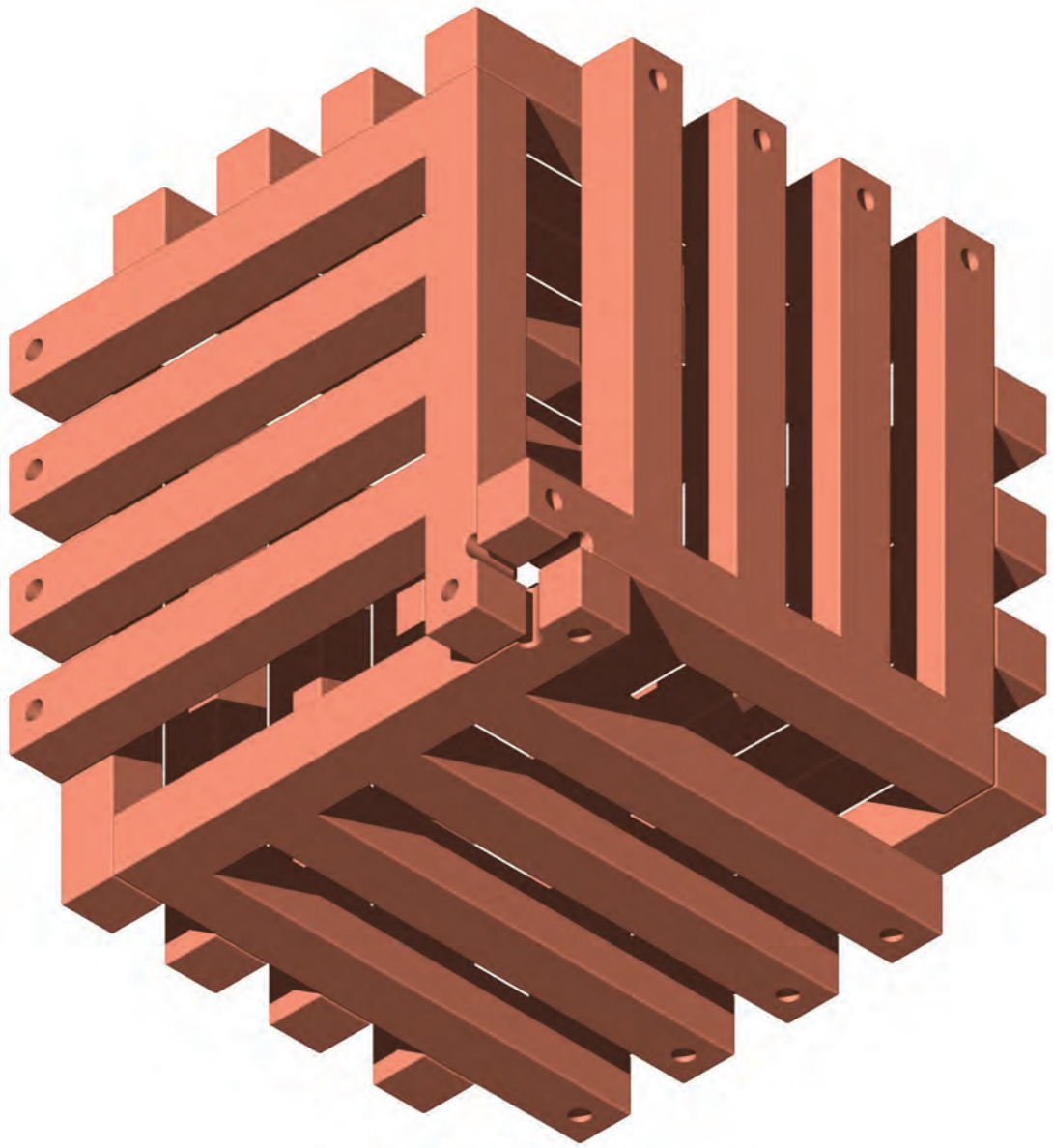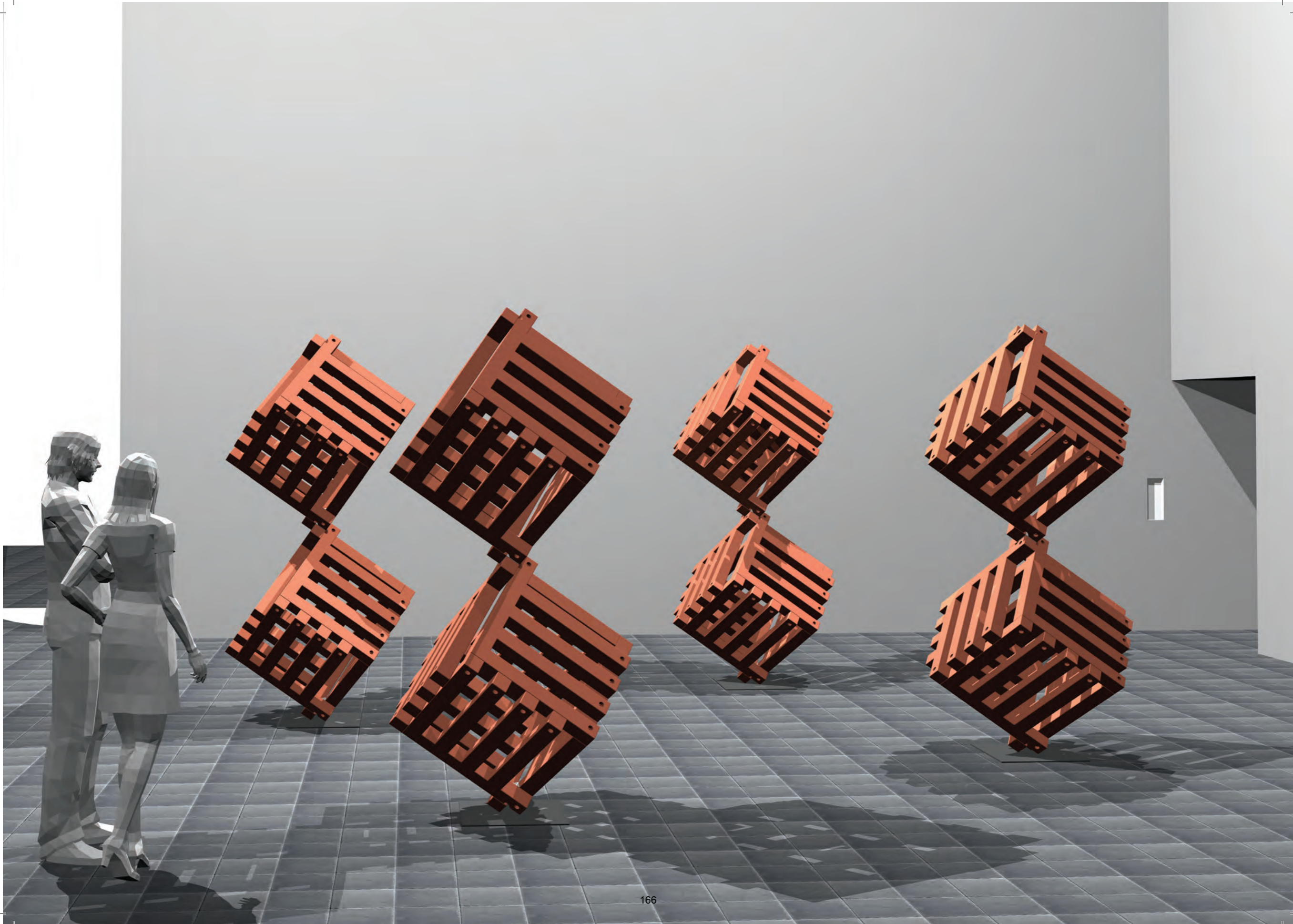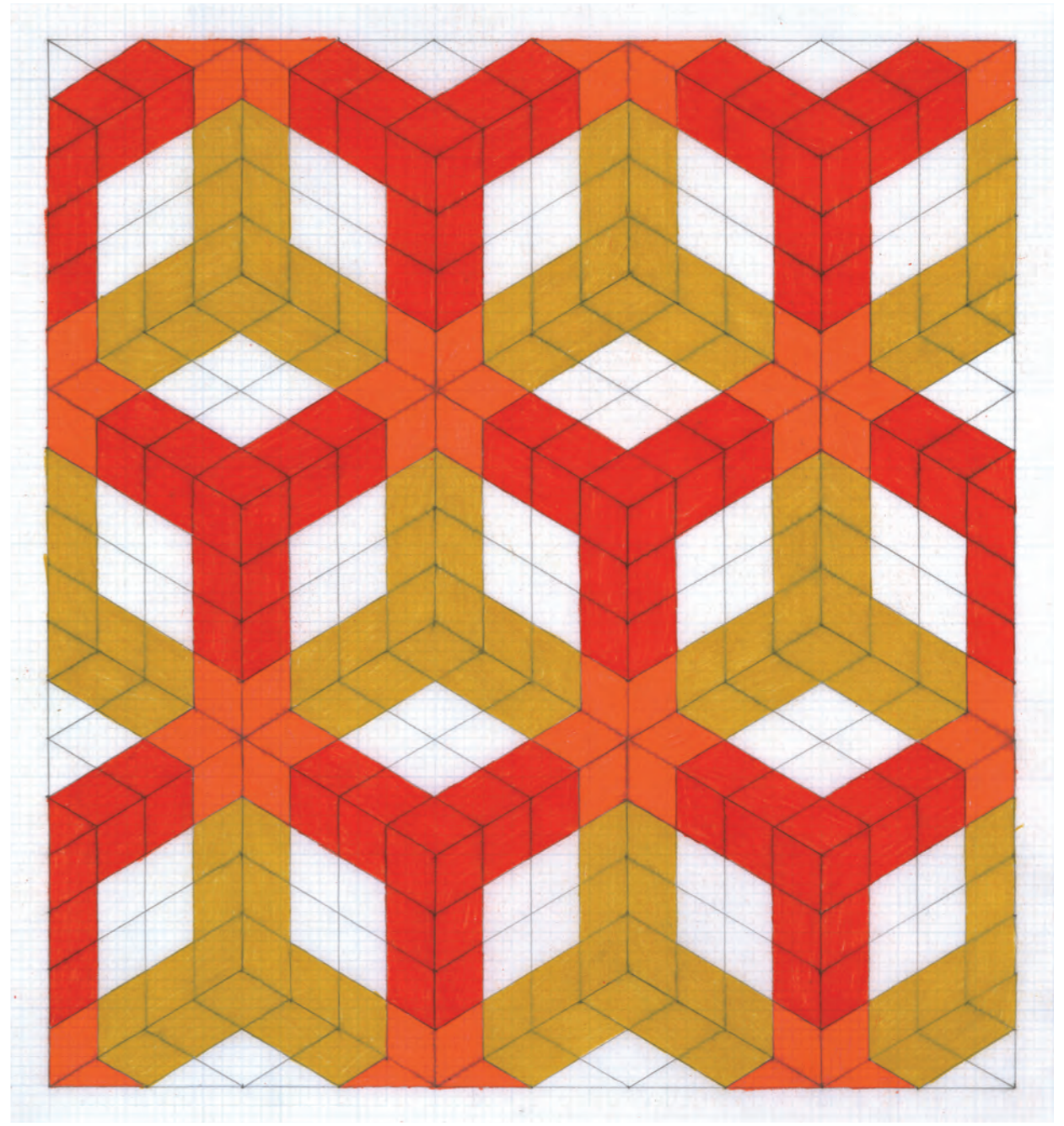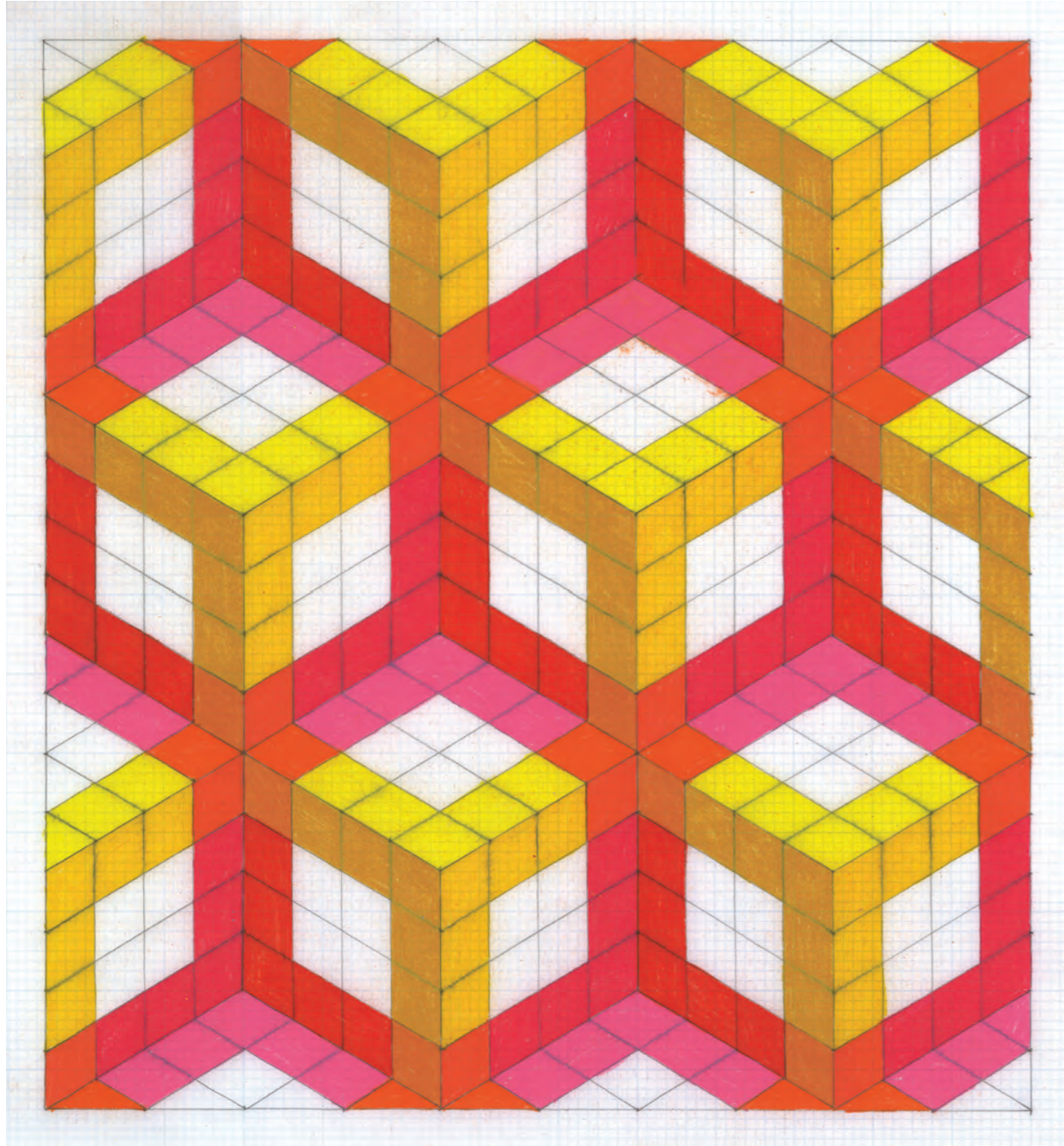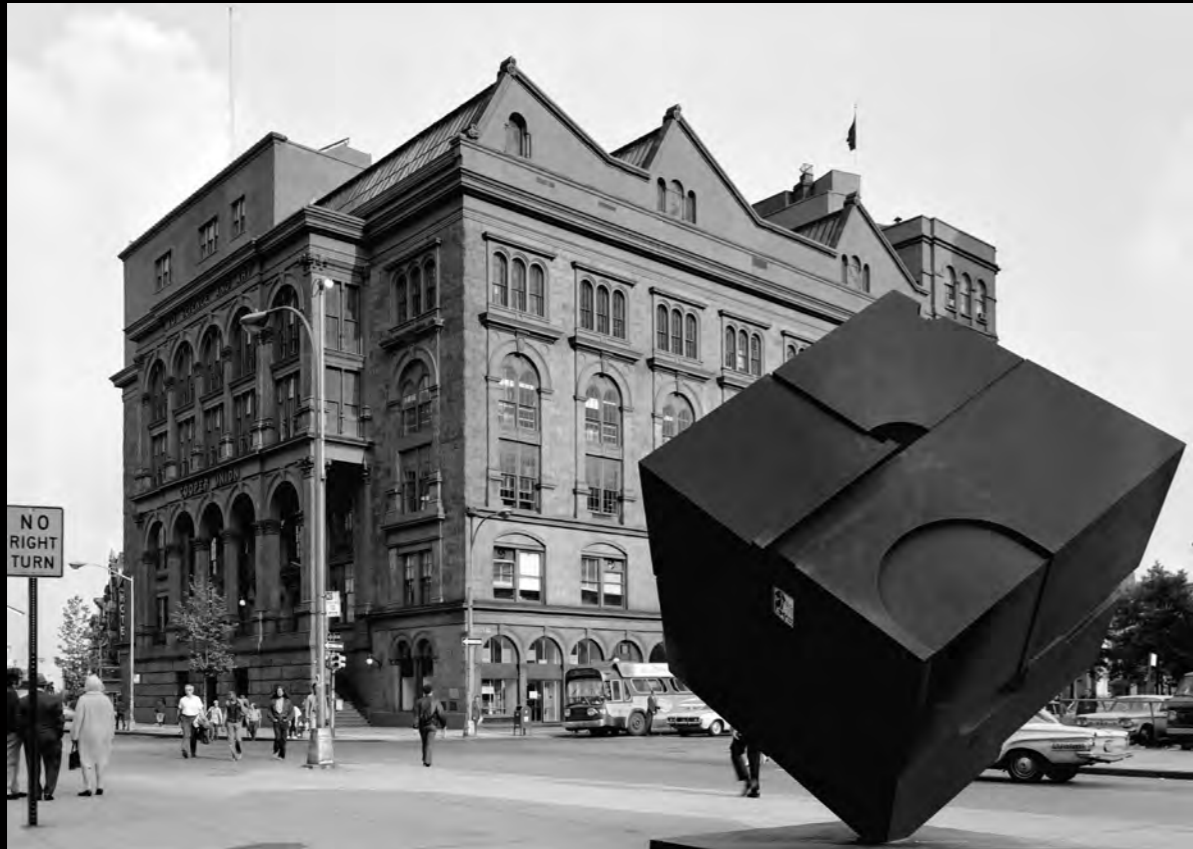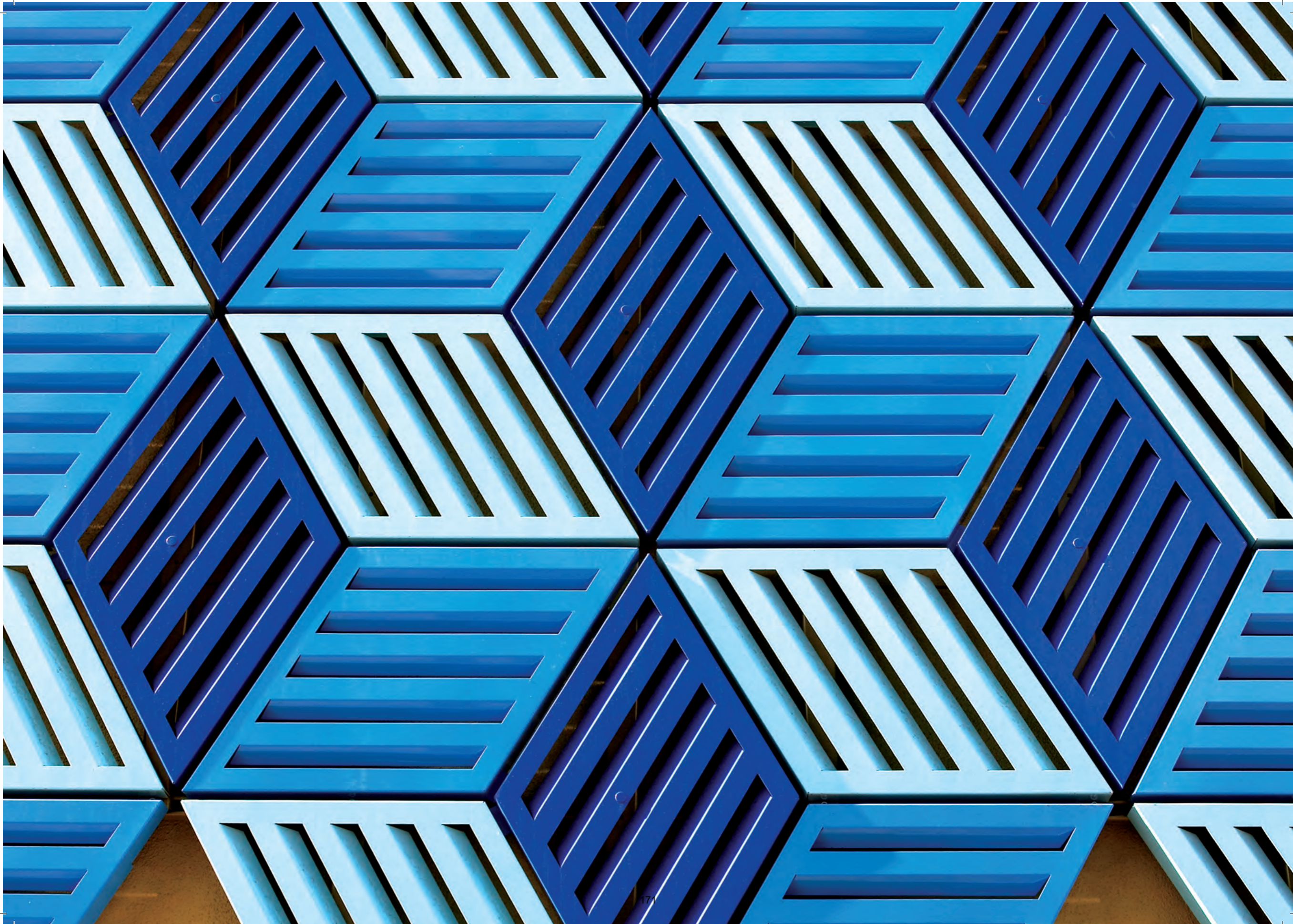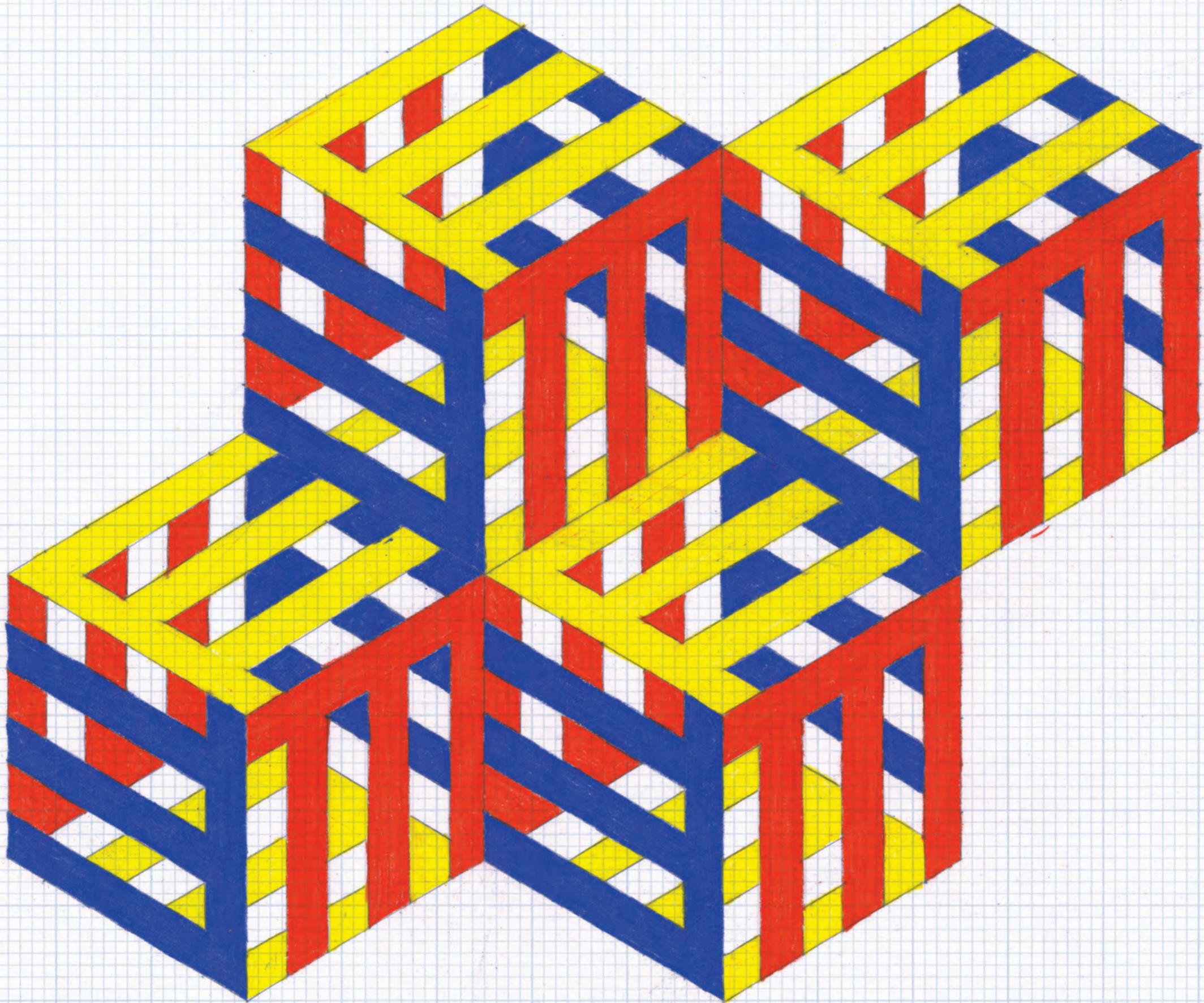
Tony Rosenthal, *Alamo,* 1967
Painted CorTen steel, 15 × 15 × 15 ft.
© Estate of Tony Rosenthal / DACS,
London / VAGA, NY 2016

Jim Isermann, Untitled (houndstooth
+ herringbone) (0198 + 0298), 1998
Fabric on wood, 66 × 66 × 66 in. (each)

Isamu Noguchi, *Red Cube,* 1968
Red painted steel, 28 × 28 × 28 ft.
140 Broadway New York, NY
Skidmore Owings & Merrill
Ezra Stoller © Esto. All rights reserved.
© The Isamu Noguchi Foundation
and Garden Museum/ARS, New York
and DACS, London 2016
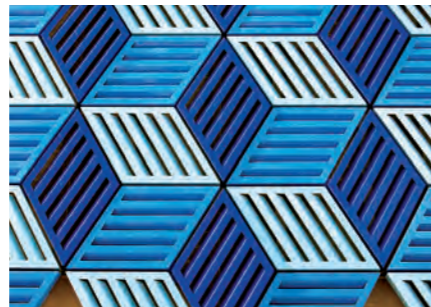
Jim Isermann, Untitled (Tilfords), 2006
459 powder coated aluminum panels
and steel uni-strut
20 × 20 × 3 in. (each panel)
overall approximately 14 × 125 ft.

Digital design and fabrication management: Metalab LLC
Rotational mould and fabrication: Deep South Plastics LLC

Constituent Components is an exhibition of six sculptures and one wall work that play out the possibilities of an isometric cube in order to create new forms. Applied to the walls as a graphic vinyl pattern and arranged across the gallery floor as double-stacked, modular cubes, these newly commissioned works explore Jim Isermann's career-long conflation of industrial design, craft production and art. Performing a fragile balance between these modes of operation, the exhibition proposes a dialogue between high and low, hand and machine, analogue and digital creation.

Drawing on examples of high-modernist public sculpture such as Noguchi's 'Red Cube' (1968) and Rosenthal's 'Alamo' (1967) – both monumental sculptures sited at the entrances to New York City Subway stations – Isermann's cubes multiply and complicate the gestures of these works, whilst resisting their imposing scale. Produced in roto-moulded polyethylene, a material process borrowed from the mass production of street furniture, these tilted cubes suggest a different notion of a public object. Arrayed across the space to evoke an indoor plaza, the sculptures are anchored on points that correspond to the existing grid of the gallery floor.

The three pairs of parallel parallelograms that make up the decal pattern repeat an image of the sculptures around the gallery. Rotating across the walls at 120 degrees in sets of corresponding colours, the pattern establishes a 'ground' for the sculptural 'figures' of the cubes. The remaining white wall functions as an inverted duplicate of these coloured forms, highlighting the eccentricities of the gallery's irregular architecture. Commercially produced and infinitely repeatable, the works examine the artist's interest in the potential of modular production as way to generate space and organise perception.

Jim Isermann, *Constituent Components*
22nd June – 10th September 2016
Bloomberg SPACE, London EC2A 1HD
bloombergspace.com

Jim Isermann lives and works in California. He has had solo shows at Mary Boone Gallery, New York; Corvi-Mora, London; Deitch Projects, New York; Feature, Inc., New York; Praz-Delavallade, Paris; and Richard Telles Fine Art, Los Angeles; and solo projects at the Hammer, Los Angeles; and the Museum of Contemporary Art, Chicago. Isermann has completed commissioned works for the Albright Knox Art Gallery, Buffalo, NY; Cowboys Stadium, Arlington, Texas; The Ohio State University; Princeton University; the University of California, Riverside; the University of California, San Francisco among many others. His work is in the permanent collection of the Art Institute of Chicago, Chicago, IL; FNAC, Fonds National d'Art Contemporain, France; MOCA, the Museum of Contemporary Art, Los Angles, CA; and the Van Abbemuseum, Eindhoven, Netherlands among others. He is a professor of art at the University of California, Riverside.

jimisermann.com

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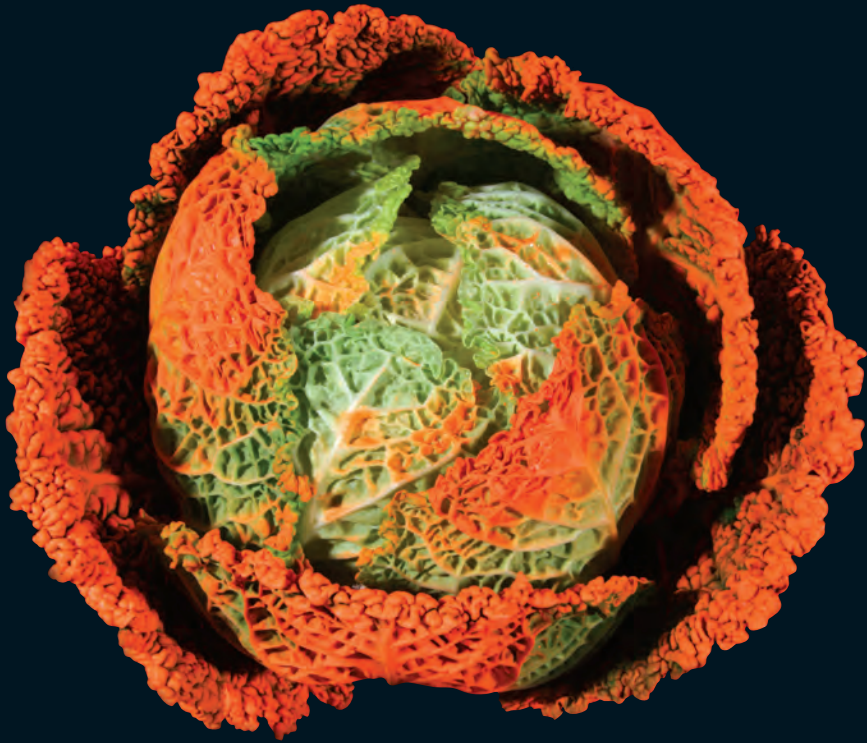
The Bloomberg SPACE commissioning programme reflects Bloomberg's philanthropic passion to support exciting talent and to commission new works. Since 2002, Bloomberg SPACE has worked with more than 470 artists and has commissioned over 130 new works.
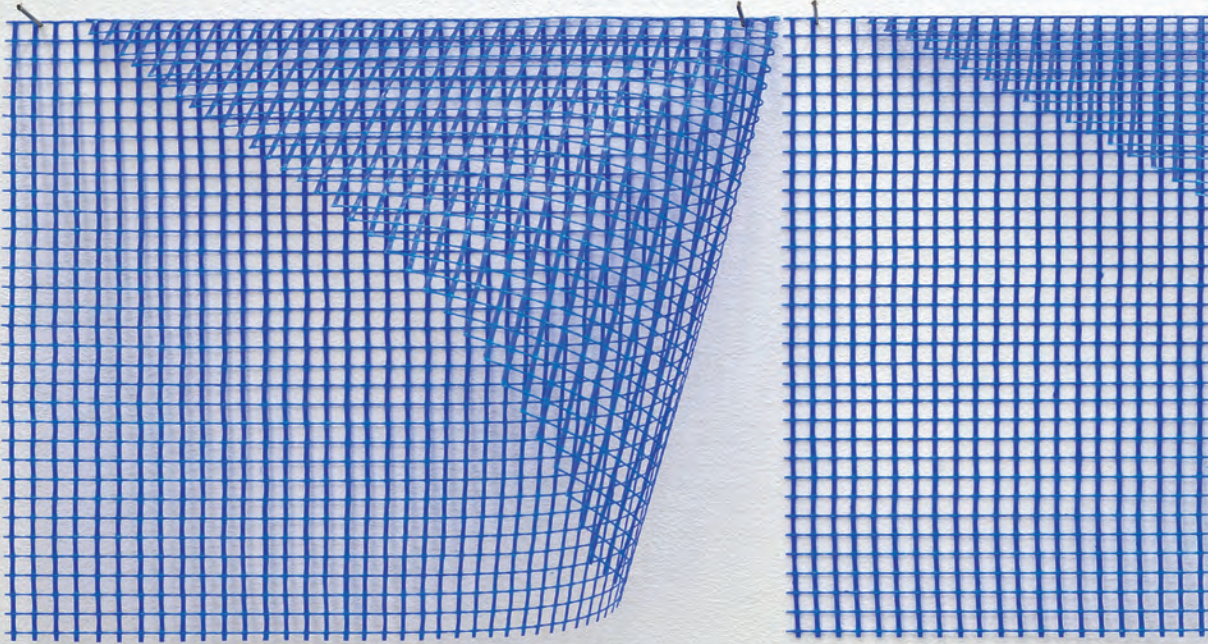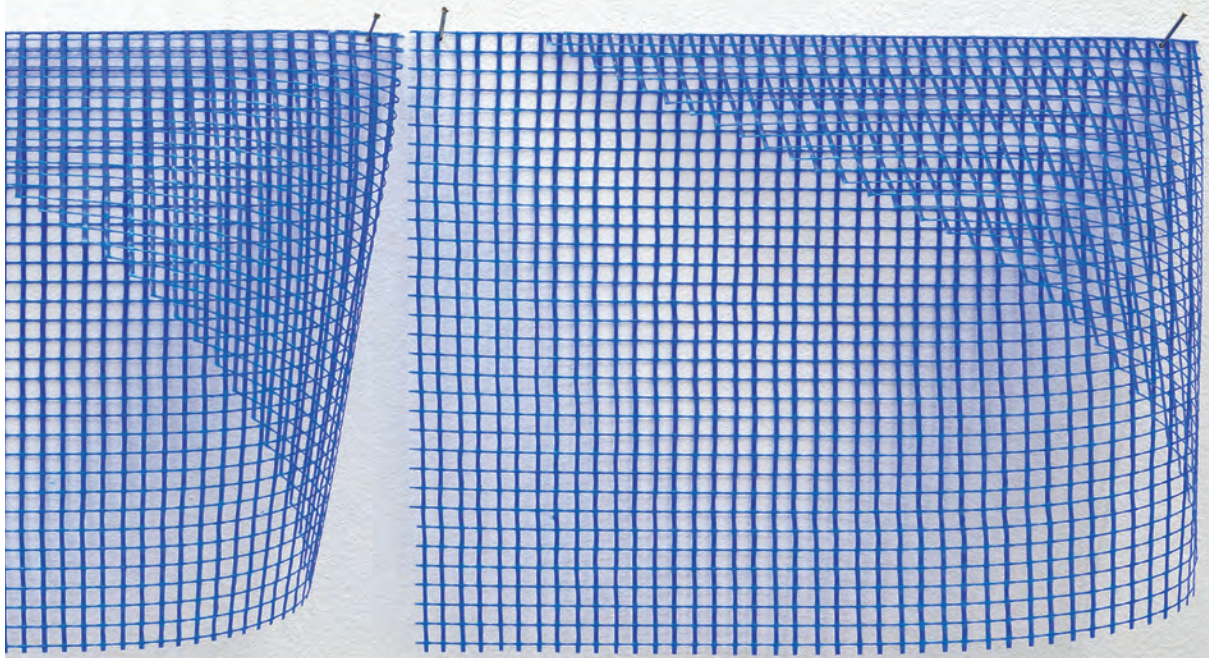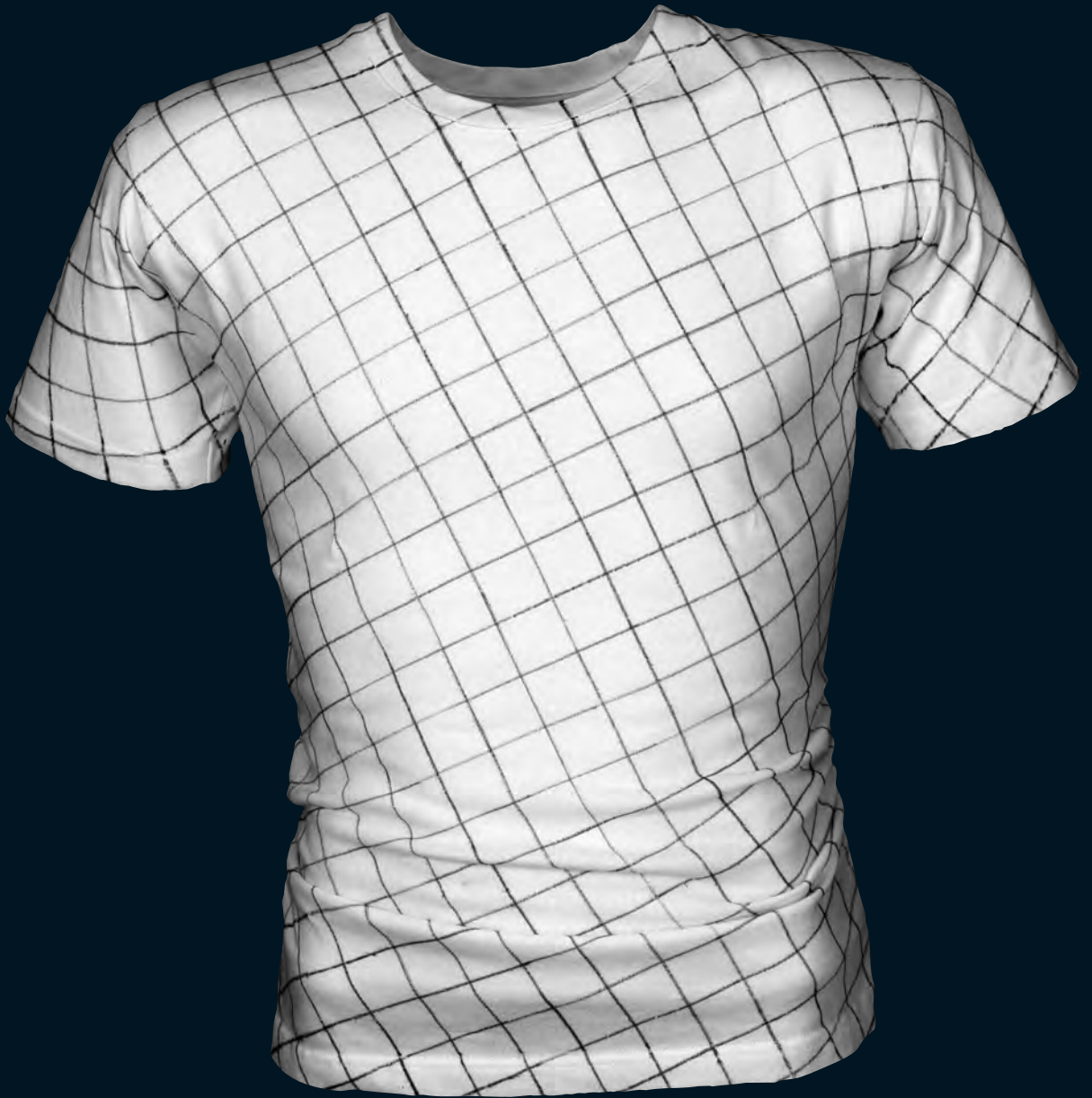
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Giueseppe Gabellone

Siobhán Hapaska

Charlotte Posenenske

Giuseppe Gabellone

Verde Acido, 2012
Cotton velvet, acrylic padding
15m × 11.5m

Ruggine e Rosso Cocciniglia, 2014
Cotton velvet, acrylic padding
21.15 × 13.3m
Photo: Marcus Leith

Untitled, 2014
Coloured pencil on wall
251.5 × 248.5cm
Photo: Marcus Leith
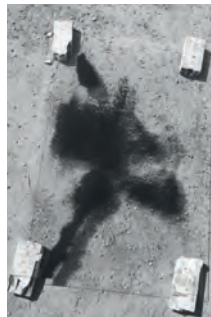
Fiore, 2011
Silkscreen on paper
160 × 120cm
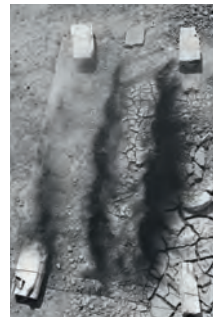
Fumo, 2011
Silkscreen on paper
160 × 120cm
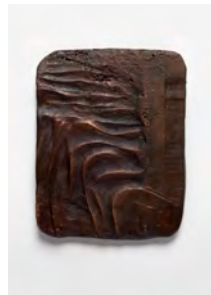
Untitled, 2014
Bronze 22.5 × 18cm
Photo: Marcus Leith

Siobhán Hapaska
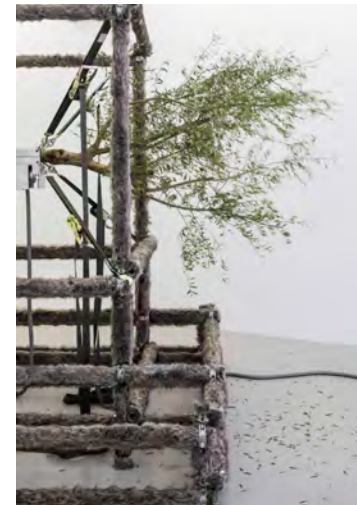
A wolf, an olive tree and circumstances, 2014
Aluminium tubing, forged scaffold fittings,
2" military ratchet straps, artificial wolf fur,
vibratory motor, electrical components,
olive tree
250 × 560 × 260cm

Bird, 2016
Concrete cloth, fibreglass, stainless steel
100 × 110 × 100cm

Touch, 2016
Concrete cloth, oak, synthetic fur, aluminium,
steel, two-pack acrylic paint and lacquer
230 × 95 × 140cm

Love, 2016
Concrete cloth, fibreglass, two pack acrylic
paint and lacquer, oak
141 × 233 × 102cm
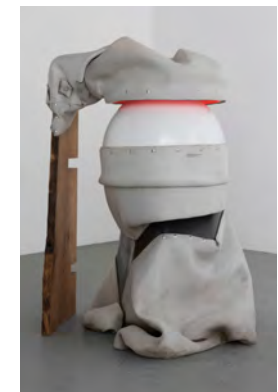
Us, 2016
Concrete cloth, fibreglass, two pack acrylic
paint and lacquer, stainless steel, oak
135 × 110 × 100cm

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Charlotte Posenenske

Series D Square Tubes (detail), 1967
Configured by Galerie Mehdi Chouakri,
Berlin, 2007, sheet steel
Overall display dimensions variable

Series D Square Tubes, 1967
Configured in public space, Siegen, 2005
Sheet steel
Overall display dimensions variable

Strip Picture, 1965
Adhesive strips
on paper
33×23.5cm

Fold, 1965
Spray-paint on paper
45×62.5cm

Series E Large Revolving Vane, 1967–68
Frankfurt am Main airport
Sheet aluminium
Overall display dimensions variable

Series DW Square Tubes, 1967
Corrugated cardboard
(precise image reference TBC)

The Mobility of Facts brings together three highly idiosyncratic objects that challenge a conventional notion of sculpture as having fixed concrete form. Each work asserts an unstable presence through distinct approaches to material, construction and scale. One way or another, they all engage with time to activate the contingencies of encounter and affect the viewer physically and psychologically.

Giueseppe Gabellone's *Verde Acido*, 2012, is an enormous padded cotton quilt that would extend beyond the dimensions of Bloomberg SPACE if spread out flat. This bright monochrome textile is arranged across the gallery's black granite floor tiles in soft folds that are inevitably displaced by the footsteps of visitors walking directly over it. The tactile familiarity of this object might appear comforting, but its excessive size gives it a disquieting presence.

In contrast, Charlotte Posenenske's *Series D Square Tubes*, 1968 –, consists of an interconnecting modular system of six steel elements that resemble industrial ventilation ducting. Inexpensive to produce and endlessly versatile, *Series D* was conceived with the express intention that its elements could be refabricated at cost price and reconfigured according to the requirements of new situations. This radical stipulation has allowed the work to elude historical rarefication and remain contemporary, since it continues to be available and adaptable to the needs of the present long after the artist's premature death in 1985. At Bloomberg SPACE, thirty-six elements are installed across the ceiling following the existing architecture.

Flanked vertically by Gabellone's mute fabric and the flowing network of Posenenske's galvanised conduit, a third sculpture is constantly trembling. Siobhán Hapaska's *a wolf, an olive tree and circumstances*, 2013, is constructed from aluminium poles clad in synthetic wolf fur and clamped with forged steel components. Within this rigid framework an uprooted olive tree is suspended horizontally by ratchet straps and vigorously shaken by means of an electric motor. Replete with material and structural tensions, Hapaska's sculpture is at once absurd and traumatic. As time passes, the relentless agitation of this unsettling apparatus causes the unfortunate tree to shed its leaves over the gallery floor.

Installed to exploit the peripheries of Bloomberg SPACE, the disparate works in this exhibition present a tangible yet resolutely uncertain mise-en-scène for the spectator to inhabit and explore.

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Giuseseppe Gabellone, Siobhán Hapaska, Charlotte Posenenske
The Mobility of Facts
9th September – 6th December 2016
Bloomberg SPACE, London EC2A 1HD
bloombergspace.com

Giuseppe Gabellone lives and works in Paris. Solo exhibitions include: GAMeC Galleria d'Arte Moderna e Contemporanea, Bergamo (2013), Domaine de Kerguéhennec, Bignan (2008), Museum of Contemporary Art, Chicago (2002) and Fondazione Sandretto Re Rebaudengo, Turin (2000). Group exhibitions include: Kunstmuseum Lichtenstein, the Centre Pompidou in Paris, Museu Serralves in Porto, Stedelijk Museum voor Aktuele Kunst, Ghent, Bonnefanten Museum, Maastricht, Museo d'Arte Contemporanea of Castello di Rivoli and Galleria d'Arte Moderna, Bologna, Venice Biennale (1997 and 2003), Biennale de Lyon (2003), Documenta in Kassel (2002), Biennale of Sydney (1998), Santa Fe Biennial (1997).

Siobhán Hapaska lives and works in London. Solo exhibitions include: Museum Boijmans Van Beuningen, Rotterdam (2015); Magasin 3, Stockholm (2013) and Camden Arts Center, London (2007). Recent group exhibitions include: Hazelwood House, Sligo; Azerbaijan Pavilion, 56th Venice Biennale; Abbot Hall Art Gallery, London; Museum Boijmans Van Beuningen, Rotterdam (all 2015); Espace Louis Vuitton, Paris (2014); Crawford Art Gallery, Cork, travelling to Dublin City Gallery The Hugh Lane, Dublin (2012); The Royal Academy of Arts, London (2011). In 1997, Hapaska took part in Documenta X. In 2001, she represented Ireland at the 49th Venice Biennale.

Charlotte Posenenske lived and worked in Frankfurt, where she died in 1985. During her lifetime Posenenske's work was shown in solo exhibitions at: Galerie Art & Project, Amsterdam (1968), Konrad Fischer Galerie, Düsseldorf (1967), Galerie Dorothea Loehr, Frankfurt am Main (1961, 1966, and 1968). Her work was recently featured in documenta 12, Kassel (2007) and In & Out of Amsterdam: Travels in Conceptual Art, 1960–1976, at MoMA (2009). Other posthumous solo shows include: Chianti Foundation, Marfa (2015/16), Gallery Melapapadopoulos, Athens (2012), Kunsthaus Wiesbaden (2012), K21, Düsseldorf (2012), Gallery Nelson-Freeman, Paris (2011), Galerie Konrad Fischer, Düsseldorf (2011), John Hansard Gallery, Southampton (2011), Artist Space, New York (2010), Museum für Gegenwartskunst, Siegen (2005), Galerie im Taxispalais, Innsbruck (2005), Galerie ak, Frankfurt am Main (1999/2000), Wolfgang Tillmans' exhibition space Between Bridges, London (2007), Galerie Mehdi Chouakri, Berlin (2007 and 2008), and Peter Freeman Inc., New York (2008). Posenenske will be the subject of major retrospective at the Dia Art Foundation, New York in 2017.

Physical Information is a programme of five exhibitions co-curated by Henry Coleman and Rupert Norfolk, exploring how physical objects can generate alternative experiences in an increasingly abstract world. Three solo commissions and two curated shows investigate the potential of sculpture to activate public imagination and orientate social space, engaging the individual viewer physically and psychologically.

The Bloomberg SPACE commissioning programme reflects Bloomberg's philanthropic passion to support exciting talent and to commission new works. Since 2002, Bloomberg SPACE has worked with more than 470 artists and has commissioned over 130 new works.

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MIX
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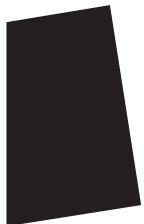
Florian Roithmayr

Axillae, 2015
Plastic mesh, pins
20×77×12 cm

The Assistants, 2014
Papier-mâché, iron
86×32×22 cm

All other photographs: Florian Roithmayr, studio research, 2014–2016.

For this new commission, Florian Roithmayr has transformed the architecture of Bloomberg SPACE to present an aggregate of his research into material interactions at an unprecedented scale. Roithmayr's gestural sculptures curl and bend over themselves as if they might envelop the viewer's body. Poised between raw material and expressive form, these works articulate the tensions between their interior and exterior surfaces. This material precariousness produces inflections as indeterminate as the wordless prefixes that make up the exhibition title—*ir re par sur*.

A sheet of paper is laid out flat. It is a sheet of a particular size. Most likely, it was much larger before. Sometimes the size is smaller, or longer and narrower.

100kg of clay is used to cover the surface of the paper. Sometimes the 100kg of clay is made up of packs of 12.5kg each. Sometimes it is four packs of 25kg. It depends on the supplier of the clay. It is important only for a short period and not beyond.

The clay is spread from the centre of the paper outwards: lengthwise along the middle first, forming a kind of spine, and then sideways, similar to the arrangement of bones. The spreading is done quickly. All of the clay should be used. The consideration hovers somewhere between the amount of clay already spread out and the amount of clay still to be used, and the changing proportion between those two amounts.

Over several days, the paper covered in clay rests. If left exposed, in an environment that is considerably dry and warm, the liquid (water) starts to be separate from the solid (clay particles) through a process of mass transfer also called evaporation. The gradual separation of liquid from solid has visual, material, spatial, and sometimes even topological consequences.

A shape is cut out of brown cardboard. The shape is a long piece of triple-layered cardboard with two corrugated layers in between. Cutting through these layers poses some difficulty, and makes for cuts that are not so even or neat. Evenness is of no concern. Nor neatness. The mind is set on the shape and its future.

The cut-out shape is placed on a table. It looks like the letter U, but very elongated. The brown cardboard shape is covered with brown packaging tape and any excess is trimmed off. Additional strips of long, brown, corrugated cardboard are cut. These strips are also covered with brown packaging tape and any excess is trimmed off. These strips are curved like a wall around the edges of the cut out shape and fastened with brown packaging tape. This work is done quickly and methodically, in an attempt to complete the wall on both the outside and the inside of the shape as quickly, but also as sturdily, as possible. The brown packaging tape sometimes sticks to itself. Sometimes it doesn't stick down so well, sometimes the wrong ends stick together, and sometimes it doesn't hold the walls to the shape so well. This is of no concern. This doesn't appear as error or imperfection. This activity is repeated in varying sizes.

Florian Roithmayr, 2016
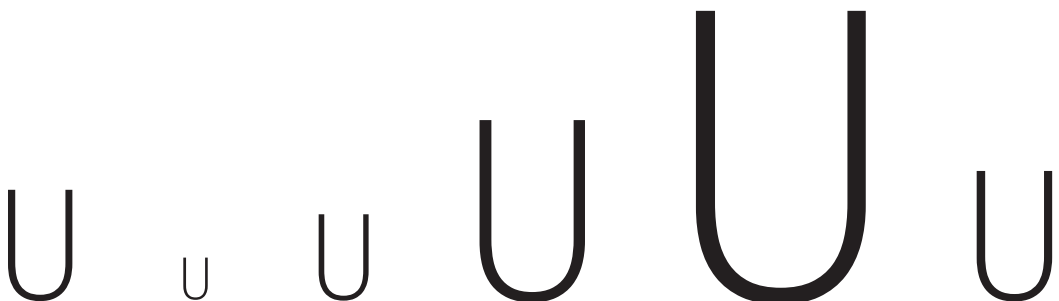
Florian Roithmayr, *ir re par sur*
20 January – 18 March 2017
Bloomberg SPACE, London EC2A 1HD
bloombergspace.com

Florian Roithmayr has recently been appointed for the public art commission of the new Chelsea Embankment Foreshore in collaboration with architects Hawkins & Brown, and is currently developing exhibitions with HS Projects in London and a sculpture project co-commissioned by the Museum of Classical Archaeology, Kettle's Yard, and Wysing Arts Centre in Cambridgeshire.

Solo exhibitions include: *with, and, or, without*, Camden Arts Centre (2015), *SERVICE*, MOT International Brussels (2015); *Matter of Engagement*, Site Gallery, Sheffield (2014); Treignac Projet, Treignac, France. Group exhibitions include: *Foreign Objects*, CCA Derry-Londonderry, *Inland Far*, Herbert Read Gallery (2016) *Things That Tumble Twice*, Tenderpixel, London (2015); *The Influence of Furniture on Love*, Wysing Art Center, Cambridgeshire (2014); Carl Freedman Gallery, Vilma Gold, The Approach, and V22 in London; S1 Artspace, Sheffield; Grazer Kunstverein, Graz; Galeria d'Arte Moderna, Turin; Galerija Miroslav Kraljevich, Zagreb; New Contemporaries and Liverpool Biennial.

Florian Roithmayr wishes to thank Wysing Arts Centre and University of Reading, Department of Art.

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Physical Information
TALKS EVENT

Saturday, April 22
1:00pm – 6:15pm

Bloomberg SPACE is delighted to welcome you to today's event. Part of the current exhibition programme Physical Information, today's event is concerned with re-imagining the possibilities of material encounters, exploring how physical objects can generate alternative experiences in an increasingly abstract world. Today, three keynote speakers and two artist interventions will explore material culture from the perspectives of art history, anthropology, and fiction.

AGENDA
1:00pm - Arrival and handout of printed artwork by Karin Ruggaber
1:20pm - Welcome: Rupert Norfolk, Physical Information
1:35pm - Keynote: Alex Potts, Art Historian
2:20pm - Keynote: Haidy Geismar, Anthropolgist,
3:05pm - Questions
3:25pm - Short Break
3:40pm - Animation by Artist, David Musgrave
4:00pm - Reading by Tom McCarthy, Author
4:45pm - General discussion with all speakers
5:15pm - Drinks Reception in the Bloomberg SPACE Gallery
6:15pm - Event Close

Physical Information
Physical Information is a programme of five exhibitions at Bloomberg SPACE, co-curated by Henry Coleman and Rupert Norfolk, exploring how physical objects can generate alternative experiences in an increasingly abstract world. Three solo commissions and two curated shows investigate the potential of sculpture to activate public imagination and orientate social space, engaging the individual viewer physically and psychologically.

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About the contributors

Haidy Geismar is an anthropologist teaching at UCL where she is also curator of the UCL Ethnography Collections. Her research focuses on museums and collections, especially in the South Pacific countries of Vanuatu and New Zealand. Recently she has been researching the digitization of cultural collections, the incorporation of indigenous protocols into museum databases, and the interpenetration of contemporary art and ethnographic collections. She is in the early stages of a book looking at new practices and forms of digital photography. Recent publications include Treasured Possessions: Indigenous Interventions into Cultural and Intellectual Property (2013), and Moving Images (2010). Geismar is also founder and chief editor of the Material World blog as Chair of the Royal Anthropological Institute Photography Committee recently founded a new open access journal, Anthropology and Photography.

Tom McCarthy is a novelist. In 2013 he was awarded the inaugural Windham Campbell Prize for Fiction by Yale University. His collection Typewriters, Bombs, Jellyfish (to be published by NYRB this June) gathers essays that have appeared over the last decade in publications such as The New York Times, The London Review of Books, Harper's and Artforum, with themes ranging from Franz Kafka and James Joyce to David Lynch and Sonic Youth. His first novel, Remainder, won the 2008 Believer Book Award and was recently adapted for the cinema. His third, C, was shortlisted for the 2010 Booker Prize, as was his fourth, Satin Island, in 2015. McCarthy is also author of the 2006 non-fiction book Tintin and The Secret of Literature.

David Musgrave is an artist who gives the abstractions of experience concrete form. His drawn and sculpted figures are palpably suspended in their materials and structures, while his novel Unit, narrated by an artificial being, is a sustained reflection on the layered codes that make fiction and language work. Musgrave has exhibited widely in venues that include Kunstverein Freiburg; Tate, London; CAPC musée d'art contemporain de Bordeaux; and the Contemporary Art Museum St. Louis. He will take part in the forthcoming show Space Force Construction, which places contemporary artists in dialogue with Constructivist works, at the V-A-C Foundation, Venice.

Alex Potts is Max Loehr Collegiate Professor at University of Michigan. His work on art and artistic theory covers a number of areas including sculptural aesthetics and the history of sculpture. In addition to the book The Sculptural Imagination: Figurative, Modernist, Minimalist (2000), his work on sculpture includes a co-edited anthology of texts on modern sculpture, The Modern Sculpture Reader (2007; reissued 2012), and articles on David Smith, Alberto Giacometti and other twentieth-century sculptors. Recent publications include the book Experiments in Modern Realism: World Making, Politics and the Everyday in Postwar European and American Art (2013).

Karin Ruggaber is an artist who makes sculpture as well as producing artist's books. Her work centres on ideas around figuration, ornamentation, aspects of touch and the relationship to architectural scale. Her books are material investigations of a sensory experience with architecture and public space. She is interested in the translation of pictorial principles into sculpture and in the ground as an arena for material thinking, composition and making. Her work has been exhibited at: PEER, London; Tate Britain; MUDAM, Luxembourg, Museo Marino Marini, Florence, Artists Space, New York; Nottingham Contemporary; Hayward Gallery, London. Ruggaber exhibited alongside Rene Daniels at Bloomberg SPACE in 2002.

Appendix 2

Playground

Playground*: polyurethane, polyethylene, polypropylene, epoxy, steel, exterior grade MDF, paint (4 x 2.5 x 2.2m)
Installation at the Royal Society of Sculptors, Old Brompton Road, London (11th February – 8th May 2018)
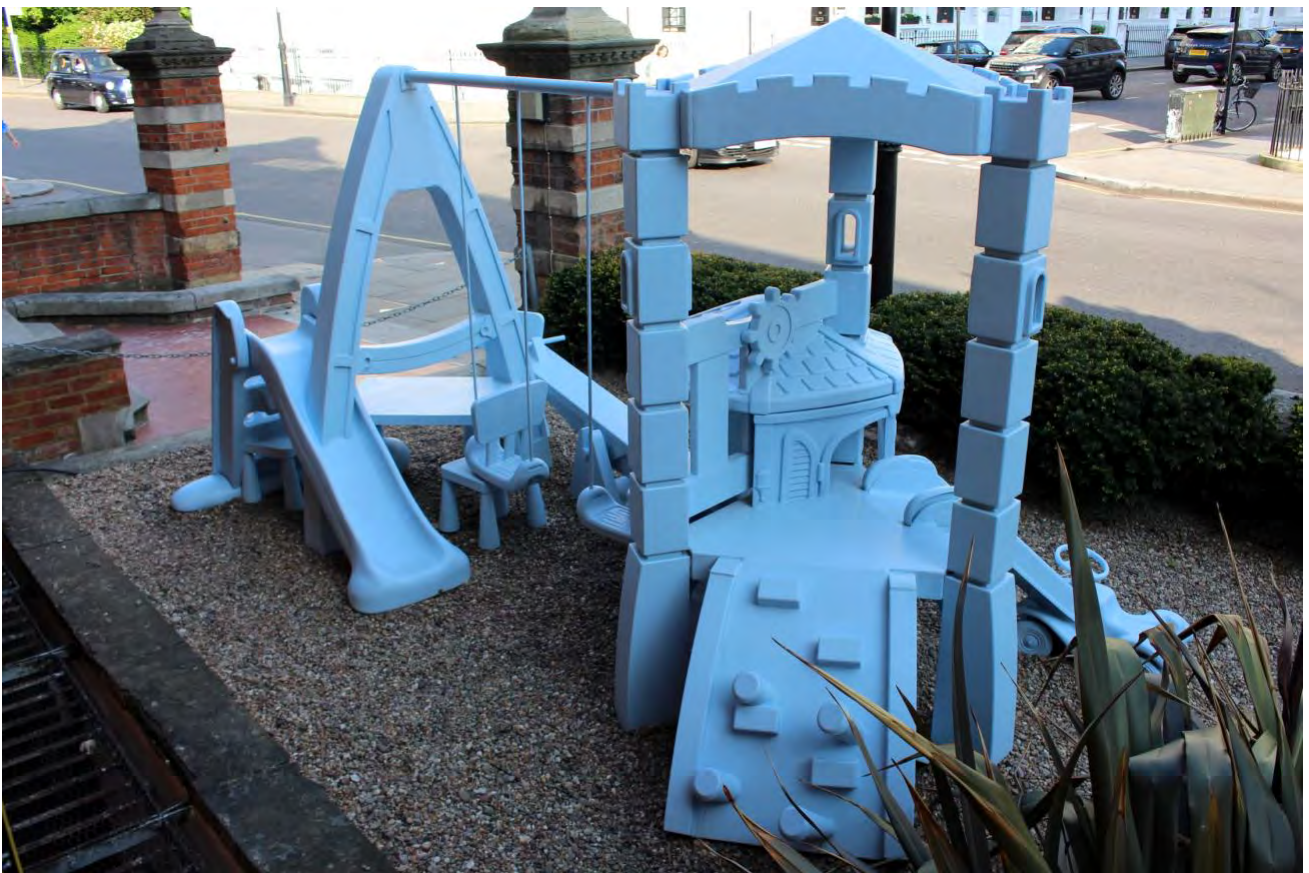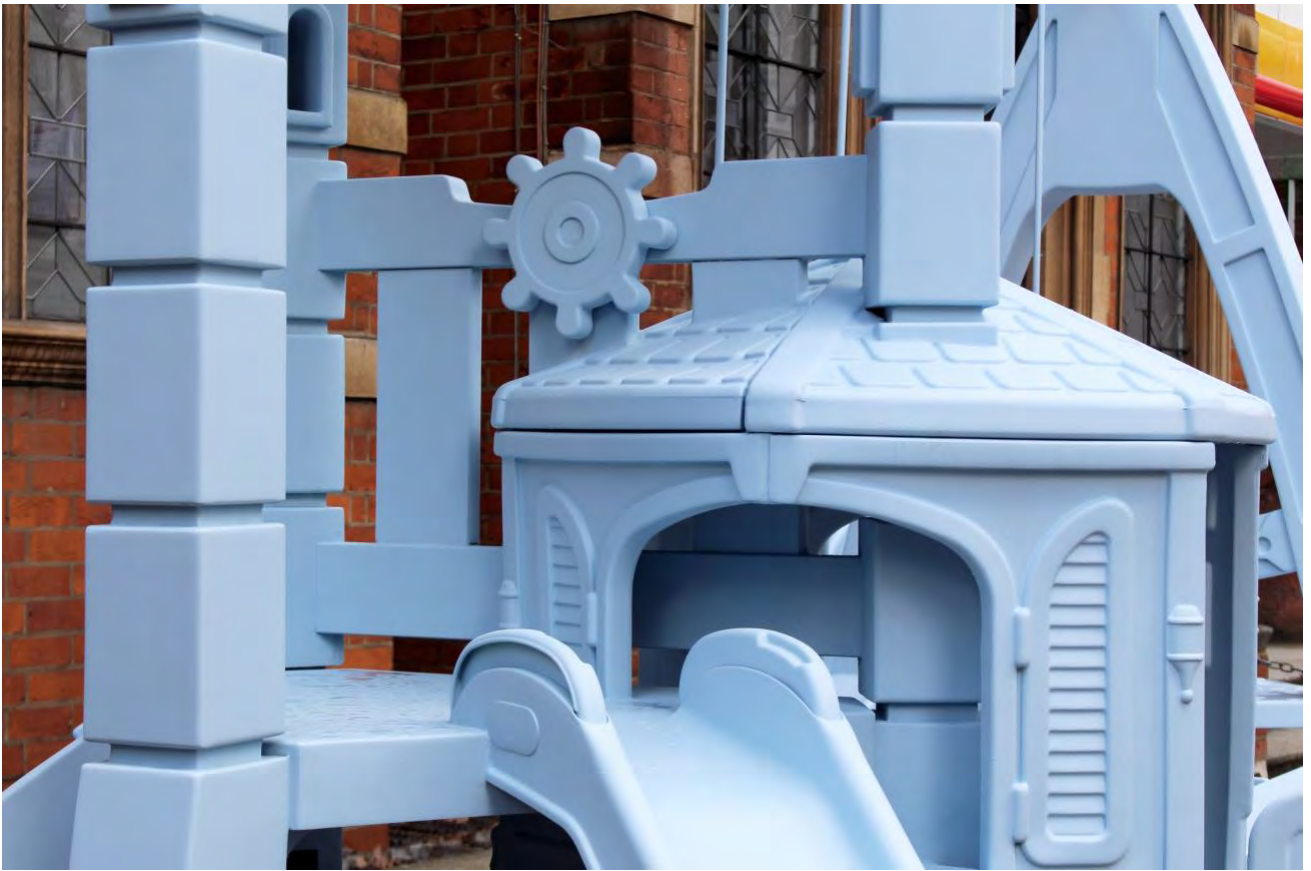
fig. 2.1 Plastic garden toys found in Galicia, Spain

fig. 2.2 Plastic garden toys found in Galicia, Spain
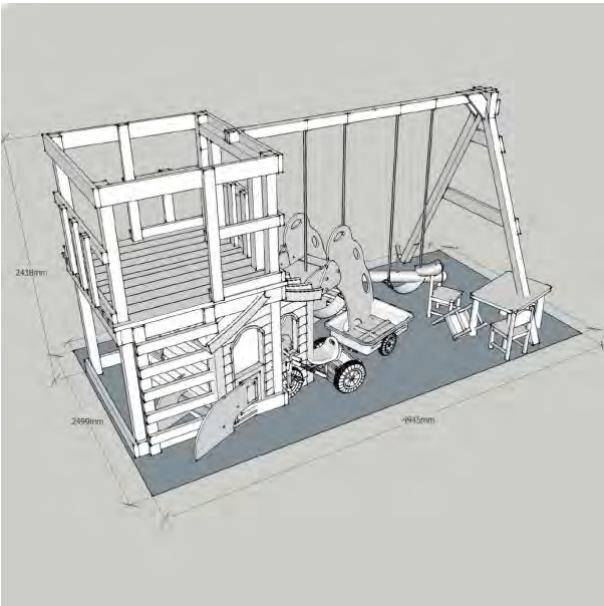
fig. 2.3 Improvised digital test using found 3D models

fig. 2.4 3D scanning slide ladder component at RCA
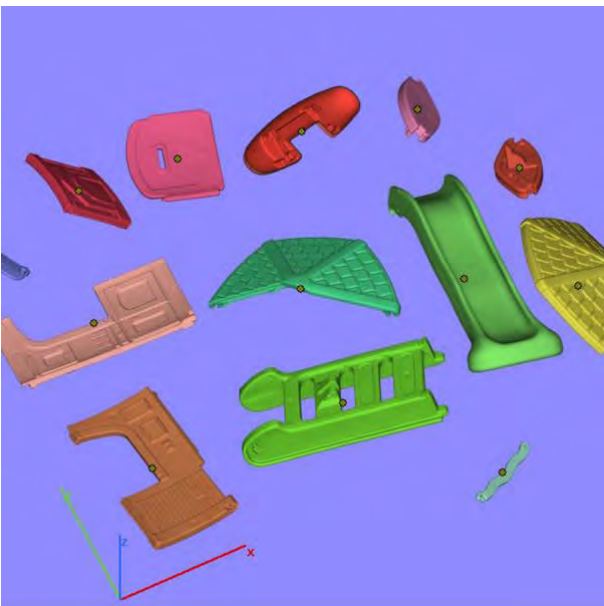
fig. 2.5 3D Scanned components in 'digital space'
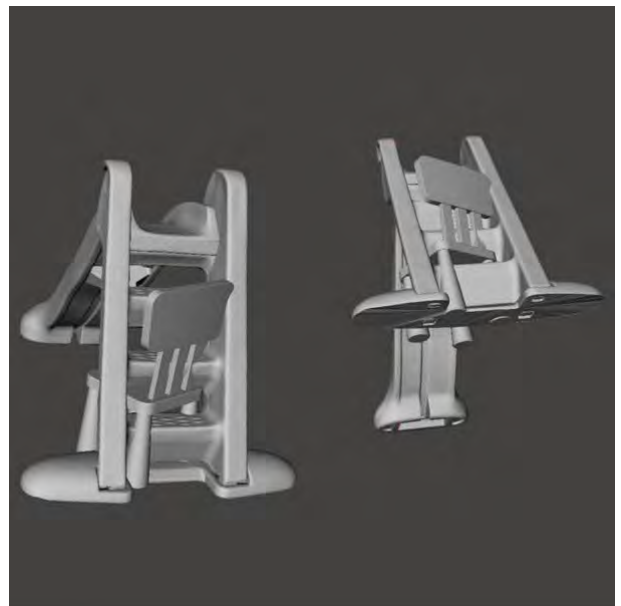
fig. 2.6 Chair and ladder 'compenetrating'
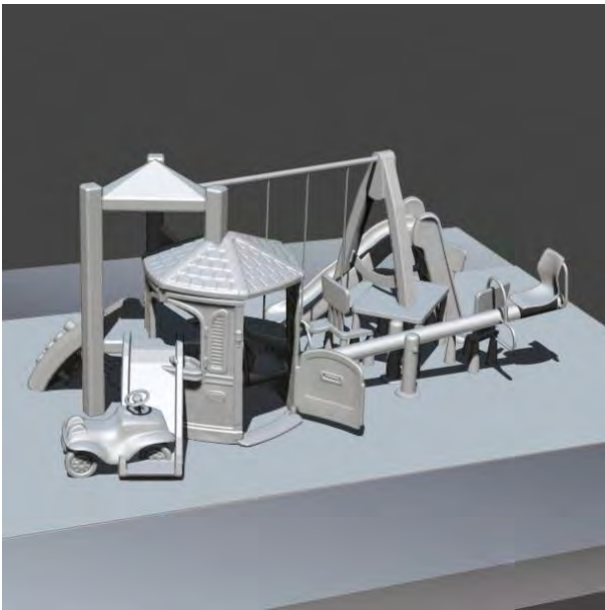
fig. 2.7 Digital model of proposed sculpture
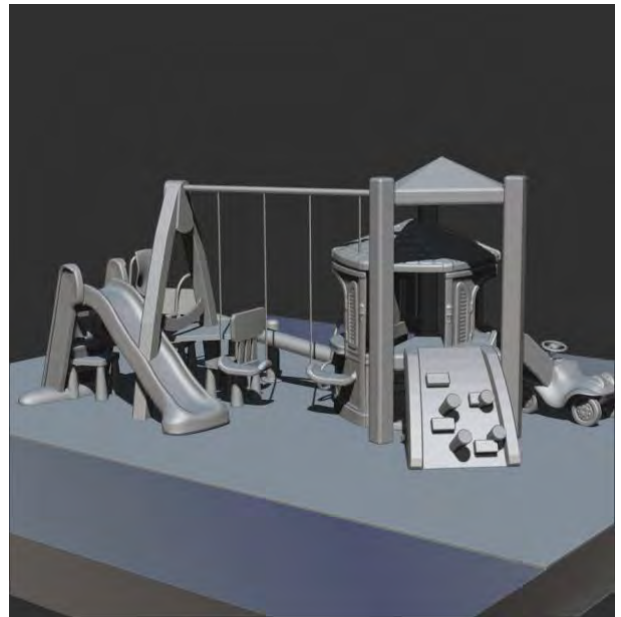
fig. 2.8 Digital model of proposed sculpture
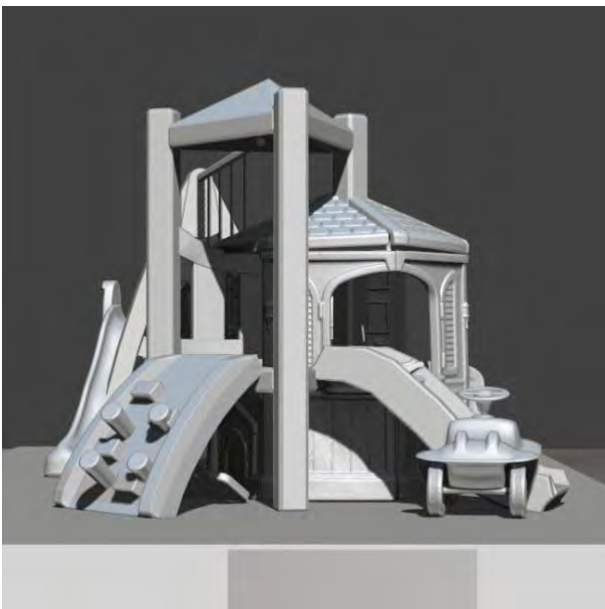
fig. 2.9 Digital model of proposed sculpture

fig. 2.10 Digital model of proposed sculpture

fig. 2.11 Digital model of proposed sculpture
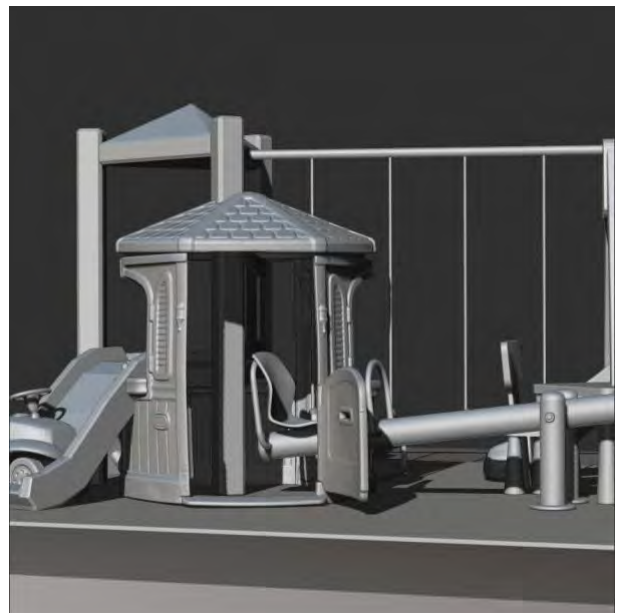
fig. 2.12

fig. 2.13 3D print of model in plaster

fig. 2.14 3D print of model in plaster (detail)

fig. 2.15 Digital rendering mock-up of proposal

fig. 2.16 Digital rendering mock-up of proposal

fig. 2.17 Checking relative scale using reference figure

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fig. 2.18 Corrected scale with new 'castle' and 'seesaw'

fig. 2.19 Experimenting with plastic 'compenetration'

fig. 2.20 Learning to plastic weld inter-fused joints

fig. 2.21 Polyurea coating prototypes

fig. 2.22 Polyurea coated prototype

fig. 2.23 Inter-fusing various found components

fig. 2.24 Fabricating seesaw from exterior grade MDF

fig. 2.25 Found plastic chair and MDF 'climbing wall'

fig. 2.26 Found plastic chair and MDF 'climbing wall'

fig. 2.27 Car meets slide

fig. 2.28 Chair meets steps

fig. 2.29 Embedding the MDF 'castle' armature

237

fig. 2.30 Embedding the MDF 'castle' armature
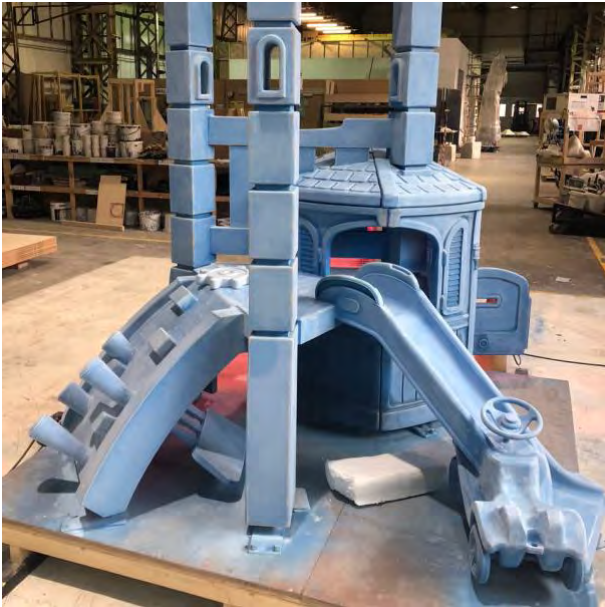
fig. 2.31 Working on the homogeneous surface finish

fig. 2.32 Another layer of filler-primer in the spray-booth

fig. 2.33 Installing on-site

fig. 2.34 Detail showing 'rope' through 'roof'

fig. 2.35 Enduring 'the beast from the east'

fig. 2.36 Enduring 'the beast from the east'

Appendix 3

Gate & Fragment

Gate*: MDF 115.5 x 8 x 234 cm

Fragment*:* Cast iron 41.5 x 4.8 x 25.4cm
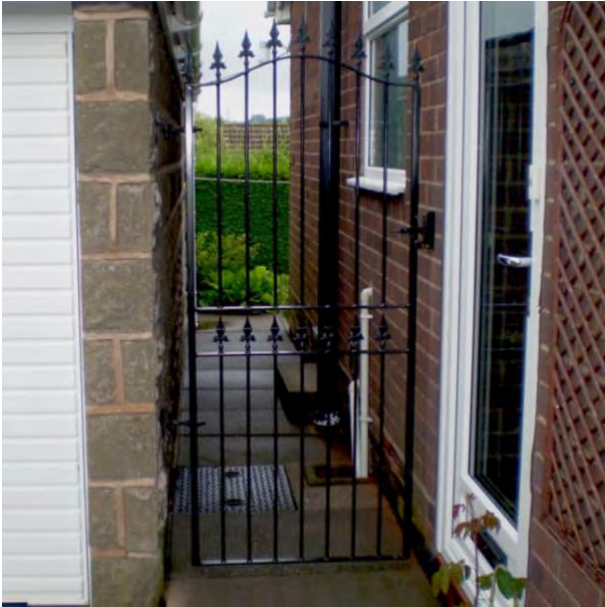
fig. 3.1 Researching suburban gates

fig. 3.2 Researching suburban gates
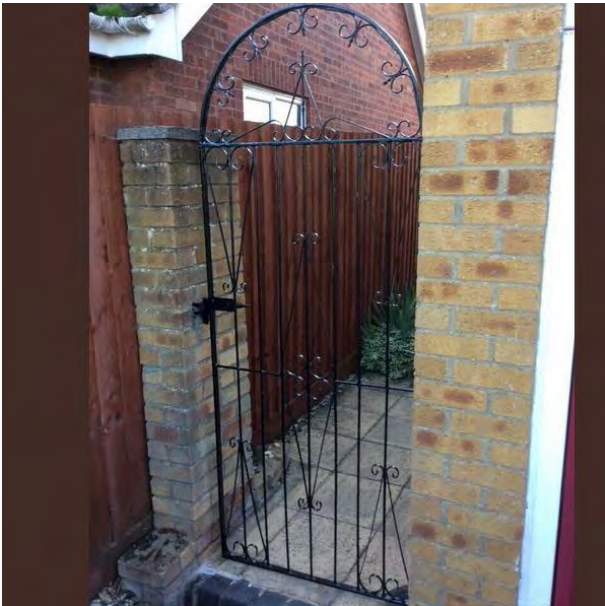
fig. 3.3 Researching suburban gates

fig. 3.4 Researching suburban gates

fig. 3.5 Researching suburban gates

fig. 3.6   Using a finger to gauge scale
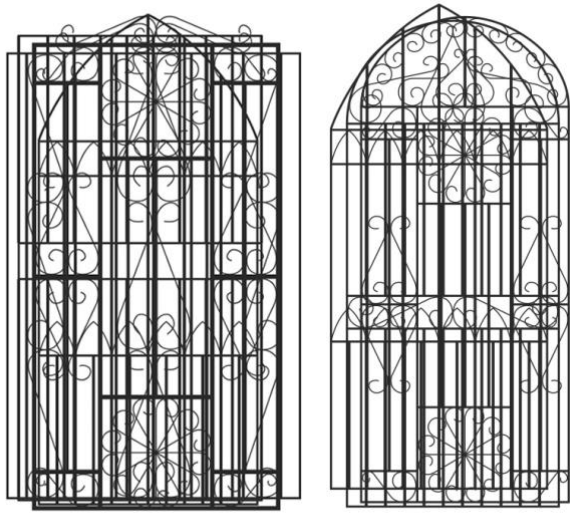
fig. 3.7 Gates studies
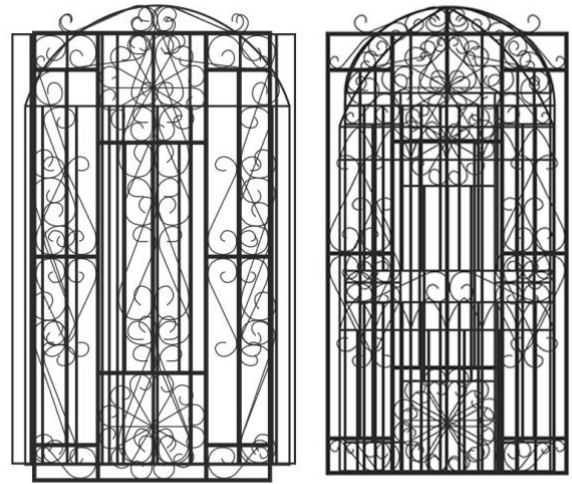
fig. 3.8 Gates studies
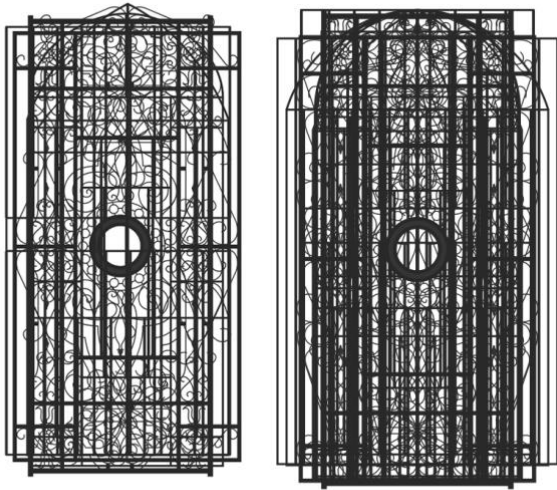
fig. 3.9 Gates studies

fig. 3.10 First laser cut and laminated MDF maquette

fig. 3.11 Three selected designs extruded
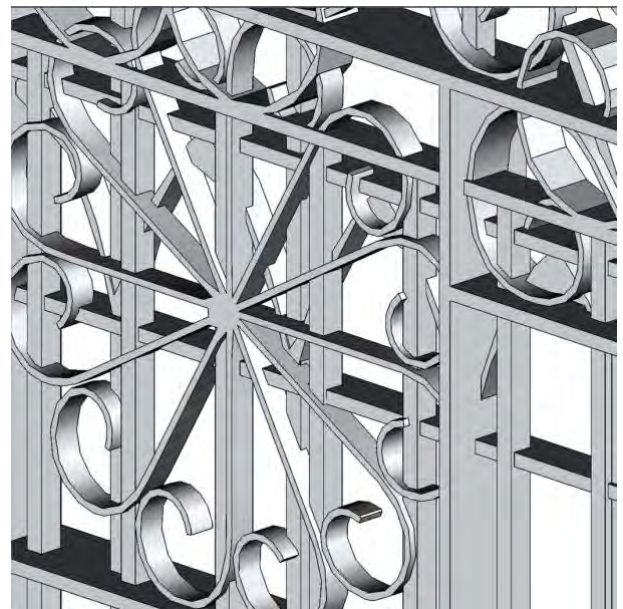
fig. 3.12 Exaggerating extrusion in Sketchup
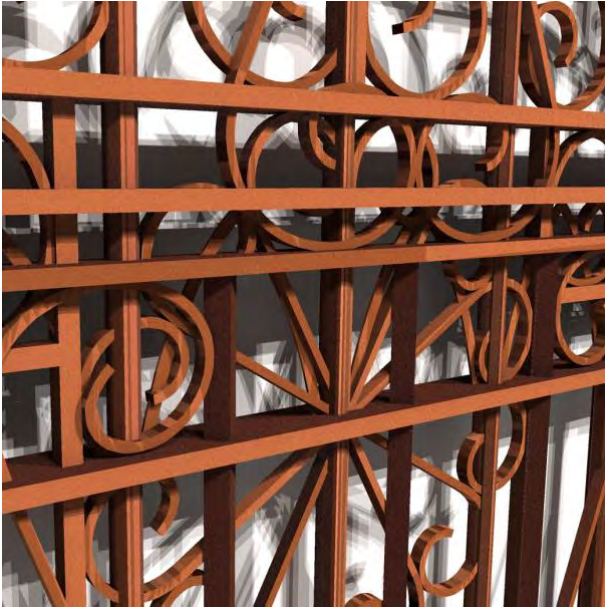
fig. 3.13 Digital rendering of provisional depths

fig. 3.14 Second laser cut and laminated MDF maquette
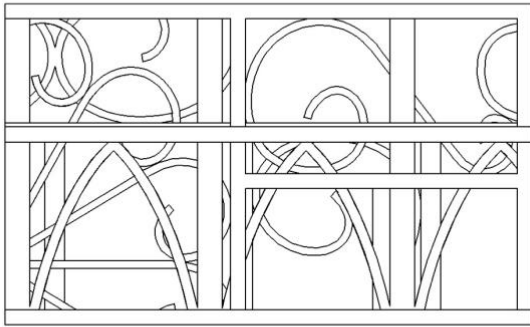
fig. 3.15 Vector drawing of selected segment
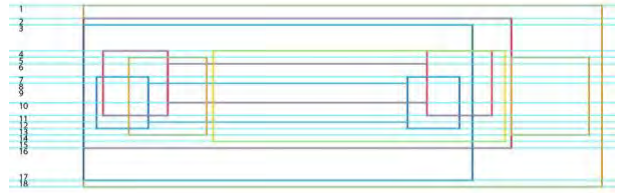
fig. 3.16 Drawing to establish depth relations

fig. 3.17 Using the bag-press to glue the layers

fig. 3.18 MDF pattern ready for filling and painting

248

fig. 3.19 Examining a wax pattern for distortion

fig. 3.20 Allowing the first iron cast to rust in the rain

fig. 3.21 First iron cast distorted by unstable wax
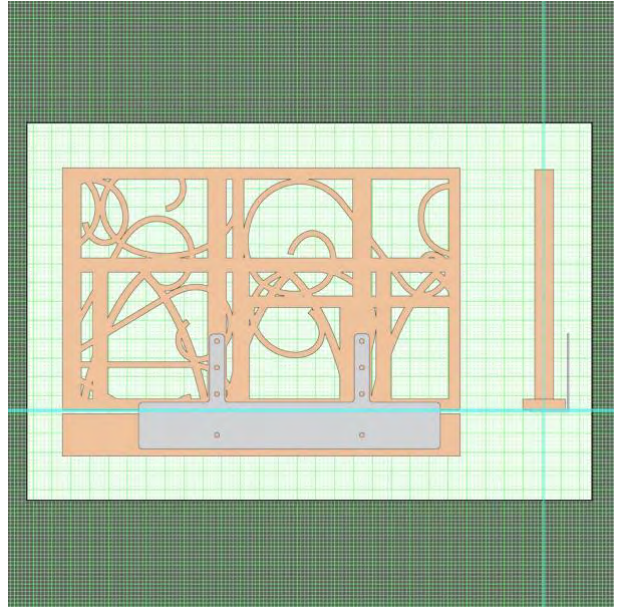
fig. 4.22 Designing a hidden wall mount

fig. 3.23 Digital rendering simulating wall mounting

fig. 3.24 Digital rendering simulating 'gate' mounting

fig. 3.25 Digitally comparing different arrangements
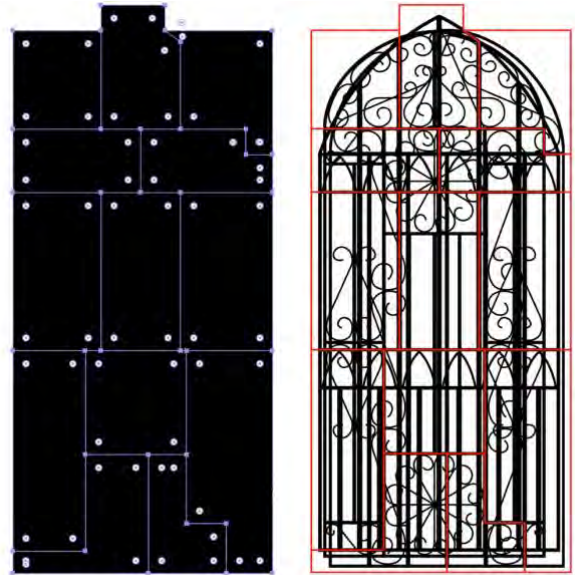
fig. 3.26 Dividing the object into 18 components
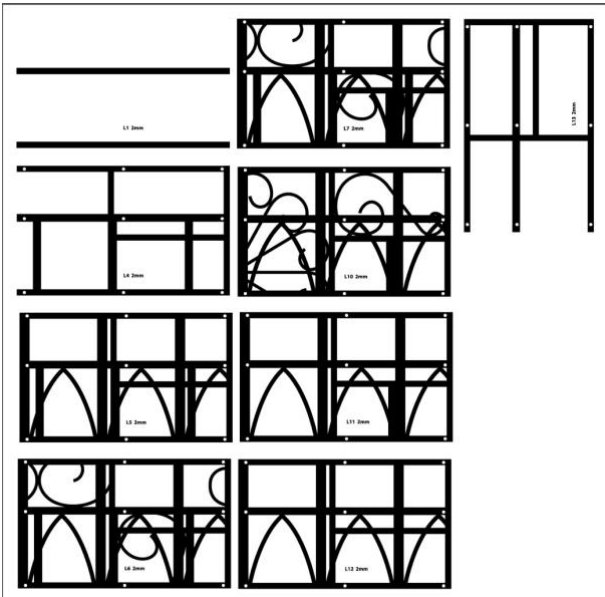
fig. 3.27 Sample cut-file showing individual layers
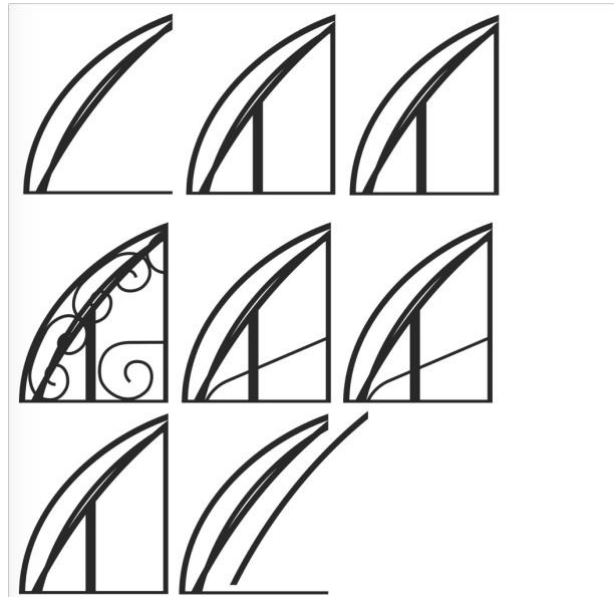
fig. 3.28 Sample cut-file showing individual layers
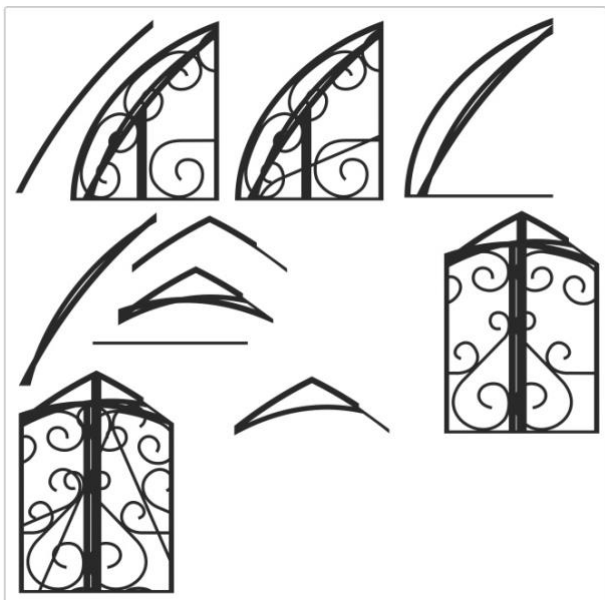
fig. 3.29 Sample cut-file showing individual layers

fig. 3.30 Clamping laminated sections

fig. 3.31 Clamping laminated sections
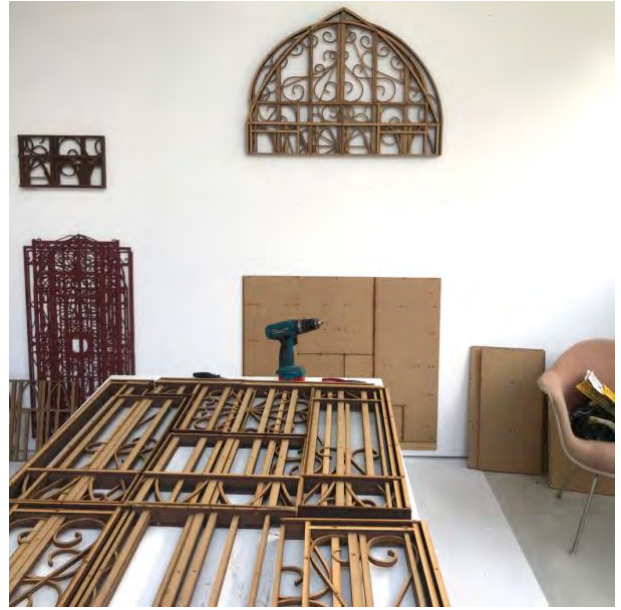
fig. 3.32 Constructing the laminated components
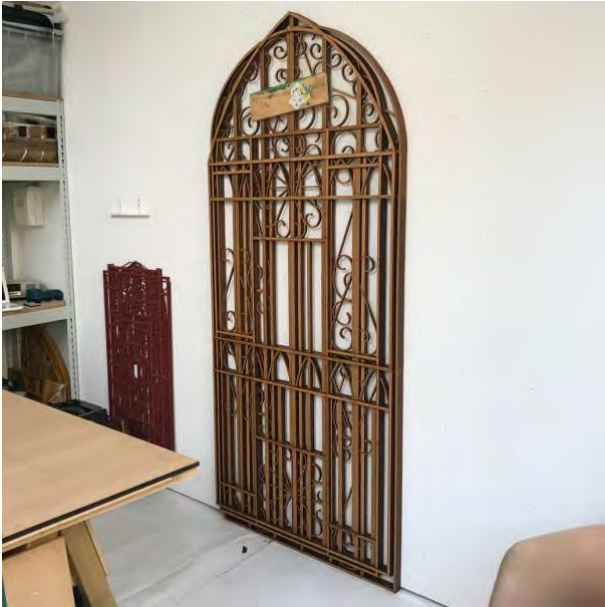
fig. 3.33 Studio installation without backboard

fig. 3.34 Studio installation testing backboard sizes
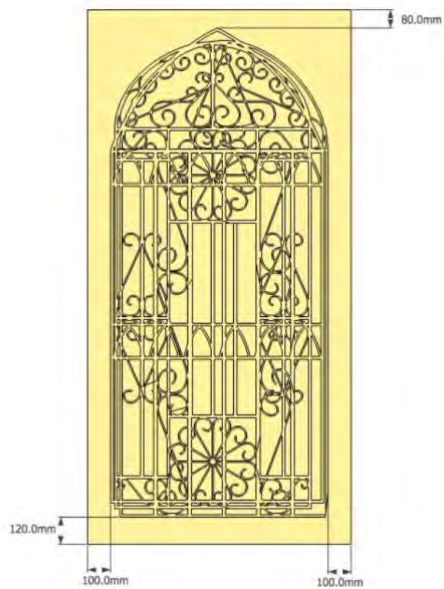
fig. 3.35 Designing the final backboard

fig. 3.36 Designing the backboard to fit a travel frame

Appendix 4

Tree

Tree: epoxy resin (43 x 48 x 50cm; table 38 x 38 x 34cm)

fig. 4.1 Original glass ornament

fig. 4.2 Rendering of 3D digital model

fig. 4.3 Doubled digital model (wide spacing)

fig. 4.4 Doubled digital model (closer spacing)
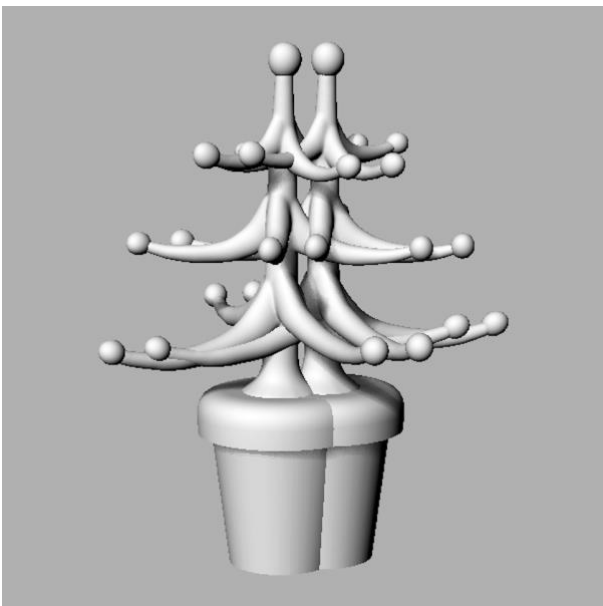
fig. 4.5 Digital model (final form)

fig. 4.6 8cm high 3D print (plaster)

fig. 4.7 18cm high 3D print (plaster)

fig. 4.8 80cm high Zund-cut foam maquette
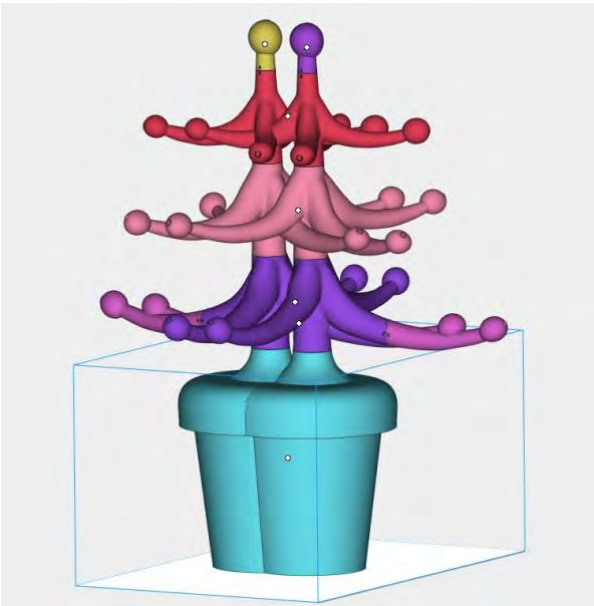
fig. 4.9 Scaled to 80cm with print envelope
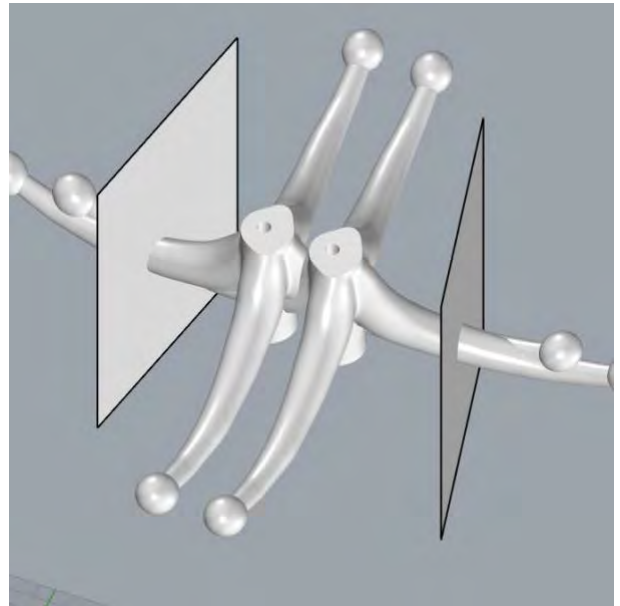
fig. 4.10 Slicing branches to fit print envelope
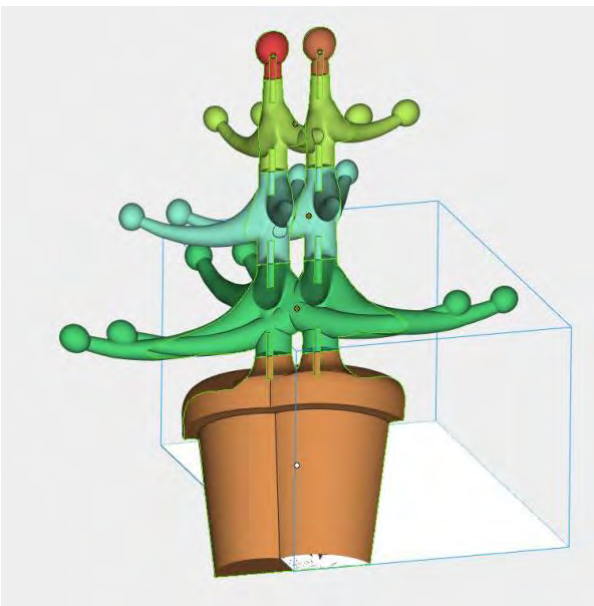
fig. 4.11 Cross-section with print envelope
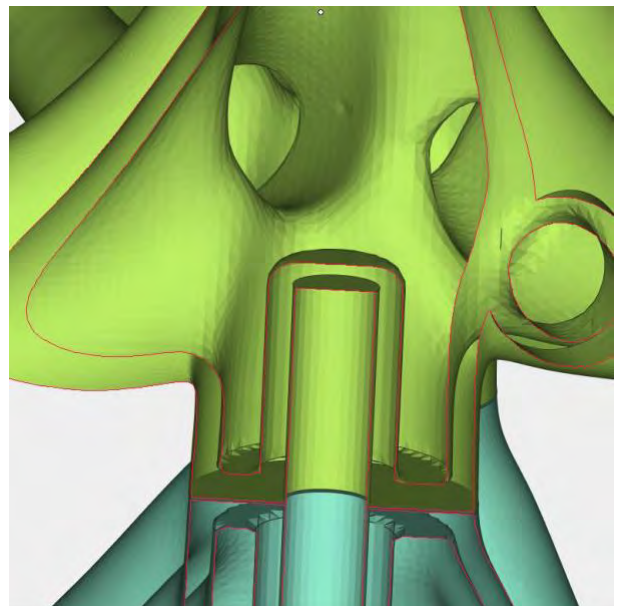
fig. 4.12 Cross-section detail of dowel socket

fig. 4.13 Digital rendering (top view)
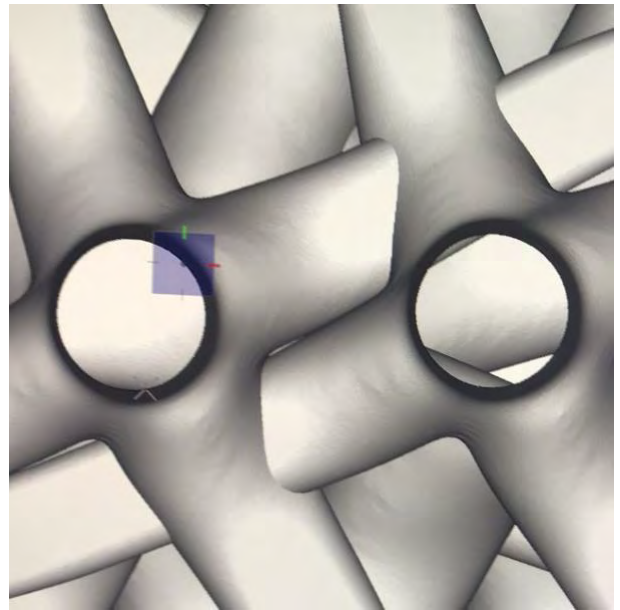
fig. 4.14 Hollowed compenetrating detail (top view)
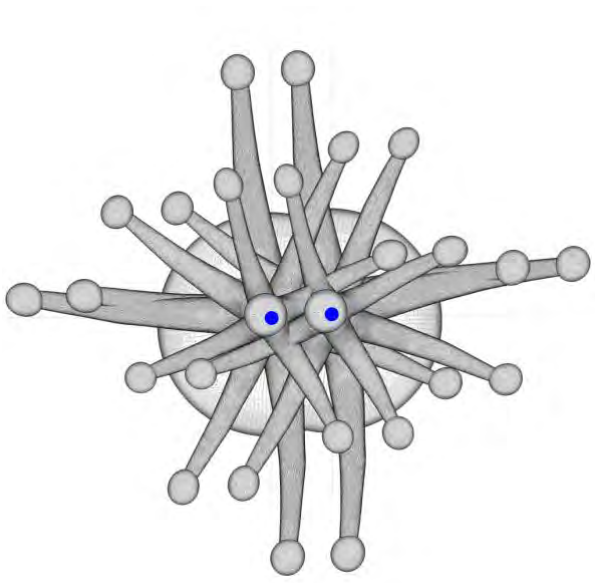
fig. 4.15 Wire mesh with dowel locations (top view)
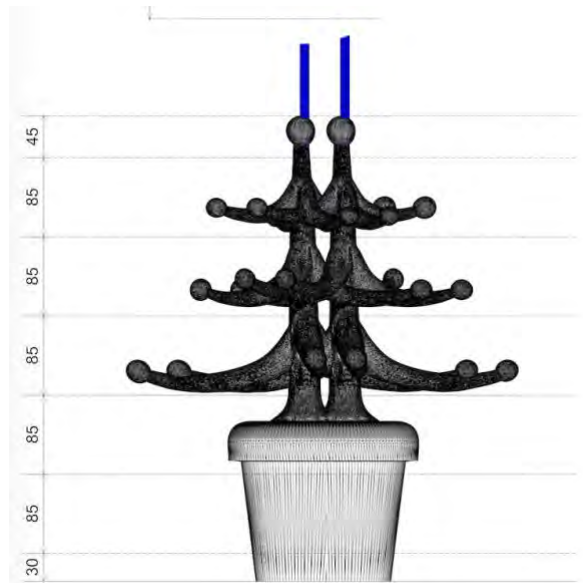
fig. 4.16 Divisions and dowel locations (side view)
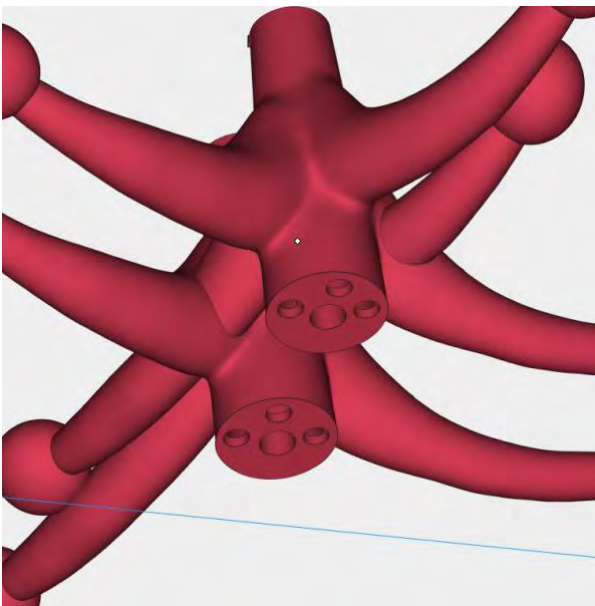
fig. 4.17 Dowel and registration sockets
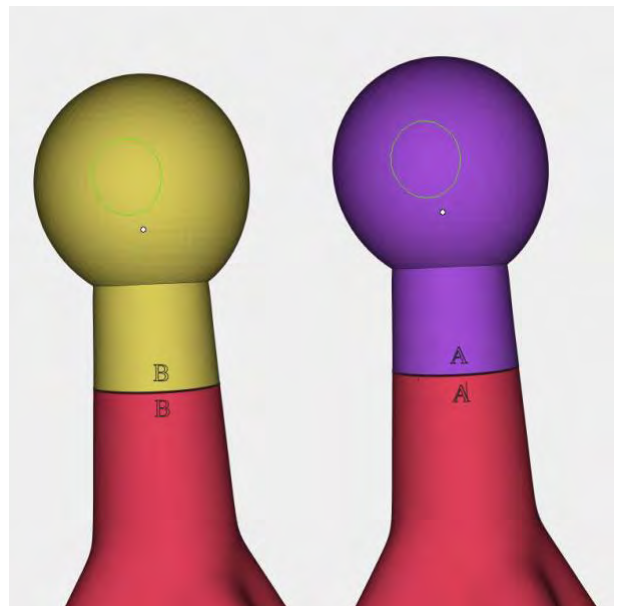
fig. 4.18 Labelling and registration marks

fig. 4.19 50cm hollow 3D print parts (dry assembly)

fig. 4.20 Hollow 3D prints with plaster reinforcement

fig. 4.21 Filling the hollow 3D print with plaster

fig. 4.22 Smoothing back the textured surface

fig. 4.23 Smoothing back the textured surface

fig. 4.24 Smoothed and assembled plaster model
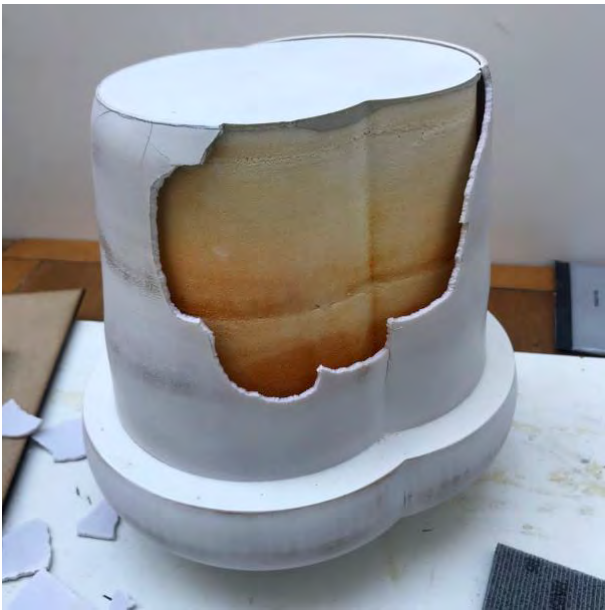
fig. 4.25 Finished surface separates from plaster core

fig. 4.26 Repaired and smoothed in 'spray booth'
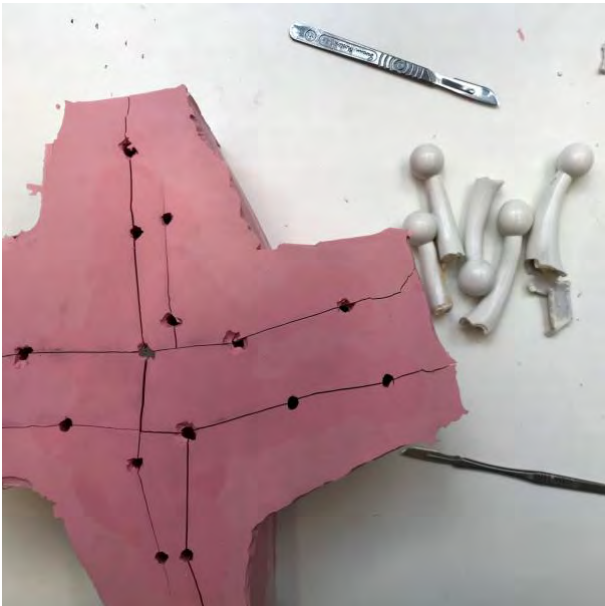
fig. 4.27 Removing plaster pattern from mould

fig. 4.28 Rubber mould ready for pouring.

fig. 4.29 Broken plaster pattern after de-moulding

fig. 4.30 Comparing resin finishes
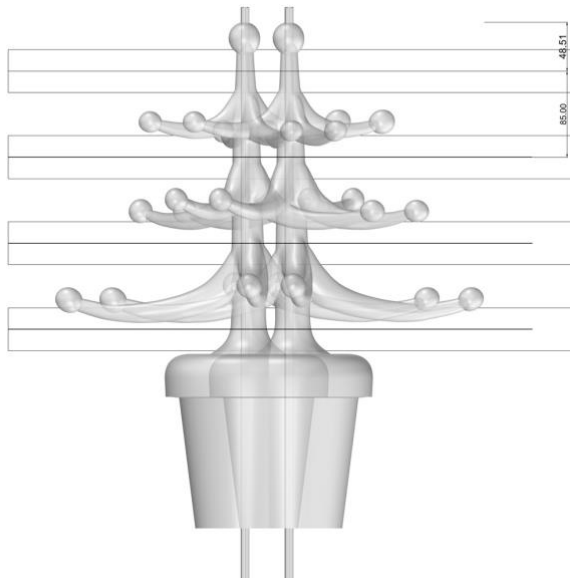
fig. 4.31 Calculating slice and dowel locations

fig. 4.32 First resin cast with dowelled joints

fig. 4.33 Gluing together the second resin cast
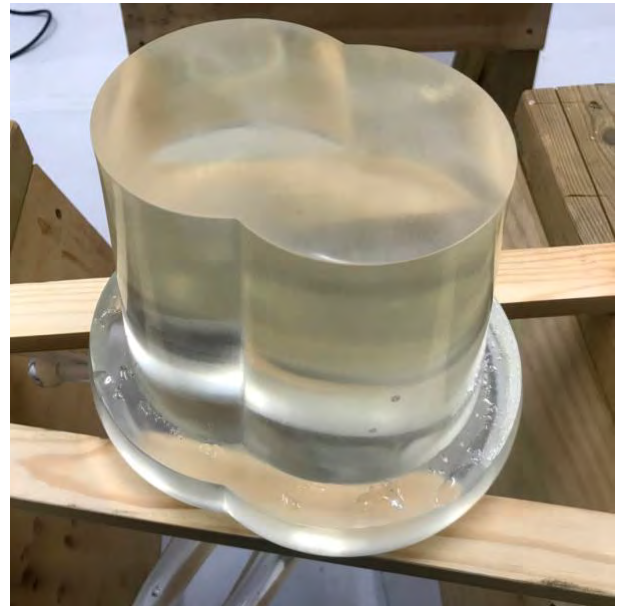
fig. 4.34 Filling and smoothing the underside

fig. 4.35 Transparent view of final digital model

fig. 4.36 Finishing complete second cast

Appendix 5

Coiled Pot

Coiled Pot: Cast aluminium 18 x 18 x 18cm (particle board 28 x 28 x 90cm)
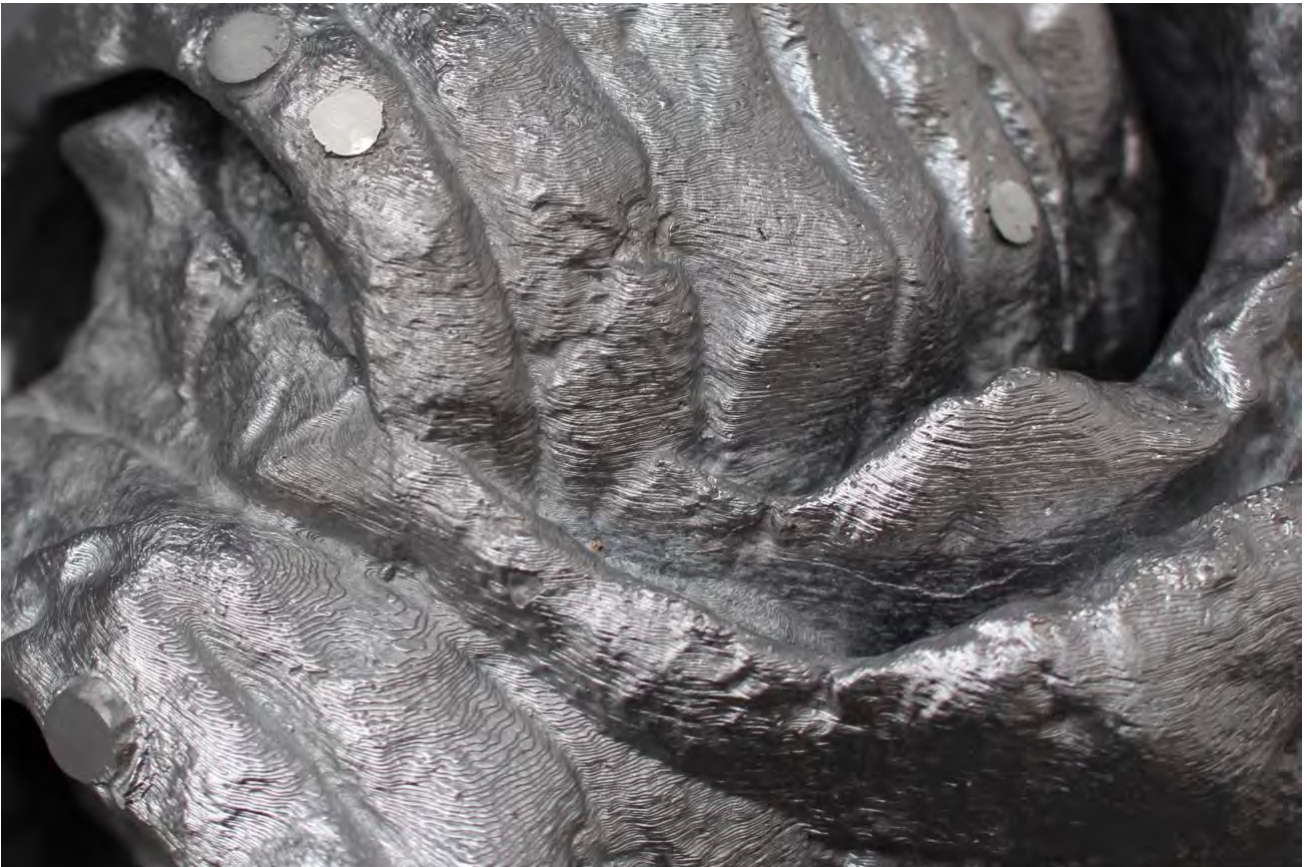
fig. 5.1 UCL Ethnography Collections catalogue

fig. 5.2 Coiled Pot "first stage"

fig. 5.3 Coiled Pot "second stage"

fig. 5.4 Coiled Pot "third stage"

fig. 5.5 Coiled Pot "fourth stage"

fig. 5.6   Selected artefact: Coiled Pot "first stage"

fig. 5.7 3D scanning at UCL Ethnography Collections

fig. 5.8 3D digital model of pot (wireframe)

fig. 5.9 Scale 1:1 3D print (PLA)

fig. 5.10 Scale 1:2 3D print (incomplete PLA/stone)
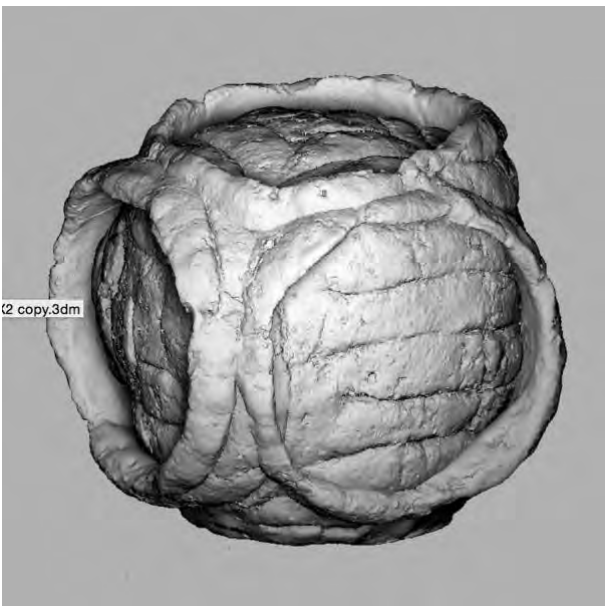
fig. 5.11 CAD manipulation test example

fig. 5.12 CAD manipulation test example

fig. 5.13 CAD manipulation test example

fig. 5.14 CAD manipulation test example

fig. 4.15 Selected CAD manipulation (lost)
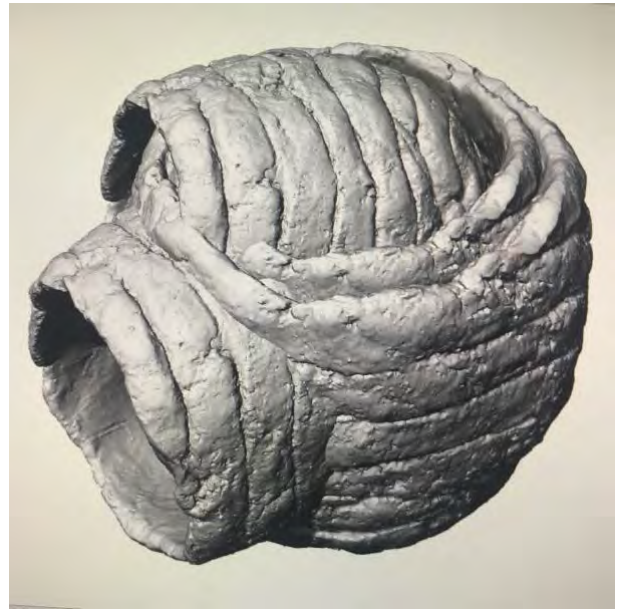
fig. 4.16 Reconstructed CAD manipulation
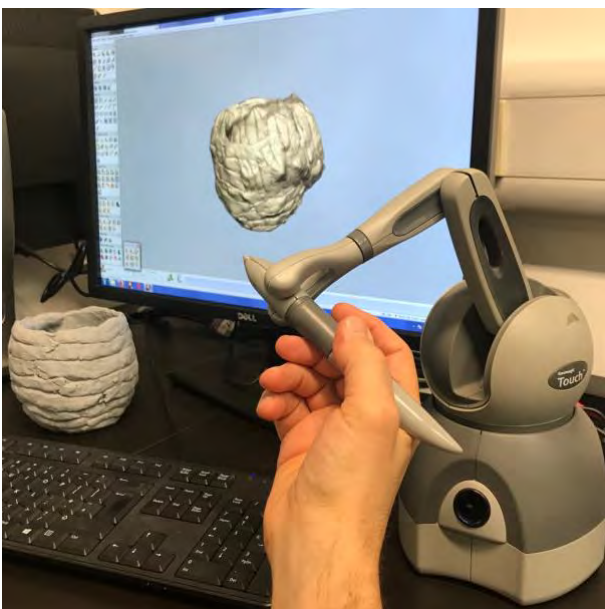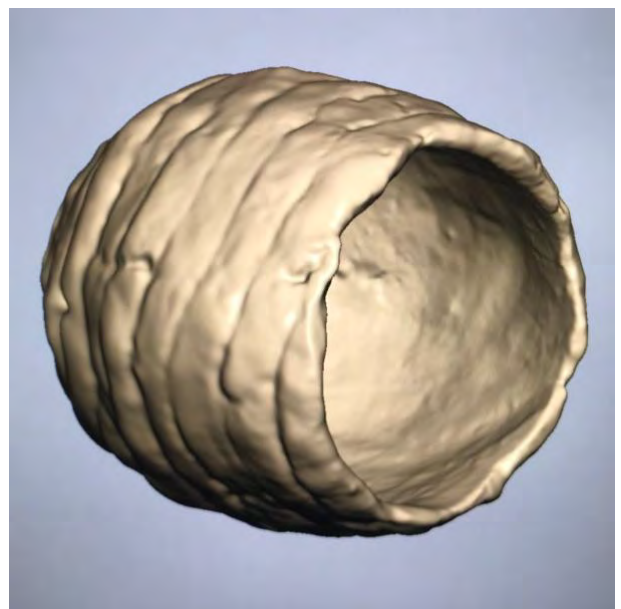

fig. 4.17 The 'haptic arm' at RCA Rapidform

fig. 4.18 Haptic smoothing tool effect

fig. 5.19 Haptic arm experiment example
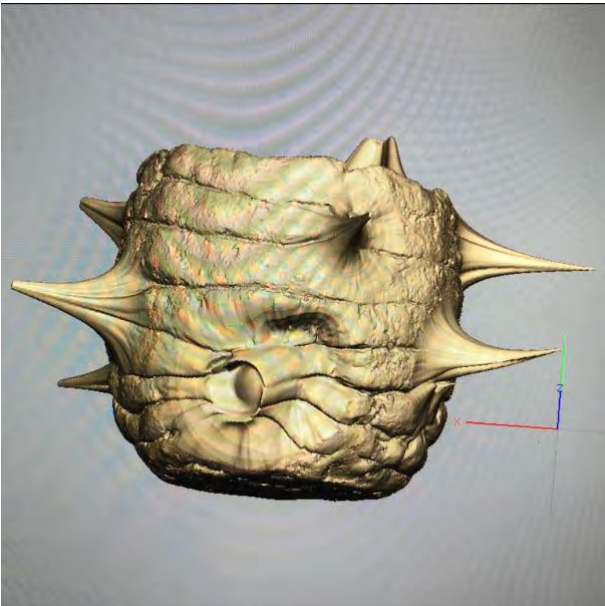

fig. 5.20 Haptic arm experiment example

fig. 5.21 Haptic arm experiment example
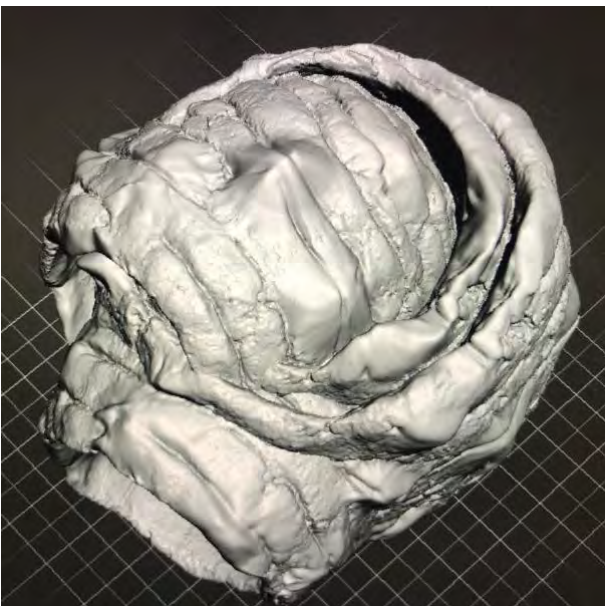

fig. 5.22 Haptic arm selected model view

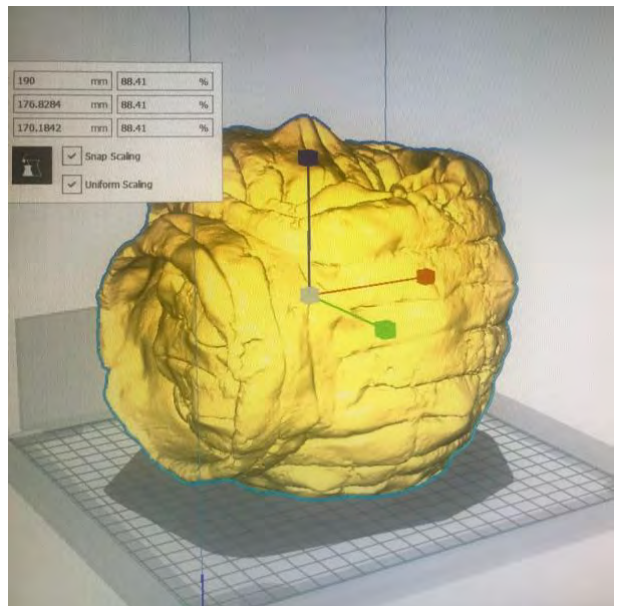fig. 5.23 Haptic arm selected model view

fig. 5.24 Sizing the model to fit material capacity

fig. 5.25 3D printing the final PLA pattern

fig. 5.26 Final PLA 3D print with undercut supports

fig. 4.27 Inserting the steel core pins

fig. 4.28 Placing runners & risers and filling cavities

fig. 4.29 Runners, risers and airs with base shell

fig. 4.30 Second layer of ludo with risers extended

fig. 4.31 Pouring the aluminium

fig. 4.32 Aluminium bubbling in the mould

fig. 4.33 Removing the ludo mould

fig. 4.34 Removing runners and risers

fig. 5.35 Aluminium cast with core pins still in place

fig. 5.36 Clean aluminium cast with core pins removed