Bits and Pieces
Crafting Design in a Post-digital Age

A thesis submitted in fulfilment of the requirements for the degree of Master of Architecture.

School of Architecture and Design
College of Design and Social Context
Rebecca Roke
B.Arch (Hons)
Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Signed .............................................................................................

Rebecca Roke

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IMAGES
Throughout the thesis, all images are provided courtesy of the designer mentioned in the associated caption. Other supplementary images have been drawn from the world wide web. I have made every effort to trace the original author but in most instances this has not been possible.
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A man who tells secrets or stories must think of who is hearing or reading, for a story has as many versions as it has readers. Everyone takes what he wants or can from it and thus changes it to his measure. Some pick out parts and reject the rest, some strain the story through their mesh of prejudice, some paint it with their own delight.

John Steinbeck – *The Winter of our Discontent*
INTRODUCTION
This thesis will examine how designs based on a conjunction between craft and digital techniques may offer new possibilities for an architect or designer in contemporary practice. How is it relevant that what initially are assumed to be two distinct approaches to designing and making can be introduced to each other and coalesce to form a constructive attitude of mutually borrowed design logic? The thesis champions the crafting of innovative design and the use of digitally derived procedures that allow for globally efficient dissemination and transformation. Such procedures have occupied the practice of architecture and design for some time, and we may describe this as occurring in the current sobriquet of a ‘post-digital age’. That is, we have become increasingly habituated to digital tools and procedures because they underpin much of the way in which we now design. Simultaneously, a ‘post-digital’ age suggests that we have ‘gone beyond’ the discrete binary constructions inherent in digital practice and should be able to extend to a more continuous, inclusive practice. At this point in time, this thesis examines how we can usefully speculate on the relationship between physical making and computer-based production in architecture and design.

Too often the stylistic overtures popularly attached to the ‘digital’ and ‘craft’ narrow our perception of what each term may encompass and how they are likely to manifest. Traditionally, digitally derived design practice is attributed the efficiency of a mathematically precise mode of operation – an oscillation between zeroes and ones that produces a universal logic of smoothly rendered forms. By contrast, ‘craft’ is often cast into the realm of amateurish making, complete with mistakes, dropped stitches, fingerprints or other traces of human fault that are understood as being charming in the context of handmade human endeavour yet fall short when measured against ‘serious’ artistic categories that include architecture, design and fine art. However, it is important to remember that a crafted object can also be considered to be something that reflects the mastery and skills held by its maker. We will return to these definitions more explicitly in the second chapter.

This thesis seeks to move beyond the commonly accepted and largely polarised positions of digital and craft. The structure of the thesis is as follows: First, the thesis offers clear and more dynamic definitions of the terms ‘craft’ and ‘digital’, seeking the ability for each to hold fast to the inherent merits of their particular logic while also finding productive opportunities to integrate with each other. Second, the thesis examines how production and tools can be conjoined in ‘digital craft’ to offer a useful direction for contemporary design practice. Selected case studies of work by contemporary architects and designers are drawn on to illustrate and observe the different relationships that the practitioners have discovered in their projects. All of the designers create work that conjoins the conception and manifestation of digital craft. The case studies vary in scale from fabric and furniture production, to large-scale installations with significant spatial effect, to complete architectural projects. The range is useful to discuss how the concept of digital craft in architecture and design can be seen in various scales and approaches. This reflects the numerous ways in which digitally created design is used to realise crafted results. It is mindful of the fact that architectural processes often follow technological innovations which are first practiced at more intimate scales, such as in industrial design. It will be useful to compare architectural practice with the idea of the more
intimately scaled relationship that craft has traditionally held. Finally, the thesis will speculate upon future developments for the conjunction of digital craft in architecture and design and will suggest that the layering of technologies and ways of making allow us to engage in a heterogenous design process. This diversity is to be championed in our contemporary ‘post-digital’ condition, a time that is often accused of promoting homogeneity and ‘flatness’ but that can also be read as a time that engages with what Pepperell and Punt call the “stable yet dynamic reality of the post-digital age.”

POST-DIGITAL MACHINES: BEYOND DIGITAL PRACTICE
In the field of architecture and design, the debate as to the value, moral worth and amount of control the designer should allow in his or her working relationship with the machine is historically well-documented. The utopian and often mechanically reliant visions that new technologies have provoked in these disciplines have frequently met with equally strong concerns by those who championed endeavours made by humans, with a particular emphasis on the human hand. Repeatedly, this tumult has stemmed from dissatisfaction or scepticism expressed by the doubtful party in the wisdom of relinquishing authorship and control to a feared machinic ‘maker’. Therefore, when considered from a broad perspective, the debate surrounding the use of digital tools and technologies can be understood as simply another manifestation of a discussion that normally accompanies evolving technological development.

For example, the legacy of digital origins can be traced to early inventions such as Joseph Marie Jacquard’s Loom of 1804, with its ability to literally make visible ‘zeroes and ones’ in cloth. This was one of the key discoveries that signalled a shift in thinking from what is epitomised as the industrial age, to what is variously described as the information, computer or post-industrial age or the ‘digital revolution’. Despite the overall continuity of technological development, the relatively swift uptake and revolutionary speed with which digital applications now operate, especially when compared with previous
‘revolutionary’ advances, such as industrialisation, has impacted significant changes in producing architecture and design. At this point in time most designers have access to the speed and efficiency of digitally wrought designs through softwares that have become industry standard. The majority of these, such as Rhinoceros, Microstation and CAD, are used to represent or render a design on-screen and produce working drawings from which a form is built. Other softwares such as computer-aided design/ manufacture (CADCAM), computer-assisted conception and fabrication (CFAO) or computer-aided three-dimensional interactive application (CATIA) are more usually used to drive machines that produce the form. The language of digital modelling and design are conceived to allow a smooth exchange between concept and object, although this does not always happen. The current digital design language is often based on parametric equations, whereby design models are built based on a set of mathematical relationships. Given the ubiquity of digital design methods it is judicious to ask: How does this efficacy impact on the craft of architecture?

POST-DIGITAL NOW?

Though initially it may seem logical to survey the meeting of craft and digital practice in a ‘digital’ world, Mark Burry, among others, currently posits the profession in a ‘post-digital’ milieu. The term ‘post-digital’ suggests that practice with digital tools and techniques is no longer novel: there are now established models of actualised architecture that were once merely digitally imagined. Foreign Office Architecture’s Yokohama International Port Terminal (2002) is a pioneering example of this, as is the work of Greg Lynn which, although largely unbuilt, pioneered the use of animation softwares such as Maya to produce ‘blobs’ [binary large objects] at varying scales. The material manifestation of work by Frank Gehry, for example the Bilbao Guggenheim (1997), has also become a highly publicised example of the fusion between digital design and fabrication techniques.

Employing the term ‘post-digital’ simultaneously implies that a critical assessment of the application of digital tools, which are now familiar and integral to most contemporary design practices, is due. It also suggests that boundaries between previously segregated disciplines can slip and cross known parameters. All of the digitally pioneering practitioners mentioned above call on rules, softwares and techniques that have been appropriated and co-opted from other disciplines to perform in the arena of architecture. Consequently, given our familiarity with the digital realm, we should now be better able to suppose how digital techniques may be reappropriated and respond to the physical manifestation of a design.

So far, there has not been a substantial treatise or discussion on how post-digital conditions may contribute to the development of architecture and design. However, in other fields, such as music, the idea of operating post-digitally has been raised. Architecture, design and music all require an analogue output to convey the creative work, but the built environment usually involves a more time-consuming mode of production that involves working with physical materials. Despite these differences we can find some interesting expressions of the potential of the post-digital in music that are equally helpful to consider in architecture. John Richards’s description of a post-digital age in electronic...
music is instructive. Richards writes:

What would seem more central to a post-digital aesthetic is the bastardisation of technology. This certainly goes beyond the digital … Bastardisation implies forcing a system in to [sic] a state in which it was never intended, or appropriating something for a use other than what it was initially designed for.

In this thesis, it is exactly the opportunistic use of software and code that is examined in the second chapter on Bricolage, through the useful trope of the techne trouve. The grafting and wilful re-application of found content, both physical and digital, is a common theme shared by the case studies throughout this thesis. The ability to act as a bricoleur – making do with found materials to produce diverse content – is an approach held by all the designers we will consider. The notion of heterogeny is also a key property of the post-digital realm. Robert Pepperell and Michael Punt remind us that the post-digital environment is, “Both changing and staying the same”. If we are to talk about the post-digital environment, that is, “Things that are both separate and integrated,” Pepperell and Punt suggest, “We need mental tools more subtle than exclusive, binary logic can supply … exposing the necessity for a new kind of diverse order.” For Pepperell and Punt, the advantage of a post-digital practice is that the unpredictability and ambiguity of human experience is seen to be valuable and that these valued properties require more flexible metaphors than binary opposites to accurately describe the resulting environment.

Many authors writing about the post-digital call on the pithy epigraph by Nicholas Negroponte, the Chairman Emeritus of Massachusetts Institute of Technology’s Media Lab. In 1998 Negroponte stated: “The digital revolution is over.” This has provoked thought as to what sort of age we now occupy. Several years after Negroponte’s proclamation, in an essay in the Computer Music Journal, Kim Cascone suggested that the failure of digital technology provides a foothold to produce more interesting work. He believes that the unveiled illusion of technology’s apparent control has provoked the realisation that digital tools are, “only as perfect, precise, and efficient as the humans who build them.” He elaborates, “Today’s digital technology enables artists to explore new territories for content by capturing and examining the area beyond the boundary of ‘normal’ functions and uses of software.” Here, we can recall the earlier observation of the inevitability of ‘glitches’ in digital architectural systems that are supposedly integrated seamlessly. We will pursue the possibility and limitations of these glitches further in the case studies included in chapters two, three and four.

SIMILARITY AND DIFFERENCE

Though diversity, irregularity and heterogenous overlap are here seen as positive aspects of post-digital practice, there are also indisputable differences between physically and digitally crafted processes. One property that I will expand on is that unlike bits, atoms are finite; they cannot be infinitely reworked. As Malcolm McCullough has observed, bits – or the accretion of small units of data underpinning digital practice – may be reversed, multiplied or rearranged without any enduring affect. By contrast, at some point a physical material will irrevocably reach breaking point and this physical mortality reminds us to
consider themes of aura and reproducibility of the artefact. As such we are confronted with a situation observed by Walter Benjamin with the advent of photography: How does one determine a balance between the Taylorist efficiencies of mass production that digital procedures excel at and the idea of uniqueness, or covetable one-off products? Benjamin's argument surrounding aura is more habituated to the consideration of haptic or tangible products, however, the debate has extended to work produced by and comprised of digital bits. In fine art practice, for example, the increasing popularity of digital media such as video work sits alongside the current decline of more traditional art forms, such as painting or sculpture.

Another significant distinction between physical and digital craftsmanship that exists in various disciplines, including fine art, is the different sense of time taken to perform each endeavour. The ‘craftsman’ working in a physical realm conjures imagery of a person painstakingly honing a specific technique by which they may wrest objects or spaces, such as an artefact or building, into physical form over time. This type of craft – a very traditional and well-documented sort – relies on skill and experience to judge how to treat a material for aesthetic and physical completeness. Many prototypes may be tested, especially for a new technique or material, before the final piece is executed. Arguably, a digital craftsman is equally highly skilled, but unlike work created by a carpenter for example, the material on which the digital master works rarely records the multiple keystrokes and mousing used to instruct the machine. At the end of this type of crafting, after numerous iterations of a procedure there is usually a smoothly rendered object ‘floating’ on a computer screen. The object is lauded for its suave regularity of surface and its ability to approximate three-dimensional perfection. While time consuming, the honing through practice that this digital method requires is much less well understood or seemingly measurable than that which we can see taking shape physically.

By observing some of the particular characteristics that digital design allows, especially the sense of multiple re-creation that the rearranging of bits affords, which is independent of a more traditional physical sensibility, it appears that the possibilities invited by digital design also implicate a Janus-headed potential. One face beams at us and offers great, untethered opportunity – a chance with which grand design adventures can be explored in a limitless manner through equally limitless design proposals. Coupled with a *laissez-faire* license for any designer with access to and knowledge of new technological tools for design – independent of traditional production hierarchies – this is an appealing, if utopian proposition for design freedom. The other face presents a greedily gleaming attitude that praises new efficiencies and embraces a capitalist logic. It grasps at the increasingly swift and standardised production that the first exploratory stance seeks to loosen away from. Primarily, this face is most interested in how the properties of speed can best dovetail with production efficiency for maximum financial gain. Despite the contrasting appeal that can be seen in each approach, both attitudes seem to engage in what the Professor of Architecture and Media Arts and Sciences at MIT, Bill Mitchell, has described as “the new land beyond the horizon”. This place of limitless possibility, “beckons the colonists, cowboys, con artists, and would-be conquerors of the twenty-first century. And there are those who would be King.”
WHAT IS CRAFT AND DIGITAL?

To strike useful ground between the slippery territory of Kings and crafts, it is beneficial to explain the terms ‘digital’ and ‘craft’ precisely. Ancient descriptions of each term are illuminating for the suggested overlap in previous centuries where both terms shared a relationship to the hand or fingers. However, this general description is less helpful in concretising an approach for contemporary designers and architects. Current discourse assists in marking out the shifting emphasis of this terrain.

DIGITAL

Considered in the adjectival sense, ‘digital’ pertains to the use of a digit or digits, which loosely gestures to its applied used in computing as a series of discrete elements that constitute data that is then operated upon. The term ‘digital’ is most useful when considered as a collocation. For example, ‘digital’ has become a short-hand description for digital forms, digital techniques and digital technologies. These collocations are popularly used to indicate how computer-driven softwares produce forms, techniques and technologies. The digital is usually silent with regard to how a digital tool is used by or in a computer. This strongly contrasts with the use of ‘craft’, which intimately evokes a sense of human mastery. The fact that ‘digital’ on its own is a collection of zeroes and ones reinforces the need to use it in collocation in order to connect it with other methods, objects or processes that make it manifest in an analogue output.

Brian Massumi expounds this idea well in his essay “On the Superiority of the Analog”. He describes that while the inactuality of the digital is a potent site for possibility, it is only when translated or connected to the actuality of the analogue that its potential can be realised. Massumi’s analogy of this in word processing is a useful example:

All of the possible combinations of letters are enveloped in the zeroes and ones of ASCII code. You could say that entire language systems are numerically enveloped in it. But what is processed inside the computer is code, not words. The words appear on screen, in being read. Reading is the qualitative transformation of alphabetical figures into figures of speech and thought. This is an analog process. Outside its appearance, the digital is electronic nothingness, pure systemic possibility. Its appearance from electronic limbo is one with its analog transformation.

DIGITAL ARCHITECTURE

I will expand on some of the current and specific operations and obsessions of digitally derived design in the following chapter, Digital Craft, but a brief synopsis of key digital practitioners in architecture and design here help to contextualise central attitudes to this term as it is found in these disciplines. Greg Lynn, Foreign Office Architects and the current fascination with what is known as ‘emergence’ constitute significant parts of nascent digital architectural history.

Greg Lynn’s ‘blobs’ of the 1990s were perhaps the most widely publicised examples in architecture of early non-standard digital designs. Lynn’s application of animation softwares, such as Maya, to experiment with three-
dimensional forms forged a new set of tools to represent and design work with. The forms he produced with these methods have a distinctly biological appearance. Lynn continues to champion this shift from rectilinear absolutes to amorphous shapes that result from a dynamic process recently commenting, “Thanks to computers [architecture] can be more complex, constantly mutating to take account of multiple environmental factors in the same way as a ship’s sail responds to the wind. Architects should stop thinking about boxes, loosen up and start thinking in terms of more flexible forms like blobs.” While Lynn is deeply interested in how calculus-based forms (that the computer excels at making) can offer flexible results, conversely, many architects following Lynn’s direction have been very much focused on qualities of representation as distinct from possible action available when using blob design strategies.

Post-Lynn, the Yokohama International Port Terminal of 2002 by Foreign Office Architects (FOA) was an equally important precedent for actualising software-based design/production process. FOA, led by Alejandro Zaera Polo and Farshid Moussavi, explains its work as a process of phylogenesis. In other words, it is charting a genealogy or line of descent of a living organism. FOA uses this evolution and taxonomy to systematically describe its work. Zaera Polo and Moussavi state in their recent monograph *Phylogenesis: FOA’s Ark*: “Our practice may be seen as a phylogenetic process in which seeds proliferate in time across different environments.” Both in description and in practice there is a sense that FOA is organically growing form with softwares, rather than ‘designing’ it in a traditional sense.

What began as an experimental field of architecture is now a design preoccupation commonly known as emergent practice or emergence. Practitioners such as NOX, Reiser+Umemoto and Ocean North, as well as specific post-graduate architecture programmes, such as the Design Research Laboratory (DRL) at the Architectural Association (AA), London, champion the ‘newness’ and ‘unique series’ available through emergent techniques. The AA’s Emergence and Design Group describe emergence as:

> Both an explanation of how natural systems have evolved and maintained themselves, and a set of models and processes for the creation of artificial systems that are designed to produce forms and complex behaviour, and perhaps even real intelligence.

The “highly distributed design networks and tools” that are found in much emergent work rely on collaborative, often self-organised and mobile networks of designers to produce form from quantitative data. Nevertheless, in contravention to much blob digital work, emergent work tends to emphasise process often to the exclusion of critiquing the emergent form.

CRAFT

Clarified by the attitudes to digital design we have discussed, we can see that the term ‘digital’ expresses a relationship to and a variety of means by which computerised processes may take effect. However, even in collocation it does not usually explain in what manner the tool is used. By contrast, the etymology of ‘craft’ points to a meaning with explicit reference to human use and intimates controlled work that is brought to bear through the logic and handiwork of a
craftsperson. By suggestion, to know a craft, the maker or craftsperson learns to predict how the material they are working with will react and is therefore able to wield this understanding of craftsmanship increasingly accurately to produce a well-controlled result. That is, to craft is to have a thorough familiarity with a process and the ability to act judiciously with materials as a consequence.

The idea of craft in this thesis is of particular interest in regard to architecture and design because it retains a close relationship to the material world of objects with functional and mythological value. Traditional crafted objects such as vessels, crowns or chairs are articles that often issue an explicit use value as well as carrying layers of embellishment particular to the material and skills of the maker. Architecture and design carry a similarly implicit relationship in their physical manifestation – how deep a stair tread reaches, the cold, bitter smell of a steel handle or the hardness and shape of a utensil in our mouth – all are integral though often unconscious influences on how we gauge and perceive objects or architectural spaces. While almost invisible and difficult to quantify, such design decisions colour our perception of places and objects. How these apprehensions are attended to depends very much on the consideration given to them by the designer. Arguably all hinge about a question of how the space or object is made – or crafted.

To suggest that all production should be hand-produced or hark to a mythologically loaded past is at best naïve. Rather, I suggest that in contemporary architecture and design we should consider the conjunction of digital methods with an attitude of a craftsmanship – efficient yet thoughtful choices about how things are created and from what materials.

THEORISING DIGITAL CRAFT
Several theorists touch on the relationship of ‘digital craft’ which has simultaneously become more problematic and more compelling as the reliance
on computerised means for design and production has become accepted – implicit, even – in the contemporary practice of a design studio. Malcolm McCullough is a key theorist in the field. His book *Abstracting Craft: the Practiced Digital Hand* locates the difficult relationship that occurs where the terms craft and digital coincide. Insightfully, when asking ‘What is Craft?’ he looks to a change in the linguistic application of craft for answers:

> The usual meaning [of craft] opposes high-technology processes in which the hand plays a diminished role. Thus the proposal of craft in the electronic medium is something of a paradox. But can we, here in the computer age, with fully optimistic and benevolent intent, suggest that the word needs a more inclusive definition?
>
> The work has resurfaced in popular usage – but as a *verb* … As a verb, ‘to craft’ seemingly means to participate skilfully in some small-scale process. This implies several things. First, it affirms that the results of involved work still surpass the results of detached work. To craft is to care. Second, it suggests that partnerships with technology are better than autonomous technology … Third, to craft implies working at a personal scale – acting locally in reaction to anonymous, globalized, industrial production – hence its appeal in describing phenomena such as microbreweries. Finally, the usage of ‘craft’ as a verb evades the persistent stigma that has attached itself to the noun. 28

McCullough’s views support my readings from the field of crafted design and the digital, a consensus that largely continues to hold craft in a traditional noun-based sense and thus discourages the shared threshold between attentively crafted design and that which is produced by digital *ergo* ‘contemporary’ means. 29 In writings where craft is presented as a noun, the general tendency is to enfold it with the romantic, the nostalgic – a term I will address shortly – and eulogise the human enterprise of its production, rather than to critically assess how the term may be of relevance in the contemporary practice of design.

Another key practitioner and theorist who has examined the relationship between digital and physical design processes is Mark Burry, the consultant design architect for Antoni Gaudi’s Sagrada Familia Church in Barcelona. Burry has a particular insight into how parametric modelling techniques, which are available through digitally derived softwares such as CATIA and CADCAM, may be shared with craftsmanship. His pioneering use of digital tools to reveal Gaudi’s intended rational architectural design facilitates the production of models and drawings to physically translate and test the analogue trails left by Gaudi. His approach simultaneously embraces the expediency that computerised algorithmic data affords and the crucial contribution of testing through physical model making. On the conjunction between crafted forms created physically and through computer-aided manufacture Burry writes:

> It strikes me that an amalgam of both handcraft techniques that are currently threatened, and the digital tools that will increasingly proliferate at affordable price points, ought to be actively sustained for at least as long as we need to understand fully what we lose through a degree of abrogation of workload to the machine, while not necessarily being blind to what we stand to gain. 30

Mark Burry has examined the relationship between digital and physical design processes in the ongoing construction of Antoni Gaudi’s Sagrada Familia Church in Barcelona. For the nave (opposite) Burry and Gaudi used various physical and digital models to test the design (above).
In other words, Burry suggests that the relative expense of rapid prototyping tools at present, and the ensuing, necessary hierarchy of these mediums for fabrication, especially of complex forms, offers an excellent moment to develop a thoughtful position on ‘hybrid activity’; to carefully articulate the relationship between *homo faber* [man the maker] and automated procedures.31

At a smaller scale, and one of ‘non-standard’ production32 that is equally applicable to design as it is to architecture, we can examine the work of Bernard Cache. The director of Paris-based studio, Objectile, Cache has a fascination for how algorithmic patterns that are generated and driven by computerised programmes may manifest physically, challenging our expectation of what a ‘unique’ design piece may be. Of particular interest is his series of knurled, undulating surfaces that unfold across planes and are used as objects, such as tables, doors and standing screens. Cache discusses the logic afforded by computerised design and its application to CFAO systems in his book, *Earth Moves*, a publication that directed attention to the possibility for crafted digital artefacts in the mid-1990s, early in digital architectural history and theory.

In *Earth Moves*, Cache identifies two principle advantages that parametric functions offer the designer. The first is that surfaces with variable curves and volumes can more easily be designed in comparison with how they would be made by traditional drawing methods. The second and more dynamic opportunity is the idea of a non-standard mode of production where, “The modification of calculation parameters allows the manufacture of a different shape for each object in the same series. Thus unique objects are produced industrially.”33 Essentially, Cache is presenting a case for the heterogenous opportunities of mass customisation or non-standard design procedures.

The concept of an industrially produced one-off – a trait traditionally assigned to the field of handmade work – is a compelling miscegenation between craft and digital that provokes a more encompassing and contemporary notion of uniqueness. At the same time as we can predict increasing interest, variation and use of CFAO or CADCAM techniques in architecture and design, it is wise to realise that the artefacts produced continue to rely on practised, crafted skill to finish them well. Techniques such as sanding, oiling, jointing and assembly, for example, significantly contribute to the final quality of the object, whether it is produced entirely by hand or machine or as an amalgam of both.

Finding an amalgam is not always easy. The struggle to oscillate smoothly between digital and analogue practice in physical matter is revealed in Mario Carpo’s ironic observation of a recent exhibition at the Deutsche Architektur Museum in Frankfurt. Surveying the first built projects of the late-nineties ‘Blobmeister’ projects, Carpo noticed that many prototypes of the new digitally manufactured architecture were constructed using mostly traditional mechanical technologies.34 This example is one of many that points to the opportunities and gaps that continue to exist in the resolution between the idealised screen object and its physical counterpart.
Although there is increasing interest, variation and use of CFAO or CADCAM techniques in architecture and design, the artefacts continue to rely on practised, crafted skill to finish them well. Claire Reece and Isabel Legge sand and refine their CADCAM screen (right) produced for an RMIT studio led by Rebecca Roke, 2006.

OVERLAPPING DIGITAL AND CRAFT

This thesis recognises that we are at a critical point in digital design culture. The thesis champions an overlapping and layered relationship between tools and systems of crafted digital design and production. This proposed conjunction is based on a belief that crafted digital design accommodates the necessary advantages of efficiency and commerce, attributes that are more readily traded, shared, transmitted and altered in a digital format. A position of overlap also demands a material resolution that attends to the crafted skill necessary to create compelling and carefully wrought physical designs. This encourages exploration of the diverse and long history of designed objects and spaces. The first chapter of this thesis, Digital Craft, will more clearly delineate in what manner digital and craft are currently apprehended and how they are to be read in this thesis. The chapter will address precedents of digital craft expressed in artefacts and in writing. Digital Craft will also define the particular debates surrounding craft and digital practice that will and will not treated in this thesis.

MESHES OF PREJUDICE: BRICOLAGE, NOSTALGIA AND PATTERN

As the opening quote by Steinbeck suggests, it is inescapable and necessary to address the particular strains of influence running through a piece of writing, such as in this thesis. In the central three chapters, the examination of craft and digital is sieved through the mesh of three prejudices: bricolage, nostalgia and pattern. The tripartite filtering offered by these thematic areas is seen as a means to approach digitally crafted design. I propose that this filtering productively includes historical precedents as well as contemporary case studies.

Each ‘mesh’ chapter explains its relationship to the key question of digital craft through a series of two principal case studies. These examples illustrate that an oscillation between analogue manifestations and digital techniques allow projects to develop with diversity, creating objects and spaces that are imbued with heterogeneous references particular to each designer. The large and small-scaled works that are treated illustrate how digital craft allows for size, materiality, genus, history and technique to become layered into the production
Bricolage and the assemblage of heterogenous fragments are processes that underpin the design of Thomas Heatherwick Studio’s “Bleigießen” (opposite) and Minifie Nixon’s Australian Wildlife Health Centre (below).

BRICOLAGE: ASSEMBLING HETEROGENOUS FRAGMENTS

In the second chapter on bricolage, the workings of a bricoleur are read in relation to the writings of the French anthropologist, Claude Lévi-Strauss. His discussion of this concept suggests that bricolage occurs when a person draws on material that is ‘ready to hand’ to create anew. We have seen that this idea can be shared with the way in which musicians, for example, may approach post-digital composition. I expand upon this concept in my thesis to encompass architecturally specific readings and examples where bricolage is conceived of as a ‘method of chance’. This technique becomes the catalyst for design strategies at various scales – an opportunity recognised in the theory of bricolage as ‘a range of utopias in miniature’ expressed by Fred Koetter and Colin Rowe in Collage City. As with Rowe and Koetter’s reading of bricolage in the context of Rome’s civic formation, I regard bricolage in the design process as encouraging the skilful adaptation and use of materials to hand into the work.

There are a number of different ways in which bricolage is considered in this chapter. I will treat two main aspects of bricolage: the techne trouve and the idea of bricolage as assemblage. Within these two approaches, there are variations in how materials are incorporated and adapted into a work or design. Often this occurs in a physical manner but it is also practiced in digital fields. The case studies illustrate how the practice of bricolage enriches the work, giving it a specificity of place and time.

Of key interest in this thesis is how a designer may apply the notion of bricolage to the crafted digital realm. For example, from where and how may a designer craft his or her materials and techniques in a kind of techne trouve? This is a specifically digital variant on the idea of an objet trouve, where a found component is apprehended for a different use. How is this relationship conducted in digitally informed practice where collaged elements may be transported efficiently and quickly regardless of any obvious site from which the bricoleur drew her material? The techne trouve is represented in the architectural processes of Melbourne-based practice, Minifie Nixon, particularly in its recent
Australian Wildlife Health Centre in Victoria, Australia (2006). Its director, Paul Minifie, considers techne trouve to be the grafting of digital codes, abstract parametric equations or established geometric relationships with digital architectural software processes in order to generate new architectural form that originated from existing data or systems of geometric logic.

Contributing to my argument for the benefits of bricolage as a technique of assemblage, I discuss the conception and execution of a large-scale installation titled “Bleigeissen” by Thomas Heatherwick Studio for the Wellcome Trust in London (2005). This project will illustrate how methods of chance productively contributed to the development of the studio’s ideas. It emphasises how opportunities of assemblage acted as a catalyst for “Bleigeissen” and were refined with a crafted digital approach.

NOSTALGIA: PRECIOUS FRAGMENTS AND PROSAIC ROOMS

The third chapter addresses the particular relationship that precedent and historic content offers the designer by way of nostalgia. Of especial interest in this thesis is from where and when a designer draws on methods, materials and techniques for design, and how this may change in contemporary currency where the efficient transport of digital files is prevalent. In this regard, current readings of issues concerning place, such as the impact of globalisation on local environments, should inform the contemporary designer’s approach to nostalgia.

As with the common concept of craft, nostalgia is a term that generally holds negative associations with a lack of progress and fusty sentimentality. I will argue that a more productive way of employing nostalgia – particularly when aligned with digitised production processes – aids the designer in engaging public appeal without merely reproducing traditional forms of expression. As Svetlana Boym has pointed out, “With nostalgia, one is [usually] longing for a home that might never have existed, reinventing the past and exploring new eccentric possibilities for the future”.36 This suggests that designers may critically access these emotionally charged sites for imaginative re-use from which potentially provocative work can take effect.

We read the filter of nostalgia through two case studies. The first is through the work of London-based design practice, Graphic Thought Facility, which is attuned to the power of combining past and present. Its lateral approach to efficiently conveying the idea of digital technology in an exhibition entitled “Digitopolis” for the Science Museum allows us to understand their method of bricolage that is allied with nostalgic nous.

The second case study regards the work of the Rotterdam-based industrial designer, Hella Jongerius, for whom reinvention and exploration of tradition is a characteristic method of enquiry. We will examine how her upholstery fabric series “Repeat” commissioned by the American textile company, Maharam, illustrates how a contemporary industrial design approach may be economically and popularly achieved while also layering the product with irony and wit by incorporating nostalgic references. Similarly, her PS Jonsberg vase series for IKEA illustrates a marriage between archetype and mass-production.
Pattern occupies a crucial role in piecing craft and digital methods together. It is considered in the fourth chapter in two ways: First, for its traditional role in decorative art and craft where codification and provocation of memory are communicated by what lies on the surface. Second, pattern is seen as an active tool by which operations such as CADCAM cutting-sheet instructions or ‘nesting’ may be economically arranged on a plane. More recently, pattern is forming an increasingly popular method by which emergent design practitioners can generate algorithmic design. The pattern of codes of life, as well as patterns based on the behaviour of natural forms underpin much of the architectural and design preoccupation of emergence.

Pattern also dovetails with nostalgia and **bricolage**: with the former, pattern shares a close association in provoking a particular memory or acting as an aide-memoire of a certain era or place. Parallels between **bricolage** and pattern can be found in the work of practitioners such as Minifie Nixon, who explore pattern through the brick skin and cupola vortices of the Australian Wildlife Health Centre. The somewhat unpredictable shapes and patterns that engulf that project exploit the associative properties of ‘flocking’ agents and the tensile Costa surface is a real-scale expression of techne trouve. In this chapter on Pattern, we consider Minifie Nixon’s Centre For Ideas at the Victorian College of Arts, Australia, to explain and refine the relationship between pattern, structure and the techne trouve.

London-based designers, Doshi Levien, are equally observant of the contemporary conditions where the exchange and trade of information that is ‘ready to hand’ is enriched and expedited through craft and digital production. Its Indo-Anglo directors, Nipa Doshi and Jonathan Levien, extract and abstract patterns – both social and ornamental – from familiar and nostalgic cultural contexts. Much of their work recontextualises these associations in contemporaneous objects that deliver new patterns of use. Its “Charpoy”
furniture series for Moroso illustrates how this process may occur. “Charpoy” is an essay in digital craft practice that shows a skilled design exploration that oscillates between material and digital techniques.

CRAFT IN THE COMPUTER AGE

As well as revealing the idiosyncratic design language of its makers, the case studies representing bricolage, nostalgia and pattern reveal techniques that encourage the conjunction of digital craft practice. When selecting these case studies, I revisited McCullough’s quote that suggests craft in the computer age is a proposal to participate skilfully in some small-scale process. Not all digitally engaged and crafted work need be small scale, however, it is clear that advances in industrial design processes frequently lead other disciplines in their consequent adoption of new production techniques. That is, the design and production of industrial objects – which encompass an admittedly broad scale shift, from aeroplanes to fabric or utensils – most often require careful consideration of techniques for mass-production and a continual awareness of new techniques for improving production efficiency and minimising cost. These exploratory works often convince and inform the later adoption of such techniques by disciplines that work at a larger scale, such as architecture.

McCullough’s third definition of craft and digital is also helpful: “To craft implies working at a personal scale – acting locally in reaction to anonymous, globalised, industrial production.” His description is of particular resonance for this thesis, seeking as it does to campaign for designs that challenge the smoothly rendered logic of blobs and orbs commonly produced by – and frequently associated with – computerised design methods.

This thesis suggests that design processes should be shared between the digital, as it is commonly referred to, and craft. Techniques of digital craft should be encompassing. They should usefully draw on precedent as well as gesturing to methods of design and making that are relevant in a post-digital world. This is a world increasingly shaped by paced technological development.
Endnotes

1 One example of this digital borrowing from industrial design is seen in the use of CATIA, a software package that was originally conceived for use in the automobile and aeronautical industries and that is now often used in architectural offices, famously at practices such as Frank Gehry’s.


3 Thomas Friedman is one popular author who recently discussed this idea of international ‘evenness’ or ‘flattening’ in The World is Flat. 2005. New York: Farrar, Straus and Giroux.


5 William Morris is historically probably one of the most vocal critics of the negative social effect wrought by mechanisation. In one lecture Morris announced: “It is not this or that tangible steel and brass machine which we want to get rid of, but the great intangible machine of commercial tyranny, which oppresses the lives of all of us.” See Adrian Forty’s account of “The Politics of Design” in Objects of Desire. Design and Society 1750–1980. pp. 32–61.

6 See Sadie Plant’s interesting discussion of the evolving relationship between recent electronic digital tools and earlier inventions, such as the jacquard loom and the Turing machine in Zeroes and Ones. 1997. New York: Doubleday.

7 Parametric modelling takes its name from the project parameters or variables that are modified during the project simulation process. A parametric modeller is aware of the characteristics of components and the interactions between them and a consistent relationship between elements is always maintained as the model is manipulated. We can see how this plays out in building a project parametrically, for example, when the pitch of the roof is changed and the walls automatically follow the revised roofline. See http://www.galorath.com/index.php/company/books/what-is-parametric-modeling. Accessed 26 October 2008.

8 See Mark Burry’s keynote address at the ENHSA conference in EAAE no. 29 “Re-searching and Redefining the Content and Methods of Teaching Construction in the New Digital Era”. Burry writes: “I am a post-digital operative. I have no particular interest in the digital per se, just as I have no interest in the traditional per se, but I have a lot of interest in their fusion. And I think that the people who I admire most and work best with are the people who rather than polarising one way or the other are able to form some kind of fusion between the digital and the analogue, without getting too strung out about the difference between the two modes of practice. http://www.enhsa.net/downloads/publi/con5/06burry.pdf Accessed 23 May 2008.

See also the Introduction to the catalogue of “Homo Faber: Modelling, Identity and the Post-digital” in which the ARC grant chief investigators (including Burry) write explicitly of the post-digital world in which they place the work: “The idea of the ‘post-digital’ therefore describes the normalising of computer modelling as part of everyday practice whether or not there is a physical output in model form. We have found evidence of designers using both digital and physical models in parallel and sequentially, but very little use of any genuine hybrid making.” See “Introduction” of Homo Faber Modelling, Identity and the Post-digital. 2008. (digital catalogue). p. 4.


11 Ibid. pp. 2-3.


15 Computers use binary numbers, and therefore use binary digits in place of decimal digits. The word
‘bit’ is a shortening of the words ‘binary digit’. Whereas decimal digits have 10 possible values ranging from 0 to 9, bits have only two possible values: 0 and 1. Therefore, a binary number is composed of only zeroes and ones. Bits are rarely seen alone in computers. They are almost always bundled together into 8-bit collections, and these collections are called bytes. http://computer.howstuffworks.com/bytes.htm Accessed 23 January 2008.


20 Ibid. p. 111.

21 Though primary, referencing the Oxford English Dictionary (OED) is here seen as a useful comparative technique, based on its authority of the main meanings and semantic developments drawn from accessible literature and modern mass media by its lexicographers. Clearly the OED expresses the general application of ‘digital’ as an adjective juxtaposing computer-based and/or electronic techniques or tools. See ‘digital’: “of pertaining to, using, or being a digit or digits; spec. designating a computer which operates on data in the form of digits or similar discrete elements. rare before M20.” Special collocations include ‘digital divide’ and ‘digital signature’ – first meaning, “the gulf between those who have ready access to computers and those who do not”; second meaning, “a digital code which is attached to an electronically transmitted document to verify its contents and the sender’s identity.” When considered as an adverb, the digital is described as: “by means of or with respect to the fingers; by means of digits; in digital form.” Oxford: Oxford University Press. p. 678.


An abbreviated description of the many listed meanings of craft cited in the OED reads:

2 verb trans. Make or construct skilfully. (In isolated use before M20.) LME.
3 verb tran. Act craftily; use one’s craft or skill. E16 E17.

Interestingly, as a noun, the etymology of craft is defined as being similarly active:

1 strength, power, force.
2 skill, art; ability in planning or constructing; ingenuity; dexterity.
And of particular relevance to this thesis:
5 An art, trade, or profession requiring special skill or knowledge, esp. manual dexterity. OE.
-b The members of a trade or handicraft collectively; a trade union, guild, or company of craftsmen. LME.

The latter interpretation contrasts Branko Kolorevic’s suggestion of how future digital manufacture will manifest. As we will see in the chapter on Digital Craft, for Kolorevic, the future distribution of tasks will occur from one centralised point that is independent of traditional building hierarchies, as compared to the shared expertise inherent in a guild or company of craftsmen.

28 McCullough. Op cit. pp. 21–22. (Author’s emphasis.)
Two recent events draw attention to the general dislike for the term craft, even by those who are responsible for popularising and educating the public about the field. First, is the re-naming and re-branding of the American Craft Museum in New York to become the Museum of Arts and Design in 2002. The museum states that the name change occurred “in order to reflect that craft is an artform equal to all others,” however, it is odd that ‘craft’ doesn’t enter into the title. Similarly, a touring show commissioned in 2005 by the British Council titled “My World – the New Subjectivity” was originally entitled “The New Craft”, however, its commissioners re-branded the show prior to its opening because the word craft was considered to misrepresent the work by emerging contemporary British-based designers. This was of particular consideration for the show on its tour of the United Kingdom with its close and difficult historical relationship to the Arts and Crafts movement and the possibility of consequent negative associations and publicity.


Ibid. pp. 32–34.

Works included in the exhibition “Architectures Non-Standard” curated by Frederic Migayrou and architect Zeynep Mennan for the Centre Georges Pompidou in 2004 most obviously illustrate this term in architecture. Non-standard refers to the mathematical theoretical breakthroughs that cleared the way for non-standard advances in fractal and catastrophe theory and artificial intelligence. Its application in architecture most often is reflected in the widespread application of programs based on algorithmic systems that presuppose changes in tools for design and production.


Collage City was published in 1978 by Koetter and Rowe. In it, they expounded the idea that small accretions of form and space offered a less totalitarian opportunity for architecture and civic design to manifest, as compared with the ‘egotistical’ and overarching schemes made famous by Modernist planners, such as Le Corbusier.


Ibid. p. 21.
1. Digital Craft
Oscillation and Inclusion in Design Process

What are the attitudes to craft and digital processes that exist, particularly as they apply to architecture and design? As stated in the Introduction, this thesis proposes that the often-polarised positions we find between the two must be examined more closely. By identifying the constructs that commonly surround ‘craft’ and ‘digital’ we can understand more precisely what is meant by each term and how they are to be used in this thesis. In this chapter we collect and sieve through interpretations and applications of each term to define what is meant by the loaded (and often loathed) term, craft, and the elusive idea of the digital. I am interested in how relationships between these entities that are assumed to be dissimilar offer a useful tension that can result in productive digital crafting of architecture and design.
DIGITAL AND CRAFT

Craft lends itself to a historically minded debate that is often linked to the demise of handwork through the advance of technological enquiry. It also tends to carry a more resolute and difficult relationship because it imbues emotionally and morally motivated questions of authorship, beauty, finesse, artistic expression and so on. By contrast, concerns of a digital nature appear to be indebted to technological progress; tools of the digital world are inextricable from the way we predominantly work by means of invisible ‘bits’. As we might expect, the term digital is more open to new meanings, both in its general use and in its application in architecture and design.

Most recently in architecture, digital processes have manifest in the exploration of forms through mathematical equations used in the life sciences to account for natural systems, the techniques of emergence introduced previously. In this chapter I will touch on this contemporary application of digital architecture insofar as it illustrates a ceaseless quest for newness, often to the exclusion of other more traditional concerns of architecture and design, such as scale, materiality, site constraints and so forth. The relatively new techniques of digital architecture, particularly in association with emergence, are sometimes ingratiated with design and manufacturing processes without careful regard for what the new techniques actually gain. At the same time, they can be seen as a current characteristic in the longer arc of the use of computers in architecture.

The idea of something new being ‘contemporary’ and therefore drawing attention for its newness is a familiar tale. However, as we will see, often the beguiling product of newness can more accurately be argued to be the result of a different approach to the way in which parts relate to a whole. Often it is through recombination of existing matter that novel qualities are revealed. When ‘out-dated’ techniques are entirely abandoned for what appears to be, in Mitchell’s terms, “the land beyond the horizon” a dislocation arises. This exclusive abandonment and severance from the past is what my proposal for digital craft seeks to resist.

CRAFT–DIGITAL CONTINUUM

In this thesis, which examines digital and craft, the supposed dislocation between old and new methods of design and technology is especially important to critique. We can, for example, argue for a continuum rather than a sharp contrast between noun-based craft and digital. The foundation of binary machines operating with zeroes and ones – computers – that we are now so reliant on was made apparent to its early inventors such as Alan Turing by observing the binary principles of analogue computers. Analogue computers include tools such as the abacus and the Jacquard Loom. It is clear that the latter arose from a traditional category of craft, specifically weaving. The desire for enabling the efficient manufacture of woven cloth in the 1800s gave rise to the cardinal loom invention. Therefore, when viewed as a continuum, the chronology of technological development between craft and digital can be seen to share interwoven concerns, rather than disjunctive breaks. We can look to this shuttling back and forth between analogue and digital to understand the inclusive concept of digital craft. The case study designers that we will consider are distinctive for encouraging this oscillation in their design process, rather than feeling confounded or caught by one medium or another.
Craft is commonly considered as a noun. In this regard it is materially and genealogically rich, however this thesis regards the use of craft as a verb.

Part of the trouble with discussing craft is that it is commonly considered as a noun. In this regard craft ranges across territory that is incredibly rich, both materially and genealogically, but is too vast to be of use in this thesis. The history of craft is coloured by shifting categories, internal factions and the ongoing defiance of craftspeople to give voice and authority to their work since it was abrogated during the Renaissance. Tanya Harrod’s authoritative survey *The Crafts in Britain in the 20th Century* gives an indication of the breadth of craft, and this encyclopaedic book only discusses its appearance in Britain. However, while irksome and unwieldy, there is also something compelling about the notion of craft. Positive or negative, the word frequently provokes an impassioned response. It also implicitly references a sense of materiality. In our discussion on craft, we will examine some of the historical problems and connotations that the use of craft reveals. More specifically, we will look at its interpretation as a verb.

In this thesis and in order to forge a constructive and necessary conjunction with digital tools, a literature review of the topic reveals that craft is most useful when utilised as a verb. As an active collocation ‘digital craft’ offers us the opportunity to reveal the benevolent, useful intent of McCullough’s statement: “To craft is to care.” We may comprehend digital craft as a skilled way of making that includes the advantages of both current and previously current technologies. This is not to discount the materially rich history of noun-based craft, but to redirect the idea as an inclusive, active practice that is motivated by questions of how we can best resolve design problems with *all* the tools and materials we have at hand.

**PIECING BITS: DIGITAL DESIGN NOW**

What is the digital? It is a term so involved in our contemporary shorthand that it is something of a shock to realise that the word ‘digital’ itself doesn’t actually mean anything. As Brian Massumi writes, “The digital always circuits into the analog. The digital, a form of inactuality, must be actualised.”
Though technically speaking, Massumi’s argument reveals that digital doesn’t actually manifest anything *per se,* we must be equally aware of its widespread *colloquial* application and its use in collocation to refer to the intricate, complex and swiftly shifting realm of digital culture, tools and applications. Exactly because the use of digital softwares and hardwares is so prevalent, this thesis is posited as existing in a post-digital realm. In other words, we have ‘gone beyond’ the digital by implicitly accepting its dominance in our environment. However, it is useful to remember that digital tools are not yet as benign as we might suppose in a post-digital age. Because digital tools and techniques have become almost invisible, we can now look to interrupt and transgress their ‘proper’ use.

More particularly, in architecture and design, what is meant when we speak of the digital? What are the current debates surrounding its application in these disciplines? Digital activity is characterised by lightness, invisibility, mutability and transferability. As seen in recent digital architectures of emergence it is especially characteristic of a sense of resistance to traditional authorial instruction and ‘inherently architectural’ rectilinear absolutes. As Italo Calvino reminds us, it is through digital means that extensive mechanisation now takes effect:

> It is true that software cannot exercise its powers of lightness except through the weight of hardware. But it is software that gives the orders, acting on the outside world and on machines that exist only as functions of software and evolve so that they can work out ever more complex programs. The second industrial revolution, unlike the first, does not present us with such crushing images as rolling mills and molten steel, but with “bits” in a flow of information travelling along circuits in the form of electronic impulses. The iron machines still exist, but they obey the orders of weightless bits.

Essential to the question of digital craft is how the machines convey those instructions from ‘weightless bits’ to material: How can such weightless bits be accounted for in the way we use them? How do they affect the design and manufacture of our work? How are they crafted? One framing answer that aligns with the intended inclusiveness of digital craft is to read the change in tools as a continuation of crafted enquiry. As Lucie-Smith writes of the story of craft, “A fundamental part of … mankind’s development is the struggle to escape from drudgery – to find quicker, more efficient ways of making things.”

Digital efficiency is the result of a nexus between the binary logic of tools (the efficient manufacture of age-old weaving techniques, for one) and the ongoing improvements of swift technological advances. We have discussed that the computer finds its origin in historic tools such as the Jacquard Loom, despite the fact that its ubiquitous presence as a light, easily purchased machine for individuals to experiment with is only a few decades old. Therefore, the idea of a digital ‘revolution’ suddenly arriving upon us is as dubious as the desire to speak of preceding ‘revolutions’ such as industrialisation. Rather, the cultural shift towards efficiency that now resides in a post-digital age should more accurately be read as a continuum of skilful advances. Viewed in this way, perhaps the inclination to presume ‘new’ tools are better than previous methods of making can be resisted. We can look to make things efficiently – thus escaping

Practitioners such as Greg Lynn, Frank Gehry and Foreign Office Architects were swift to recognise the opportunity that digital tools provided. Their respective discoveries were discussed from top in *AD Folding in Architecture,* 1993, and seen in the Bilbao Guggenheim, 1997, and Yokohama International Port Terminal, 2002.
our ‘drudgery’ with any number of techniques for conveying instruction by machines – whether by chisels or computer-driven drill bits.

While this inclusive reading of technology and tools is constructive, as architects and designers there are also distinct consequences of employing swift electronic impulses to instruct the ‘iron machines’ of our industry. One obvious result is the greater freedom of form that may be produced with less effort. The blobs and orbs that have come to characterise digital design are in part a joyful response to the possibility of easily exploring double-curved (randomly curved) surfaces and forms through computer softwares. This type of parabolic architectural experiment had previously been achieved without computers by pioneers such as Frei Otto and Günter Behnisch in the catenary roof structure they devised for the main stadium and indoor arenas of the Olympia Stadium in Munich (1972). Painstakingly calculated and tested through a series of mathematical equations and physical models, the roof by Otto and Behnisch proves that double-curved surfaces are possible to design without the aid of computers. However, speed and newness have proved irresistible: in contemporary architecture new digital softwares encourage the exploration of irregular forms that were previously difficult – even tedious – to create. Because of the speed with which these forms can be created and tested, new, unforeseen advances in this field of enquiry have been realised. Accompanying this hastening freedom is the ability to convincingly represent undulating forms as architectural proposals. In other words, with the computer we can analyse the formal possibilities of an object from many different perspectives, develop many possibilities swiftly and therefore understand them better and represent them in ways that allow for their recognition as ‘convincing’ architectural forms.

In the early nineties, practitioners such as Greg Lynn saw the opportunity to draw on these new tools. For Lynn, animation software such as Maya offered the possibility to quickly produce easily altered, double-curved forms. Motivated by what was unarguably a new horizon in architectural design, Lynn famously developed his philosophy of blobs, which was communicated in the sell-out Architectural Design monograph Folding in Architecture of 1993. Foreign Office Architecture’s landmark Yokohama International Port Terminal of 2002, was similarly motivating for digital architectural practice. The expansive ferry terminal made physical the rhetoric of Deleuzian folds beloved by and inherent in the preceding exploratory models of Lynn. Frank Gehry, too, began to produce physical models that were then digitally scanned and post-rationalised with CATIA into constructable architectural forms. Since its completion, his sinuous Bilbao Guggenheim (1997) has generated columns of discussion about how a distinctive architectural project can invigorate obscure townships. The project flies a sinuous, silvery flag for non-standard digital architecture.

While Lynn’s legacy began as a distinctly ‘onscreen’ and theory-driven presence, FOA and Gehry’s resolution of the undulating forms in built reality cemented the ‘real’ non-rectilinear form in recent architectural history. Since then, of course, the computer has entered practices almost without exception and the newest digital architectural obsession is emergence, a term we will discuss shortly.

The resulting efficiency and mutability afforded by digital tools is both a lighthouse and an albatross for the craft of design. It illuminates the practice
of design for the broad disciplinary interaction it promotes: between film and architecture, in Lynn’s case for instance, or architecture and engineering if we consider the legacy of CATIA. Digital design and architecture can be communicated remotely to a multitude of people with many different results: to send, alter, receive, print multiple copies or produce cutting patterns of digital files, for instance. There is now a greater possibility that those who would not have had the opportunity to manufacture small amounts of their design previously may now produce short-run editions without incurring exponential cost. Though physically weightless, as Calvino reminds us, all those bits are responsible for what is produced. As designers, we are responsible for how the bits behave. And as such, weighty issues accompany a realm that offers such seemingly invisible agency.

Here, we return to the Janus-headed predicament mentioned in the Introduction. With all the newly introduced freedom of digital architectural design, one of the missing criteria of its use seems to be a full perception of limits. While the bits may appear to perform so exactly on-screen, without examining their translation to physical reality we may find that atoms protest in reality. We can remember Massumi’s challenge for us to realise our ‘analog computers’. Massumi argues that we need to think of the analogue and digital together as a process of co-operation engaged in continuous self-variation but not necessarily as one of symmetrical relations. He writes: “The processing may be digital—but the analog is the process,”10 continuing, “The analog and the digital must be thought together, asymmetrically.”

The difficulty in translating between digital and analogue computing in architecture is illustrated by the work of Rotterdam-based practice, NOX. Its director, Lars Spuybroek, is an advocate of what he calls the “digital design revolution”.12 NOX is firmly in praise of the inimitable advantages that digitally produced design – in particular, emergence – affords. In Machining Architecture Spuybroek’s “part manual, part manifesto, part monograph” he suggests that contemporary design methodologies of ‘machining’ are a matter of “stepwise procedures of adding information into a system to generate form”. In heavily mathematical rhetoric that seems especially popular among many digital practitioners,13 he champions the argument for “convergent and divergent methods” by which design becomes a transformative system. That is, a system that employs “bottom up” strategies where computerised “agents” that are coded with particular properties accumulate and dissipate to create forms that are based on rules governed by the designer.

The weightless efficacy of digital practice as it is described by Spuybroek often seems to occur as if the designs were conducted in a vacuum, as an abstract scientific test. That is, where the ideas are not considered in relation to the physical world that architecture relies on to become physically present. This dislocation between exuberant, abstract digital testing and its relation to skilled physical manifestation is seen in much digital architectural representation. We are frequently presented with disembodied forms that glow and gleam, floating against a uniformly darkened background. NOX’s Son-O-House of 2000–04 installed at Son en Breugel in the Netherlands, exemplifies the disjunction between analogue representations on-screen and analogue composition in physical reality. Compared with the ephemeral idea that the project was
poetically conceived of – an orchestrated “arabesque of intertwining lines” – its physical manifestation falls with a flat thud. The claim made for its digital visage is a project of lightness and on-screen it appears to float. However, off-screen the complex arrangements translate into heavy, poorly resolved connections where the meshed, curving walls rudely meet the earth. The concrete base is too heavy and incongruous for us to pretend that the arched intertwining meshes ‘float’ or that they seamlessly slide into the ground. In reality, the Son-O-House is not a form without walls or floors.

DESIGN WITHOUT AUTHORS
As Hélène Frichot has noted, “It is not uncommon today to hear a student or even certain architects describe how they have ‘evolved’ a form, or else how they have ‘grown’ a form.” While it is easy to see many advantages of digital practice that shrug off drudgery, one of the difficulties that accompanies the inevitable allure of such new techniques is that constituent parts of learning in architecture and design are often foregone in order to quickly win mastery over the favoured medium. This is especially obvious in the tuition of novice architectural students. The prevalence and publicity of digitally derived architecture – a comparatively swift architecture of ‘making’ is often accompanied by statements that glamourise or favour digital architecture to the exclusion of other relevant concerns.

Regard Lynn’s conversation with Ingeborg M Rocker, for example, where Lynn suggests that the shift towards the digital, “the technological regimes of computational design devices,” should preside over an investment in the study of architectural history or theory. I would argue that the ‘authorless designer’ often championed in the field of emergence promotes a dismissive attitude towards both authorial enterprise and the relation of the author to cultural and physical contexts that exist outside its special area of focus. For example, FOA has explained its work as a process of phylogenesis and it uses this evolution and taxonomy to constitutes a system of its work where the two unite.
Its recent monograph, *Phylogenesis: FOA's Ark*, states: “Our practice may be seen as a phylogenetic process in which seeds proliferate in time across different environments.” In this context, agency is given to process while almost negating the author of the process. In effect, by reducing the importance of a designer, the mute method-making and sense of detachment or isolation that is used to explain much emergent architectural work is a counterpoint to the hard won identity and skill a craftsperson reflects in her work.

Essentially, behind all the digital argot, devotees of emergence such as Spuybroek, are proposing that digital codes organised ‘bottom up’ should be implemented as the central organising principle for contemporary design. Why is this a useful design method to consult? What is achieved by prioritising ‘bottom up’ strategies in architecture? What is compelling about the idea that ‘agents’ are responsible for completing the work apparently unaided by other elements of care or experience that the designer has collected in her design career? Are agents hijacking the craft of design practise?

These questions hit upon one of the central criticisms aimed at the generation of digital design from mathematical code, parametric equations or other ‘borrowed’ data. Characterised as ‘The Stopping Problem’ this is essentially a question of authorship. Not only for NOX but for many other digital practitioners, it seems that because the final digital form is driven by an introduced equation, an ‘other’ body is seen to be processing the design iterations thus excusing authorship and responsibility. Clearly, this is not the case: at its most elemental consideration, a designer selects which code or equation to use, oversees running iterations of its performance with varied ‘inputs’ and eventually selects which version is ‘best’. As Massumi explains:

The process does not of itself generate a completed form. It generates a proliferation of forms. The continuity of the deformational variation can be cut at any point, any number of times. The constraints can be tweaked and set in motion again to experimentally generate whole new series of formal separations. The outcome of any given run cannot be predicted. But a choice must be made: a set of forms must be selected to provide the foundation of the actual design.

It seems that often the ability to produce any design in the computer is too alluring and the iterations too vast, for the consequent question of how
to precisely craft the artefact in relation to physical materials to be properly attended to. While new digital tools can greatly expand a designer’s vocabulary of complex forms, the ability for this new language to operate as a convincing design tool also relies on a consideration of how the computation methods may be used to translate between the ‘abstract’ digital form and its analogue reality. What innovative work between digital and physical realms can these borrowed equations be used for? This question concurs with Massumi’s challenge: by considering the physical limits of analogue computers we can be more strategic about how to use digital innovation. It could be said that for architects and designers, the actual unity and resolution of a design is one of the ultimate challenges and attractions of the discipline. To hone this resolution, frequent oscillation between digital and physical processes is required.

HERMETIC DIGITAL BUILDING: A CAPITALIST LOGIC
We have already acknowledged that productive efficiency is encouraged by digitally produced and revisable designs. For example, in the work of Objectile and writings of Bernard Cache we can see a helpful expression of how this efficiency may also allow for heterogenous opportunity. Nevertheless, efficient digital design opportunities are also susceptible to a less inclusive application of digital design that hinges about capitalist logic. Branko Kolarevic’s book, Architecture in the Digital Age: Design and Manufacturing addresses the commercial advantages that digital production offers. He promotes the importance of integrating softwares to produce a complete architectural cycle that ultimately could be controlled by a ‘master builder’ in the medieval sense. Citing Gehry’s Guggenheim Museum in Bilbao as exemplifying a Crystal Palace or Eiffel Tower of what he calls our “Information Age” Kolarevic’s remit identifies with sweeping changes in production that were first made obvious by techniques of industrialisation. He envisions profound consequences, “as new digitally-driven processes of design, fabrication and construction are increasingly challenging the historic relationship between architecture and its means of production.”

While Kolarevic is perceptive of future changes in methods of procuring buildings that will not necessarily take the common form of a blob, he recommends an increasingly close proximity between maker and machine. My critique of his proposal is that there is something lacking in the idea of determined physical testing that duly follows a process, which is tightly controlled by only a few ‘masters’ from start to finish. The seamlessness of this advanced technological method seems too stitched up. In the efficiency of such universal logic, where is the opportunity for oddities, eccentricities, improved information through discussion or serendipitous discoveries to occur? Often these can be co-opted for unexpected benefit and effect. Conversely, what happens when digital data or manufacturing processes inevitably corrupt or lose a clear path in what is expected to be a ‘faultless’ production method? The idea of a universal fabricator who merely presses print to complete her architecture seems to do away with many productive tensions between material, thought, form, site and other unexpected concerns found in architecture and design, all of which invite careful design innovation.
INNOVATION THROUGH ASSEMBLAGE
We can argue that an intrinsically necessary, though difficult, part of crafting architecture and design exists in orchestrating an assemblage of parts. Resolving relationships to form a whole in the physical world, with the agency of digital and analogue tools, presents a challenge to innovate digital craft. The idea of using what is at hand — our knowledge, skills, tools, precedents, material and so forth — and making sense of it, also gestures to the premise of *bricolage*.

In the second chapter I discuss this term in detail with respect to its use in architecture and design, but what essentially underpins this type of practice is that through discovery and testing we literally make something anew. In this way, the seductive appeal of a recent tool — such as the computer — can be read as just ‘another’ tool of a suite, rather than inducing hierarchy and preference based on newness. We can look to Michel Serres and Bruno Latour’s discussion of innovation through assemblage in the context of a ‘new’ car to understand how this idea of innovation operates. They write:

> In order to say “contemporary,” one must already be thinking of a certain time and thinking of it in a certain way … Consider a late-model car: It is a disparate aggregate of scientific and technical solutions dating from different periods. One can date it component by component: this part was invented at the turn of the century. Another, ten years ago, and Carnot’s cycle is almost two hundred years old. Not to mention that the wheel dates back to Neolithic times. The ensemble is only contemporary by assemblage, by its design, its finish, sometimes only by the slickness of the advertising surrounding it.26

In Serres and Latour’s example, what becomes clear is that it is the recombination and honing of how parts relate that denotes a novel approach, not just the newness of finish or a the apparent capacity of a tool. This practice of revising through repetition and discovery can also be identified as a characteristic of craftsmanship.27

CRAFT
As Richard Sennett describes, “Craftsmanship names an enduring, basic human impulse, the desire to do a job well for its own sake. Craftsmanship cuts a far wider swathe than skilled manual labour; it serves the computer programmer, the doctor, and the artist … Every good craftsman conducts a dialogue between concrete practices and thinking; this dialogue evolves into sustaining habits, and these habits establish a rhythm between problem solving and problem finding.”28 As introduced previously in this chapter, my focus in this thesis is the idea of the active participation of craft; that is, craft as a *verb*. Principally, this choice reflects the actuality of involving oneself in the act of work, no matter what field we engage in. However, another reason for this decision is writ large by Tanya Harrod, an expert in the field of craft. The following passage signals her quandary when trying to pin down what might constitute a noun-based understanding of craft. She writes:

> Craft could encompass blind ex-servicemen making nets just after the First World War … miner’s wives in the Rhondda valley, making quilts … and hand block-printed textiles designed and made by Phyllis Barron for the Duke of Westminster’s yacht … Any definition of craft could also

Much of the skill that is essential to the act of craft exists as tacit knowledge. For example, a craftsman may have great expertise in digital animation or glass blowing, but the ability to describe the act is usually revealed better by visual demonstration and practice rather than by description.
take in lots of handwork in industry and surviving vernacular craft such as hurdle making or basketry. After the Second World War the situation becomes, if anything, more complex.\textsuperscript{29}

What she discovers in the impossibility of defining the term is that, while necessarily far-reaching – and compelling for its heterogeneity – the variability also reflects the fragility of craft as an identity.\textsuperscript{30} This idea of fragility and discontent, as well as the traditional lack of recognition of craft by the academy is picked up on by McCullough who also favours the use of craft as a verb to mediate between its irreconcilable boundaries as a noun. He writes:

As a noun, the term ‘craft’ suggests class differences and amateurism … Craft is seldom any longer practical trade, but it is not yet often art. It is outside of academic consideration; ever since mechanization has taken command, craft has been stranded in bourgeois territory where few self-respecting aestheticians would dare to tread. \textit{But a new usage may change this situation.} Based on observations of a linguistic tendency, and with a desire to explore an academically belittled area, \{verb-based craft\} is a mediation on the seeming paradox of intangible craft.\textsuperscript{31}

We can see that noun-based craft exhibits irreconcilable paradoxes and engages with a field of Brobdingnagian proportions. For these reasons, in this thesis unless explicitly described otherwise I am treating craft as a creative act of knowledgeable, reflective \textit{activity}. I am discussing craft as a verb as it relates to continual making and reflection in the design process of architecture and design in a post-digital age.

What is difficult about employing a verb is that translating ‘making’ into words is difficult. The absence of descriptions of craftmaking in written form has caused much anguish in the history of noun-based craft. In part, the reliance of craft on \textit{doing} has consolidated its exclusion from the canon of revered disciplines and the academy. Much of the knowledge that is essential to the act of craft exists as tacit knowledge. For example, a crafts-person may have great expertise in digital animation or glass blowing, but the ability to describe the act is usually revealed better by visual demonstration and practice rather than by description. This is true of most designers and craftspeople; they learn and experiment by oscillating between finding and solving problems in an ongoing process of making.

An especially compelling way of engaging craft in contemporary design processes occurs at the conjunction between digital and analogue techniques. Determined repetition between drawing and computerisation, or between the results of CAM milling and CAD finesse are examples of digital craft. It is wise to be aware that the analogue techniques that are used to translate the digital instruction into physical proportions often cross into the difficult terrain of noun-based craft simply because they describe a fundamental craft category, such as carpentry, for example.

Despite the difficulty of describing an act of craft, in literature we can find many descriptions of craft or craftsmanship where active participation in the event is explained. Rainer Maria Rilke’s poem, “Wind that grips this country like
a craftsman,” for instance, spurs us to consider not what is made but conjures up the dynamic engagement and reflective practise of a craftsman working at his material:

Wind that grips this country like a craftsman
Who, from the start, has known his material;
Finding it hot, he knows what must be done
And grows enthusiastic with his work.

No one could stop this magnificent momentum;
No one could oppose this fiery defiance–
And he is still the one who takes a long step back
To offer his work the bright mirror of space.32

What is useful here is the immense sense of vigour and concentration Rilke describes in the craftsman’s endeavour. But importantly, Rilke also identifies the “bright mirror of space” that is, the moment of reflection on the work. This concurs with Sennett’s description of craftsmanship where a critical consideration of what is made is a fundamental part of improving one’s practice. We can almost hear McCullough intoning “to craft is to care”.33 So, too, does this attitude resonate with the ideas of David Pye, a late Professor of Furniture at the Royal College of Art, London. He articulated his view of skill and engagement, which he saw as essential to the act of craft and termed a Workmanship of Risk, thus:

As a first approximation, [craftsmanship] means simply workmanship using any kind of technique or apparatus, in which the quality of the result is not predetermined, but depends on the judgement, dexterity and care which the maker exercises as he works. The essential idea is that the quality of the result is continually at risk during the process of making.34
Again we encounter McCullough’s idea that care informs craft. Similarly, Jonathan Levien of Doshi Levien, evokes a designer’s concern for achieving design excellence. His description of a rhythm between problem solving and problem finding in the way Doshi Levien’s design office works conveys this:

The three-dimensional CAD aspect is more a way of recording what’s happening with the hand. With the hand you’re able to achieve a sort of serendipity and exploration that is not necessarily possible with the computer. We use the hand to do what CAD or whatever [software] program, will not enable us to do or will not give us the freedom to do … And then we go back because obviously you need to digitise it so that you can communicate with manufacturers and people who are producing the work.35

While I would counter his statement about the hand – the hand is attendant in both operations – what is important is the attention Levien places on achieving the best possible design by whatever means necessary. This is a clear description of craftsmanship existing within the capacity afforded by digital tools. It is an inclusive example that explains how digital craft is made at Doshi Levien. It also touches on the notion of bricolage – making do with what is at hand – that we will consider more extensively in the following chapter.

CONCLUSION
Hands and brains are present in equal measure in digital craft. The craftsperson is curious and motivated to create a work to her greatest intent through whatever means possible. In the best instance, this idea of productive and creative fusion encourages diversity and a sense of satisfaction for the maker. Sennett explains that for the craftsman, “another struggle … is the eternal search for ways to make things which are better in themselves.”36 Here is the constant we are looking for in digital craft: the search for skilled improvement that comes about through mechanical and intellectual questioning in order to produce the best possible result.

Hopefully, designers who have grown up with digital technology and are at ease with the operations of a post-digital world will also be engaged with possible design manifestations that exist beyond digital representation. Will those for whom digital practice is familiar and is therefore an ‘invisible’ medium continue to be curious about how designs may translate to material reality? A recent journalistic discussion about the current popularity of noun-based craft in design – embroidery, woodturning, or weaving for example – suggested that digital technologies are embedded in designers of youth but that the act of making, which has long been shunned, has become a new territory to explore. British design consultant and curator, Peter Ting, comments:

If you look at the age of a lot of the people creating this new kind of [digital meets noun-based craft] design work … they’re people who were brought up in the 1980s and 1990s, and who have never had any doubt about technology. For them it’s completely and utterly reassuring that the technology is there and that it works. But I think there’s a rediscovery – or it may just be a discovery – of the notion of where things come from.37
Case studies in the following three chapters, Bricolage, Nostalgia and Pattern, will consider how this sense of discovery between materiality and digitality manifests. Though each chapter examines a particular approach to creating digital craft, all the designers look to unite problem finding and problem solving by oscillating between digital and analogue techniques. They are all interested in approaching design with distinct lines of enquiry and authorship. This results in work that carries the meshes of prejudice particular to each designer. Specifically, they all share an implicit understanding that Serres and Latour illustrate: to make something new, whether digital or analogue or both, it is often a matter of recombining existing parts with an unforeseen emphasis or interrogation in order to yield sustained innovation.
Endnotes

1 Antoine Picon offers insightful points of negotiation between architecture and what he calls “the virtual”. Unlike those who critique digital architecture and associate its use with the demise of the profession, Picon suggests that the impact of the computer, “May more accurately be described as a reshaping of, rather than an estrangement from physical experience and materiality”. One such example is the ability to actually design the properties and appearance of new materials rather than passively applying existing materials to a design. See Antoine Picon. 2004. “Architecture and the Virtual: Towards a New Materiality.” in Praxis: Journal of Writing and Building, no. 6.


3 Discussions about design practice at Thomas Heatherwick Studio, Doshi Levien design office, Minifie Nixon, Jongeriuslab and Graphic Thought Facility all revealed that the way in which design solutions are found is through a continual process of negotiation between hand produced work, digital tools and reflection on how the analogue and the digital meet. The designers all considered this comparison and conjunction as being integral to their design method.

4 See Tanya Harrod’s extensive discussion of how representatives and individuals of craft have been negatively epitomized yet have continued to attempt to regain their agency in the twentieth and twenty-first centuries. Harrod offers a book of ideas and arguments. Her conclusion is telling in that, although she believes craft is currently “approaching design” in its conception, it remains a troubling, paradoxical and complex field. 1999. *The Crafts in Britain in the 20th Century*. New Haven: Yale University Press.


7 Ibid. p. 137.


11 Ibid p. 143. (Author’s emphasis.)

12 This term and all those that follow in this paragraph are taken from the Introduction to Lars Spuybroek’s *Machining Architecture*. London: Thames and Hudson. p. 4.

13 See the recent description of the form displayed at “Homo Faber: Modelling, Identity and the Post-digital” by Tom Kovac, for example, which has an almost impenetrable meaning. Is this faux-scientific language a disguise with which clear descriptions of what is being made and how are evaded? Or is the language used merely emulating the specific etymology that is so often found in specialist mathematical or scientific literature and from which the codes of architectural life integral to emergence are borrowed?


18 It is somewhat ironic that the format of FOA’s book draws strong parallels to the bible and the biblical theme of Noah’s Ark with architectural animals paraded two by two. The ‘good book’ generates fiery debate about the evolution of humankind – surely giving rise to one of the most phenomenally
charged arguments about the ‘authorship’ of our universe.
19 Traditionally, it is very important for craftspeople to include a ‘maker’s mark’ on their work to distinguish their output and to chart changes in their exploration or design direction.
20 Massumi writes: “Indeterminacy must be designed to emerge from an interplay of constraints. What constraints are set to interact will be an arbitrary decision of the architect, working from a more or less explicitly developed aesthetic orientation, and taking into consideration the functional parameters of the desired end product as well as client preferences on a number of other levels (including cost).” See Brian Massumi. “Sensing The Virtual, Building The Insensible” in Architectural Design: Hypersurface Architecture, vol. 68, no. 5/6, May/June 1998, pp. 16–24.
21 Ibid. (Author’s emphasis.)
22 It is interesting to note that producing a precisely executed physical prototype is integral to the success or failure of a design in the automobile industry, an industry that funds research from which many digital design softwares borrow heavily. In fact, it is little known that many physical prototypes produced for car manufacturers continue to rely on the ability of model makers to physically hone the approximate digitally formed clay mould by hand. The hand is favoured to achieve delicacy and fineness of shape and line.
23 Paul Minifie has observed that this may be the consequence of the construction technique. That is, because double-curved surfaces are essentially all the same, there is no easy way of judging what is good or poor about the design. Paul Minifie in conversation with Rebecca Roke. April 2008.
24 Here, we see another of many variations describing the particular ‘age’ we are operating in.
27 Richard Sennett has discussed this in The Craftsman writing: “Craftsmen take pride most in skills that mature. This is why simple imitation is not a sustaining satisfaction; the skill has to evolve. The slowness of craft time serves as a source of satisfaction; practice beds in making the skill one’s own. Slow craft time also enables the work of reflection and imagination – which the push for quick results cannot.” Sennett, Richard. 2008. The Craftsman. New Haven and London: Yale University Press. p. 285.
30 Ibid. p. 10.
31 McCullough. Op cit. p. 22. (Author’s emphasis.)
33 McCullough “What is Craft” in Abstracting Craft: the Practiced Digital Hand. pp. 21–22. (Author’s emphasis.)
37 Peter Ting quoted by Jenny Dalton. 2007. “That’s Not All Folk” in How to Spend It magazine, Issue 189 November 3. Published by the Financial Times Ltd. p. 76.
The conjunction of serendipitous discoveries and the process of making is particular to *bricolage*. In this chapter I propose that through this 'method of chance' designers can interrupt what would usually be step-wise and predictable processes of design. *Bricolage* allows ideas to move in new directions. The introduction and solving of an unexpected logic or process may help to reveal unforeseen design solutions. In this sense, we can see parallels between *bricolage* and Serres and Latour’s idea of creating anew by assembling constituent parts in unforeseen combinations. My proposal for *bricolage* as a method to assemble heterogenous fragments contrasts with the hermetic practice of a ‘master builder’ that we discussed in the previous chapter.
Bricolage seems an appropriate and under-represented ideology for design practice in a post-digital framework. Like the post-digital, the plurality offered by techniques of bricolage seek to move beyond binary combinations towards more diverse constitutions. Bricolage beckons the architect and designer to take risks and to question how randomly unearthed finds can be productively – and sometimes unexpectedly – put to work. The protagonist that I will draw on to illustrate this ‘method of chance’ is the bricoleur as described by the French anthropologist, Claude Lévi-Strauss. His figure of an artist who draws on both engineering principles and the serendipity of bricolage parallels my interpretation of how the methods of chance in bricolage can avail the designer in crafting post-digital design.

I suggest that ‘found’ ideas, materials and techniques offer the opportunity for a layered approach to solve crafted digital design in a post-digital age. The value of bricolage is that it makes connections between knowledge that is usually exclusive to a particular field of practice. In other words, designers who incorporate heterogeneous finds chanced upon through bricolage are more likely to discover opportunities for diversity in design intent and production. The particular ‘meshes of prejudice’ that bricolage affords are championed because they also encourage the idiosyncrasies of each designer to be revealed. The voice of each designer is made manifest through a very particular series of references – or signs – that create a distinct language and can be read as compositions of a designer’s narrative. We will briefly touch on the theory of signs in linguistics as proposed by Ferdinand de Saussure to understand how this paradigm may operate. Saussure’s linguistic theories also helped Lévi-Strauss to resolve his ideas on bricolage.

The advantageous use of bricolage in design revisits theoretical and historical analyses in architecture. In particular, we can look to the writings of Colin Rowe and Fred Koetter in their pioneering book of the mid-seventies, Collage City. Rowe and Koetter’s desire to avoid predetermined and totalising architectural arrangements at a civic scale called on methods of architectural bricolage. For them, bricolage was regarded as a way to resist the rote repetition or propagation of a utopian stylistic intent that they believed the modernist architect’s tradition (characterised by doctrines of Walter Gropius, Hannes Meyer or Marinetti) was responsible for.

In this chapter, the variation of result introduced by methods of bricolage will be illustrated through two contemporary case studies: the Australian Wildlife Health Centre by Melbourne-based practice, Minifie Nixon and “Bleigeissen” a sculptural project of significant scale by London-based Thomas Heatherwick Studio. As we may anticipate, and as will be revealed on closer examination, each project employs a particular logic of bricolage. Each accumulates constituent techniques and materials to form distinct design conclusions. The variations of bricolage that we will consider in these case studies are respectively the techne troue and assemblage.

Both bricolage and the objet troué [found object] share the unpredictable intent of co-opting ‘found’ material for another use. The application of bricolage to digital design techniques is explored in the investigation of techne troue.
Minifie Nixon applied the *techne trouve* - appropriated digital data - to digital architectural software to design the Australian Wildlife Health Centre in Australia.

[found technique] – a specifically digital variant of the *objet trouvé* that relies on an almost illicit appropriation of existing data or systems of geometric formations for reuse in computer-based processes. In this chapter I discuss the *techne trouve* with regard to the Australian Wildlife Health Centre by Minifie Nixon. This project grafts digital codes of established geometric and biological relationships with current digital architectural softwares. Through this combination, the practice has generated architectural forms that animatedly speak of context and function. As we will see, the method of *techne trovare* becomes especially useful in architecture when it is functionally effective in evolving a new generation or series of generations of form. When these forms explicitly engage with material considerations we often find design innovation.

Thomas Heatherwick Studio's large-scale installation “Bleigeissen” for the Wellcome Trust in London illustrates *bricolage* through its use of an assemblage of techniques borrowed from digital imaging and from traditional beading techniques. “Bleigeissen” is an assemblage of small-scale units that impart a grand spatial effect. The project is especially useful for illustrating an interwoven relationship that oscillates between initial chanced finds, appropriated techniques of digital imaging and analysis, and physically crafted form. In this project, the use of digital tools was essential to help rationalise the project’s scale and organise the skilled construction logic for the thousands of dichroic beads that constitute the form.

Of especial interest in this thesis with its consideration of digital craft is how *bricolage* affects the nature by which a designer may create his or her materials and techniques: From where and to what effect does a *bricoleur* collect and apply her set of tools in post-digital practice? Is the *techne trovare* inherently different from the physical collection and adaptive reuse of *bricolage*? If so, how does this difference occur and affect the ‘chanced’ design methods and production?
MATERIALS AT HAND: MAKING DO WITH BRICOLAGE

In *The Savage Mind*, Lévi-Strauss lucidly observes the role and action of a *bricoleur*. For him, the co-opted collection formed by *bricolage* is used to ‘make do’ with what is at hand, incorporating a consequently broad range of skills to solve a task:

The ‘bricoleur’ is adept at performing a large number of diverse tasks; but unlike the engineer, he does not subordinate them to the availability of raw materials and tools conceived and procured for the purposes of the project … the rules of his game are always to make do with ‘whatever is at hand’, that is to say with a set of tools and material which is always finite and is also heterogeneous.  

In architecture and design, actions of a ‘bricoler’ nature resonate for the suggestion that a broad range of references are drawn on – ones that may not be obviously correct nor follow accepted ‘step-wise’ procedures. The accompanying notion is compelling. That is, the sense that a diverse suite of technical knowledge is drawn on to propose how a heterogenous collection of materials can be shaped and applied to suit a particular situation.  

Considered separately, the step-wise cycles of digital manufacture proposed by Kolarevic or the finely honed techniques of a specific craft, for example, lean towards isolated solutions to problems that follow predictable, logical processes. This educated but solitary pursuit resonates with Lévi-Strauss’s idea of an engineer who addresses questions of the universe with specific calculations and measures. We know that architecture and design require precision and accuracy in order to clearly communicate and create the designer’s concept. In this regard, their alliance with engineering has been well documented. However, in contrast to the traditional rigidity of the engineer’s practice, the *bricoleur* addresses a collection of oddments left over from human endeavours. “The artist [as described by Lévi-Strauss and for which I would substitute architect/designer] sits between these modes of thought – the engineer and the *bricoleur* – ruminating on universal problems but also entertaining the potential uses of resources that have been maintained or enriched by the remains of previous constructions or destructions.”  

By introducing the notion of *bricolage* into the ‘knowable’ limits of architectural techniques, the likelihood that unexpected methods could be drawn on in a diverse manner is strengthened. As such, the specific known limits that are often exclusive to particular disciplines may be questioned and read anew. Optimistically, this repudiates the habitual division between material and digital practice.

For these reasons, the method of *bricolage* and its potential applications in architecture and design is of particular interest in this thesis. An *ad hoc* attitude to our design and environment encourages inquisitive thought. For example: How could a found object be co-opted to solve a different situation? Does a commonly overlooked material hold other unexpected possibilities for use? Can a manufacturing method be interrupted or re-appropriated to answer a different design problem? *Bricolage* offers the opportunity for such curiosities to be regarded and digested, then acted upon with the specific measures and
calculations that we inherently use to make spaces and objects with.

CONTEXTUALISING BRICOLAGE
In this chapter I explicitly address the idea that the act of *bricolage* is the realisation that the static closed entities traditionally colouring perceptions of regions, contexts, tools and techniques are more easily weakened in our current world of increasing global mobility and integration. The subsequent possibility for digital craft in a post-digital context is that by incorporating heterogenous material our designs will necessarily consider a multiplicity of histories. *Bricolage* allow these to be appropriated in unexpected ways to create works that refer to diverse sources found by the designer.

As Robin Evans describes, “As soon as we identify something as broken, we become detectives of its history. What larger entity was it detached from? How did it end up in bits—or ... how are we to imagine it got that way?” This passage resonates for Evans’s notion of a detective: a conceptual figure acting with great curiosity. Not unlike the *bricoleur*, the detective is someone who seeks to discover links between a fragment and its possible application in previous and current uses.

This sense of understanding and re-piecing in the practice of *bricolage* implicates three crucial decisions. First: What is collected? Second: From where is the material drawn? Third: How is the found item incorporated to form anew? These questions require selective decisions to be made by the “artist [architect/designer] who is both something of a scientist and of a *bricoleur*.,” They all hinge about the context in which *bricolage* is executed. This is consistent whether the *bricoleur* is collecting from a digital context or a physical one. Either way, the found technique of an object needs to be unravelled and its properties and applications carefully observed in order to constructively inform how it can be re-used in a design process.

THE LANGUAGE OF BRICOLAGE
The constitution of a whole through constituent parts that *bricolage* encourages also gestures to procedures of linguistic structure. Linguistic structure and structures in the built environment both share the ability to communicate and suggest associations with other references, periods of time, cultures and so forth, thus acting as ‘signs’. This is co-existent with Lévi-Strauss’s approach to structuralist thought, which underpins his fascination with mythical thoughts that he argues are reconstituted and communicated by *bricolage*. Lévi-Strauss draws on the theories of the so-called ‘father of linguistics’, Ferdinand de Saussure, for his understanding of the communication of signs. A key thesis of Saussurean linguistic structure [structuralism] is that signs in linguistic structure occur when a certain word-form combines with a certain meaning. As John Lyons points out, the essence of Saussure’s principle is that:

The structure of language at every level depends upon the complementary principles of selection and combination ... the selection of one element rather than another produces a different resultant syntagm [linguistic units made up in a particular order] with a characteristically different meaning.”
We can see the parallel between signs in linguistic structure and *bricolage*. Both share the ability to evoke a multitude of references depending on the way ‘units’ are selected and combined anew. In *bricolage*, the assemblage of relations between the found fragments communicate characteristically different meanings. The resulting *bricolage* recalls various sites of selection and combination held by the *bricoleur* – certain periods of time, disciplinary interests, geographic contexts, materialities and so forth.

We will revisit this idea in many of the case studies in this thesis, where the language of the designer and their field of references provide a clear narrative of their practice. In the chapters on Nostalgia and Pattern we will see that the language of signs wrought through *bricolage* is also in effect. For example, in Nostalgia, Hella Jongerius draws on existing motifs, archetypes and weaving patterns discovered at an old mill to create a layered set of references for her “Repeat” textile series. She sees this re-use of familiar material as an opportunity to both engage and challenge expectations of the audience.

**FINDING VOICE**

An intrinsic and valuable ingredient of the process of *bricolage* is the idea of a particular voice or language being transcribed through the found ingredients:

> The ‘bricoleur’ ... speaks not only with things, as we have already seen, but also through the medium of things: giving an account of his personality and life by the choices he makes between the limited possibilities. The ‘bricoleur’ ... always puts something of himself into it.¹⁵

It is clear that an inherent quality of collecting and employing objects is partiality. Like a bowerbird’s mania for collecting blue objects, each *bricoleur* has especial filters with which they decide on the industrious and useful potentials stored in found treasure. As well as the tangible work that such finds can do, they also communicate in the less easily quantified language of signs we discussed above.

In part, what is appealing about *bricolage* is that there is no apology for bias or newly configured narrative. Rather, it is an embedded part of a *bricoleur*’s action that is directed to a diverse actual use. Lévi-Strauss offers us a concrete description of how this could manifest:
A particular cube of oak could be a wedge to make up for the inadequate length of a plank of pine or it could be a pedestal – which would allow the grain and polish of the old wood to show to advantage. In one case it will serve as an extension, in the other as material. But the possibilities always remain limited by the particular history of each piece and by those of its features which are already determined by the use for which it was originally intended or the modifications it has undergone for other purposes … The decision as to what to put in each place also depends on the possibility of putting a different element there instead, so that each choice which is made will involve a complete reorganization of the structure, which will never be the same as one vaguely imagined nor as some other which might have been preferred to it.16

What Lévi-Strauss describes is a very practical application of *bricolage*. Coloured by previous use a piece of oak can assume different purposes that are dependent on how the *bricoleur* interprets and appropriates the material. Not only is the physical application of the material open to variation in use, so too, is the possibility of an entirely different substitution occurring that would answer an entirely different task depending on the interpretation of a different *bricoleur*.

**COLLAGE CITY**

The variation and openness to difference described above concurs with instances in architectural history where heterogeny has been championed. Colin Rowe and Fred Koetter’s argument for adopting an attitude of *bricolage* in civic architectural practice is perhaps the most direct example. In their 1978 treatise, *Collage City*, the argument for *bricolage* is illustrated through a historical analysis of Rome, documenting the slow and unplanned civic formation of Rome illustrated in Nolli’s figure-ground plan. They enthusiastically describe the city as a “graphic example of collusive fields and *interstitial debris.*”7 Such anarchic civic tracery was the result of unpredictable construction founded on necessity of use with an absence of overarching intent.

Rowe and Koetter suggest, “Collage … is a wilfully interjected impediment to the strict route of evolution.”8 The unwritten, unplanned nature of collage extolled by them is also practised by the *bricoleur*. In their view, a “truly useful dialectic” would be possible between the engineer and the *bricoleur* in order “to establish a more ideally comprehensive city of the mind than any which has, as yet, been invented.”9 This resistance through difference was posited as a method by which the monotony of totalising schemes that they saw as characteristic of the Modern project could be dumbfounded. Though equally utopian in its own way, Rowe and Koetter’s common humanity of resistance sought to appropriate a pastiche of found materials and references in order to encourage a society of pluralism.

**BRICOLAGE: THE TECHNE TROUVE AND ASSEMBLAGE**

An attention to everyday objects that provoke curiosity and invite material diversity through their unexpected recombination is not exclusive to *bricolage*. There are a number of different ways in which the broad notion of *bricolage* is employed, including collage, assemblage, Folk Art, montage, the *techne trouve* and gleaning.20 The primary focus of this chapter will address *techne trouve* and assemblage as they apply to *bricolage* and design. We will see how case studies of
diverse digital craft draw on these methods of *bricolage* to create multi-layered design dialogues. However, the effect of *bricolage* is closely related to the work of collage and it is helpful to speak briefly of the specific qualities of the latter to address these parallels.

**COLLAGE**

In fine art, collage has a distinct legacy of expressive action and narration, particularly for Picasso and Braque who pioneered the advantages of the medium and its ability to directly convey the artist’s environment. Collage is often regarded as a medium that offers qualities that extend on more conventional, established representational methods such as oil painting or drawing. It also offers the facility to conjure up peculiar juxtapositions and subversive social statements through the swift act of cutting and pasting material together. Of its advantage, Kurt Schwitters observed the ‘other’ dimension that found objects gave to his work, noting, “When I adjust materials of different kinds to one another … in addition to playing off colour against colour, line against line, and form against form, I play off material against material”. This possibility for materials to be reinvested with new and unpredictable meanings, while inherently recalling fragments from past uses, is a mutually powerful characteristic of both collage and *bricolage*.

**TECHNE TROUVE**

As Schwitters’ description attests, seizing on found matter to swerve away from a linear and fixed approach to making can reveal materially and formally unexpected effects. How then, can this method of appropriating found material be considered in digital media? The digital domain lends itself well to multiple manipulations of bits: it encourages cutting, pasting and hacking digital code. In this environment could the strategies of *bricolage* fluidly enfold with progressive equations fought between zeroes and ones? John Richards’ suggestion of post-digital practise as “Bastardisation” or the use of digital systems to operate in ways “other than what it was initially designed for”
closely parallels the underlying principles of *bricolage* and by extension, the *techne trouve*. Because we are so reliant on digital tools to effect design practices, the *techne trouve*, which conjoins chanced finds, digital practice and ‘bastardisation’, is important to consider in post-digital design practice.

In this thesis I am treating the *techne trouve* as a technique specifically found in the digital medium, and specifically one that borrows from digital codes, parametric and geometric equations to make anew. This broadly gesture to the field of emergent practice that we have discussed previously. Frequently, in emergent architectural practice, pieces of digital code or equations of biological systems are severed from their origins and grafted with digital architectural softwares. The hybrid procedures are used to generate digital architectural forms, such as the familiar disembodied, sinuous pale figures floating over dark backgrounds.

Pioneering architects of emergence often thieved knowledge from the disciplines of biology, engineering or genetic construction sequences to literally inform their architectures of emergence. However, these have quickly become normalised operations and therefore often fail to maintain innovation in their assemblage. In other words, the early innovative applications of emergent architecture have been followed by a propensity to recycle these processual qualities of digital architecture. As amorphous form has been popularised, this has often superseded further critique about how the emergent *process* can generate new assemblages of tools and may be increasingly functionally operative in the physical world.

In contrast to the representational focus of much (especially early) digital architecture, practitioners such as Paul Minifie promote a more selective use of ‘stolen’ or found digital techniques. For him the *techne trouve* must be functionally present and explicit in its application for physical, material use. How can the prevalent use of borrowed digital tools in architecture be read differently, to engage the *techne trovare* at a more complex level, thereby avoiding the repetitive imagery of architectural blobs?

**MINIFIE NIXON AND THE TECHNE TROUVE**

Minifie Nixon has discovered that the advantage of using the *techne trovare* is that the ensuing explorations allow the designer to discover and control a range of answers for materially efficient and “elegant”26 architectural forms. For then, the *techne trovare* is seen as an active tool to unite the diverse architectural demands of construction logic, materials, technical expression, cultural references and so forth. It is not seen as a means to simply generate multiple amorphous forms.

As distinct from the architectural blob typology, what is emphasised in Minifie Nixon’s use of *techne trovare* are the functional properties found in digital code that can be put to work. Minifie notes, “It’s not [about] applying an impressionistic, representational description but [the *techne trovare*] must actually be present in its use.”27 An example of this ‘presence of use’ can be seen in the ‘found’ technique of a Voronoi tessellation. This geometric lozenge behaves in certain, quantifiable ways that can be conjoined with architectural considerations. The composition of Storey Hall in Melbourne (1995) is one example that we will revisit with regard to Pattern later in this thesis. However,
what we can see in Storey Hall is that the techne trouve of the tessellation is engaged in a way that is about its functional capacity to organise space and materials. Admittedly, as with the physical collection of bricolage, in techne trovare a vast number of informative found techniques exist for interpretation and use. The question of which techne trovare to choose resonates with the bricoleur’s query, for instance: ‘Which fragment to salvage?’ Either way, it is when the found tool/technique/material is implicitly incorporated into new use/s that innovative designs are formed.

Minifie Nixon has found that before designing with a techne trovare, one must first observe the particular technique, understand what constitutes its particular properties and what its spatial possibilities offer. A common characteristic of the techne trovare is that although most found techniques enable a boundless array of possible things that could exist and still be consistent with that technique, they’re also like a family of properties. That is, for each particular geometric form or data structure there are only a defined number of operations you can achieve with it. Like Lévi-Strauss’s block of oak we discussed earlier, each found technique has a certain number of uses. If you want to achieve a different effect you need to find a different tool. It is also worth remembering that the tools of one technique may not necessarily be compatible with another. One tool won’t necessarily just map elegantly onto another because this may destroy the fundamental capability of each. These criteria are not unlike rules of linguistic structure that are followed to accrete and create recognisable ‘signs’.

We can see that the criteria employed by Minifie Nixon for using found techniques can limit what is drawn on without being indebted to any particular area of reference. This resonates with Lévi-Strauss’s description of the rules of a bricoleur’s game: to make do “with a set of tools and material which is always finite and is also heterogeneous.” Both the bricoleur and Minifie Nixon has its own set of criteria for using found material.
At the Australian Wildlife Health Centre (opposite) the taut rubbery golden cupola of mimics the geometric properties of a Costa surface (detailed below). The brick wall adopts a strategy borrowed from 'flocking' patterns that chart avian flight.

For Minifie Nixon the criteria include:

- spatial properties
- appropriateness to the desired architectural effect
- compatibility between techne trouve and other found tools.

Minifie Nixon’s tripartite way of engaging with techne trouve introduces clear criteria for how such a technique is to be used in its work. Having established whether or not the techne trouve fulfils the criteria, the ability to then engage it with “conflict and unity in architectural composition” is entertained.

AUSTRALIAN WILDLIFE HEALTH CENTRE

We can see how the techne trouve takes effect in Minifie Nixon’s composition for an animal hospital at the Healesville Wildlife Sanctuary in Victoria, Australia. Of the distinct design, some would argue that the ‘conflict’ mentioned above by Minifie won out. There are two main parts to the Australian Wildlife Health Centre: a swooping, taut and rubbery looking surface of golden colour, which plunges into the centre of the project and shelters the central courtyard. The other distinct part of the project is an almost reptilian grey-brown brick skin that wraps the façade and accommodates entry and reception areas. Each has been created with techne trouve methods. The golden ‘cupola’ mimics the geometric properties of the Costa surface; the masonry wall borrows from convergent properties originally detected in the flight of birds and illustrated in Craig Reynolds’s diagrams. While the intersection between these two parts is quite blunt, the operation of bricolage as it is effected through the techne trovare also reveals some ‘abject’ and unexpected qualities of the project preferred by the architects. Below I discuss how the techne trovare as it informs the design of the cupola, daubed substantially with Minifie Nixon’s Australian prejudices. We will then compare this method of bricolage (techne trovare) with that used by Thomas Heatherwick Studio in “Bleigeissen” (assemblage).

COSTA CUPOLA

Discovered by Celso Costa in 1982, the Costa surface is an example of a very conservative continuation of geometry, in the sense that it engages with established geometric ideals, such as Platonic volumes. Minifie Nixon saw the appeal of conjoining this geometric type with what it saw as ‘abject’ qualities
often found in the Australian suburban condition. Minifie explains, “The ‘family’ of tensile structures that are referenced in the gold Costa surface of the Australian Wildlife Health Centre (AWHC) have a certain abject quality, like petrol station canopies or tedious shade structures. They seemed so irredeemably beyond the pale and it seemed like a slightly ironic, amusing thing to try and redeem them by another approach.”

Redemption in this instance was found in conjoining the techne trouve of the Costa surface with the fabrication of the golden vinyl. After initial testing on-screen, it became apparent that the three criteria for Minifie Nixon’s use of techne trouve were present: the Costa surface inherently creates an elegant tensile structure; it fitted the desire for a taut roof structure; and in this instance the technique mapped with the need to create a form that would admit light and provide shelter to the project. In fact, the Costa surface is here both the technique for finding form and the object itself. Having established these criteria, the surface was developed with the meshes of Minifie Nixon’s prejudice: the ubiquitous, abject sailcloths that protect Australians from the harsh sunlight of the antipodes. Indeed, these tensile structures can be argued to constitute a part of the ‘Australian Ugliness’.

While the golden membrane references its abject neighbouring sails, it simultaneously draws parallels to histories of architecture. Minifie elaborates, “The choice of gold material … was very important … It can talk about the history of a golden cupola or dome and on one level it’s just like a dome. In another way, the fact that it is not white meant that it was distinguishing itself from the rubric of Modernist purity. As a consequence it discovers an older, richer and pre-modernist relationship.” In the bulging cupola, histories of architecture, the techne trouve and the Australian Ugliness are all conferred and writ large. Minifie argues, “My sense of organic unity also includes reference to a certain amount of the immediate cultural context and I see no reason why this can’t be compatible with technique or abstraction or similar considerations.”

His explication exemplifies Lévi-Strauss’s idea of a bricoleur’s voice being enunciated through bricolage. Recall Lévi-Strauss’s sentiment presented earlier:

“The ‘bricoleur’ … speaks not only with things, as we have already seen, but also through the medium of things: giving an account of his personality and life by the choices he makes between the limited possibilities.”

What we are beginning to see is that, through bricolage, the heterogenous catalysts for a designer are always in play, whether in digital or material contexts. Bricolage offers an opportunity for diverse origins to be explored by the bricoleur [architect/designer], who selects suitable pieces and creates anew. In the case of the AWHC, and in the following example, the designers oscillate between digital and material testing to determine the result. Let us now consider bricolage in the instance of assemblage, illustrated through Thomas Heatherwick’s “Bleigeissen”.

GUESSING THE GAME: “BLEIGEISSEN”
Thomas Heatherwick Studio approaches its projects with an appreciation for unusual found objects, specific conditions of a brief and how to reconcile them
with whatever materials and techniques are most appropriate. Its design process often coalesces contemporary technologies with the work of craftspeople. Whereas Minifie Nixon is more inclined to draw on design opportunities found in reapplying mathematical equations and established geometric formulae through digital methods, Heatherwick employs *bricolage* in a manner that is closer to Lévi-Strauss’s original meaning. That is, by discovering physical objects or fragments to hand and interrogating and co-opting them to solve a design task. Heatherwick’s “Bleigeissen” installation for the Wellcome Trust headquarters in London exemplifies this practice. It is an assemblage of techniques borrowed from both digital and physical realms, to choreograph and craft small components. “Bleigeissen” is also something of a paradox: a mass-produced, one-off commission brief.

Upon entering the Wellcome Trust the glistening form suspended in the 30-metre-high atrium is immediately striking. It is “Bleigisessen”, an immensely over-scaled version of a 50mm piece of frozen pewter that Heatherwick’s studio ‘found’. Constituted of thousands of strings from which many more thousands of dichroic beads hang, its composition of many small elements is an integral response to the original design brief. When first approached, Heatherwick was asked to design a work that would fill the lofty space and sit above the existing reflecting pond. However, the building envelope was already in place and any materials could only enter through the relatively modest size of the front doors.

Heatherwick wanted “Bleigisessen” to communicate the impression of dynamic form or fluidity of growth. This idea responded to the Trust’s extensive research into stem cell and other biological growth processes as well as the actual watery expanse already in place. The project designer, Stuart Woods recalls, “Our ambition was to capture the movement of fluid travelling or falling down space, or the idea of a growth that could propagate, drip or mutate.” Capturing this elusive idea physically was difficult and required hundreds of tests in wax, water, metals and through the growth of crystalline structures. Finally, someone in the
The Studio captured a digital image of the cast lead, allowing them to transform it into a malleable and scaleless digital file (below, centre). Physical and digital modelling suggested that the shape would work but the site restriction at the Wellcome Trust building insisted on its constitution by small components (opposite, below right).

Studio remembered the German folk tradition of ‘lead guessing’ or bleigiessen; the Studio then threw hundreds of small molten metal pieces into ice to try and form miniature lead casts. Here, we can see similarities between the initial ‘chanced’ idea of the game, bleigiessen, which was repeated many times over, and the numerous digital iterations of the techne trouve that prefigured the resolution of Minifie Nixon’s Costa surface. One was achieved through physical means, the other primarily on-screen but both can be considered as crafted practices leading a design enquiry.

Once found, the promising ‘expressive drip’ needed to be re-scaled in order to assess its potential to communicate dynamic growth. Laser scanning is relatively new to the discipline of architecture, but has been used to digitally configure parts of the body for medical diagnosis, such as in ear, nose and throat analysis, for some time. The automotive and aeronautic industries also commonly use digitally captured shapes with a high degree of tolerance to test for performance. Woods originally trained as an automotive designer and could see the possibility in borrowing this technique for investigating the properties of the 50mm lead cast. The Studio captured a digital image of the dripped lead that allowed them to transform it into a malleable and scaleless digital file.

How to translate the file physically, at an enormously magnified scale while maintaining a sense of dynamism proved difficult. The desired properties were tested through physical and digital modelling which suggested that the shape would work but the entry restriction to the Wellcome Trust building insisted on its constitution by small components. Converting the promising form into an accreted physical object involved another degree of serendipity: Heatherwick’s mother, Stefany Tomalin, is a founding member of the Bead Society of Great Britain. It became evident that a grid of programmed bead ‘curtains’ would allow the project to take shape. The beads allowed entry through the front doors but also demanded a rigorous system to organise the three-dimensional form that was to be composed of almost pixel-like layers of beads.

Forty-two-millimetre wide glass beads were developed to incorporate a dichroic lens. The reflectivity and refractions from the dichroic beads allowed light to pass and crackle into iridescent shards, enlivening the design and paralleling the original design intent for change – of brightness, colour and shadow according to diurnal fluctuations. How the strings and beads would
A grid of programmed bead ‘curtains’ allowed the project to take shape (opposite). The beads facilitated entry through the front doors but also demanded a rigorous system to organise the almost pixel-like layers of beads on long tables (below). Behave was tested in a 1:1 physical model, which confirmed how dense each ‘data’ string should be, how closely they ought to be assembled, as well as gesturing to the likely responses to light.

Simultaneously, the digital scan was tested and refined to organise for the best packing pattern distribution of a bead matrix that accurately echoed the shape of the original lead cast. Woods notes, “From [that] point the project also became about a major feat of time schedules and logistics. Though it was a bespoke design, because of the number of repeated beads, the project became like designing for mass production.” In this way, digital engineering and spreadsheet software were integral to rationalising how the components would be assembled, string by string, and suspended from a lattice overhead. Each 30-metre-long string carried a strict data pattern and any mistakes in composition or assembly required snipping the string and starting anew.

Some months later, after hours of assembly on specially designed 30-metre-long tables, the thousands of beaded strings were complete. It is clear that “Bleigießen” was realised through an assemblage of techniques both digital and material; neither logic alone could have realised the project. The original hand-crafted castings and consequent beaded manufacture gesture toward a dynamic design process rendered through tactile, physical forms. The capturing, use and efficient constitution of the form was realised through digital imaging, engineering and spreadsheet logistics. Woods reflects on this oscillation between computer and material tools commenting:

Digital techniques are another tool and as with any tool, you’re only as good as the skills you have with it. So, computer scripting and so on allow for iterative forms but it seems that often designers primarily using this technique almost don’t go beyond it … An important thing to state is the way the studio is run: we don’t use technology to generate forms but are influenced by realities of physical behaviours of materials. Computer softwares help us sculpt, capture and produce these, but we don’t start designing in the computer. 

In design practice, much contention seems to arise when questioning the degree to which intersections between physical and computer testing are encouraged to occur. Working exclusively in one or other field obviously
impairs opportunities to develop innovative designs. This reinforces my argument for recognising the practice of bricolage as a helpful interjection in what would otherwise be linear, exclusive design processes.

CONCLUSION
Heatherwick and Minifie offer two distinct instances of the bricoleur at work in the design studio, with some overlap in their approaches. Both are interested in co-opting techniques and materials that they have found. Both also follow a rigorous series of enquiries as to how bricolage components can be co-opted to realise functionally effective design choices. For Minifie Nixon this is revealed in the strict criteria for adopting a techne trouve method. In the work of Thomas Heatherwick Studio the eccentricities of material behaviours are interrogated and translated with whatever suitable techniques are at hand – whether analogue, digital or both – to find the best solution that answers a defined brief.

Both the Australian Wildlife Health Centre and “Bleigeissen” are embedded with physical constitutions that reference areas of interest or ‘signs’ particular to the designer. The AWHC communicates ironic references to Australia’s typical suburban condition: shade structures and domestic brick-and-tile environments. It also nods abstractly to historic European architecture. “Bleigeissen” billows and writhes with dichroic beads – a choice of material that discreetly talks about Heatherwick’s maternal heritage. Its form recalls the folkish practice of lead-guessing, and it also expresses a shape that abstractly recalls the exploratory scientific practices of the client, the Wellcome Trust.

While the techniques by which the designers are diverted from linear design processes are different, both Minifie Nixon and Thomas Heatherwick Studio are alert to the possibilities that bricolage can offer. They are equally attuned to the need for designers to call on a range of techniques and tools when crafting design and architecture in post-digital practice.

In both projects we can see the potential for what Lévi-Strauss discusses in regard to the use of bricolage: the potential for mythical, unexpected and enchanted worlds to be wrought by the serendipitous incorporation of things found at hand. These potential experiences are also of consequence in the operation of longing, reference and associative recollection, themes we will address in relation to the emotive affect of nostalgia. In the following chapter on Nostalgia we will see that practices of bricolage form an undercurrent to the nostalgic design methods we consider. Bricolage in design practice also informs the design decisions in the subsequent chapter on Pattern. For now, let us examine the properties of Nostalgia in design, particularly bearing in mind the principles of selection and combination expressed by a bricoleur that we have discussed in this chapter.
Endnotes

1 Jane Bennett also discusses the unexpected moment (for which we could substitute the term 'object'). She describes the potential for enchantment to be found in the unexpected moment (object) and proposes that in the first instance, “Enchantment involves … a surprising encounter; a meeting with something that you did not expect and are not fully prepared to engage” See Bennett, Jane. 2001. The Enchantment of Modern Life: Attachments, Crossings, and Ethics. New Jersey: Princeton University Press. p.5.


3 Thanks to Paul Minifie for his useful discussion and elaboration on the techne trouve. To my knowledge, Minifie coined the term and has spoken about it without specifically labelling it in lectures and discussions. Excerpts from our conversation will be published in a forthcoming book chapter: “Techne Trouve: a discussion on the architectural application of found techniques in the work of Minifie Nixon.”


5 The rebounding of a ball, a horse swerving or a dog straying from its direct course in order to avoid an obstacle are examples of how the old sense of the verb bricoleur would have been used. In particular, it applied to ball games and billiards, to hunting, shooting and riding. Interestingly these pursuits would have entertained the gentrified classes, a social class of very different standing from Lévi-Strauss’ instructive bricoleur – a Jack-of-all-trades who would undertake odd jobs.

6 The narrative that an architectural detail may communicate is pertinent to this idea, in that by its very nature, a physical detail is able to locate a story of its making, place and dimension. The crafted details implicit in the work of Carlo Scarpa are examples discussed in this regard by Marco Frascari. See Frascari, Marco. 1984. “The Tell-the-Tale Detail” in VIA7: The Building of Architecture. pp.23-37.

7 See for example Le Corbusier’s explanation in Towards a New Architecture. 1927. London. pp. 18-19. “Our engineers produce architecture for they employ a mathematical calculation which derives from natural law.” In this example, Corbusier illustrates a ‘development’ of the engineer’s mind, which is distinct from the ‘savage’ mind that Lévi-Strauss attributes to a bricoleur.


9 According to Charles Jencks, ‘ad hoc’ architects question modernist architectural orthodoxies by designing buildings that responded to the immediate needs of the community. Ad hocists do not follow grand plans but pull together structures that serve the purpose of the here and now. Jencks proposed adhocism as a strand of postmodern architectural practice informed by grass-roots concerns. His primary example of an adhocist project was Ralph Erskine’s 1974 Byker Wall housing estate design in Newcastle. See Charles Jencks and Nathan Silver’s book Adhocism: The Case for Improvisation. 1972.


13 Ibid. p.13.

14 Lyons points out that although modern linguistics has progressed beyond Saussure’s notion of syntagmatic relationships, the Saussurean principle of the interdependence of relationships held between signs (the syntagmatic and paradigmatic) underpins this strand of linguistic theory. See Lyons, “Structuralism and Linguistics” p. 13.

15 Lévi-Strauss. Op cit. p.21. (Author’s emphasis.)

16 Lévi-Strauss. Op cit. pp. 18–19. (Author’s emphasis.)


18 Ibid. p.143.


20 An excellent account of gleaning is seen in Agnes Varda’s film of 2000 “Les Glaneurs et la Glaneuse.”

21 Particularly between 1907 and 1912 we can see the use of collage in fine art. Picasso’s first collage “Still Life with Chair Caining” of 1911–12 is one of the earliest examples where physical objects were directly applied to the canvas.

23 The ‘thievery’ from other disciplinary knowledge in the post-digital architectural practice of techne trouve parallels an overarching disciplinary ‘theft’ from collage seen in the early twentieth century. At that time architecture first seized on the opportunities that the Cubist’s revolutionary methods of collaged fragmentation had provoked in modern art and turned them to architectural intent.


25 Ibid. p. 283.

26 Here, the use of this adjective is less about an idea of style or grace but relates to the notion of an ingeniously concise or most simple and efficient way of creating form.


28 Ibid.


31 Ibid.

32 The original idea of Australia’s ugly suburban terrain was conveyed by Robin Boyd’s treatise, The Australian Ugliness (1960) as a reaction to his distaste for the commonly found ‘tragedies’ in Australia’s suburban architectural fabric.


34 Ibid.

35 Lévi-Strauss. Op cit. p.21. (Author’s emphasis)


37 Ibid.

38 Ibid.

3. Nostalgia
Precious Fragments and Prosaic Rooms

In the efficiency of a post-digital world, an examination of nostalgia may seem a dated, or even an irrelevant concern. In this chapter I will argue that the affect of nostalgia is a useful emotive device for the contemporary designer to attend to. The operation of nostalgia colours our understanding of cultural motifs – and of particular relevance for this thesis, material reminders – and how they are disseminated, remembered and desired. When considered critically, nostalgic references may be introduced in the design process to engage with and challenge our audiences. By employing age-old and contemporary techniques in the production of digital craft, the astute use of nostalgic reference can introduce multiple layers of meaning to design practice.
PRODUCTIVE NOSTALGIA

I propose that a productive tension between past and present can be introduced to digital craft through an exacerbation of nostalgic reference. Through case studies, we will see that designers who employ nostalgic reference and are also conversant with post-digital practice have the skills to reconcile a diverse range of material with contemporary tools, thus oscillating between established and new design methods. To use nostalgia productively, the designer resists perpetuating a direct repetition or cloning of the emotive reference, the ersatz nostalgia we will examine shortly. Instead, the underlying logic of the designer’s own progressive rethinking, or re-systematising of existing techniques and ideas are applied to those that constitute the borrowed nostalgic material.

It has been observed that in the face of historical and technological upheaval, an exacerbation of nostalgia frequently erupts as a kind of retrospective escapism in an effort to resist the ‘threat’ of new and unknown territory. As such, it is helpful to briefly locate one of the more general conditions of contemporary social culture that we are currently said to inhabit. Co-existent with the post-digital milieu, we are presented with the paradigm of globalisation. The negative effect that is argued to be central to this paradigm is an accelerated and disempowering state of international homogeneity. Globalisation is contended to be the consequence of ongoing rapid changes wrought by technological advancement – the result of an internationally voracious appetite for trade and exchange. Though the fallibility of this sweeping claim for global ‘sameness’ can be posited, in such times of apparent blandness and perceived deprivation we can also trace a curious general reaction towards tradition, nostalgic memory and the consumption of nostalgic artefacts: in other words, retrospective escapism.

In such a period of foment, is it possible that nostalgia may be considered productively in the design process? Could we helpfully regard how the methods and tools inherent in post-digital practice may elide with nostalgic references? Could nostalgically charged material engage each designer’s ‘mesh of prejudice’ and as such encourage heterogenous design despite a condition of ‘sameness’ that globalised forces are accused of producing?

Throughout this chapter we will continue to revisit the idea of assemblage – an act of bricolage – as a method to provoke the type of innovation that was discussed in the context of Serres and Latour in the preceding two chapters. Their model of ‘contemporaneity’ rendered through an example of a late-model car is also seen when nostalgic reference is co-opted for use in digital craft. However, rather than simply being ‘a wheel’ or ‘a windscreen’ as in their example of an automobile, in the context of nostalgia these assembled parts can allude quite specifically to their origin. With nostalgia, objects, patterns of behaviour and other resonant cultural ephemera that existed – or that suggest what has existed previously – are critically revisited and re-contextualised in a contemporary manner. What we will discover in observing digital craft as it is read through the mesh of nostalgia is a conjunction of past and present that is rendered contemporary by being combined anew.

In this chapter, case studies of work by the Dutch industrial designer, Hella Jongerius and the British design collective Graphic Thought Facility (GTF) illustrate how this manifests at different scales and in a range of materials.
Work by Jongerius and GTF provide convincing explanations of how nostalgia can be interpreted to produce a dislocation between expected and unfamiliar patterns of use and memory in contemporary design.

The work of Graphic Thought Facility is discussed by way of its signage for “Digitopolis,” a permanent exhibition for the Science Museum, London. This project reveals GTF’s characteristic humanity and ad hocery in the way it finds solutions to design problems. Often the studio cobbles together an amalgam of existing, found and re-interpreted techniques to solve its work. The results are both poetic and pragmatic. Its design agenda is simply, “To craft effective, creative solutions that address commercial needs.” The way in which this is achieved, however, often defies convention or expected results.

Jongerius has a practice that is largely distinguished by instances in which existing archetypes and/or archival material meet contemporary methods for industrial and handmade manufacture. Her work often surprises and renders expected forms ‘new’ by experimenting with pioneering materials and new assemblages of archetypes. Her early polyurethane Pushed Washtub of 1996, which marked her debut as a notable international designer, is one such example. The two projects by Jongerius that we will examine closely in this chapter include “Repeat,” a series of upholstery fabric for Maharam, and her PS Jonsberg vases for IKEA. The projects have been selected to illustrate how digital craft and nostalgia operate across different disciplines and for a range of audiences, both exclusive and general. Necessarily, the projects each required different manufacturing approaches.

**NOSTALGIA IN A GLOBALISED, POST-DIGITAL WORLD**

Coexistent with the post-digital world we have spoken of is the current general conception of the ‘age’ of globalisation. Indeed, many of the swift methods by which information and influences are disseminated, that are argued to have brought about a malaise of globalised ‘sameness’ are made more possible
through digital means. In such an era, we are nudged towards the idea that globalisation is an inevitable form of internationalism defined by the marketplace, and that capitalism is therefore keenly extending across the planet, regardless of physical or economic boundaries. At such a time, the currency of nostalgia could be criticised as outdated, or worse, as failing to relate to the age. I am doubtful as to the idea of the recent ‘arrival’ of globalisation and suggest that its badge is partially contrived as a convenient label. This critique is particularly evident if we consider that global trade and negotiation has occurred far beyond the mostly Western times and methods suggested by globalisation theorists, such as Thomas Friedman. Nevertheless, it is interesting to note Svetlana Boym’s argument that in such an epoch of perceived sameness, nostalgia is not engulfed but is exacerbated. She suggests that the sensibility of nostalgia embeds a utopia for the past, writing: “Nostalgia inevitably reappears as a defense mechanism in a time of accelerated rhythms of life and historical upheavals.” Architecture and design critic, Louise Schouwenberg, makes a similar observation, commenting: “The seemingly unstoppable eradication of cultural differences is a process that elicits fierce counteraction. People all over the world are in search of a specific identity and, not infrequently, seek it in the past.”

How is the impulse towards nostalgia relevant to digital craft? First, it is helpful to understand what the term means in order to accurately reflect on its possible use value. Nostalgia, a term coined in 1688 by the Swiss doctor, Johannes Hofer, has been identified variously as the sentiment of loss and displacement, drawing on its etymological roots from nostos [return home] and algia [longing]. Implicit in this description of the term is an understanding that a person has moved away from what they identify as ‘home’ however problematic and charged the idea of what constitutes a home can be. Hofer identified that in a state of dislocation, the traveller latched on to objects, smells, sounds, food or other rituals that, generally speaking, were formed from a vast array of culturally specific references, often with sensual or haptic properties. In turn, these references rejuvenated an attachment and attention towards the home.

The act of physically moving away from a place indicates an inherent understanding that a passage of time has passed. As such, one’s current vision of the homeland necessarily operates to a greater or lesser extent in a time lag. It follows that in the first instance, nostalgia must be understood as a psychological dislocation from the current pace of life and environment. Boym describes this broadly as “a rebellion against the modern idea of time, the time of history and progress.” A key part of the nostalgic effect then, is that, while being in the present, the sense of another chronometric period is created through the suspension of time in one’s memory. Its status and usefulness for a designer therefore pivots about how this different and possibly ‘rebellious’ use of timing can be employed in a contemporary context and especially how it can be conveyed in physical form.

Rebellion and wan melancholy – an emotional state that has been historically observed of nostalgic sufferers – may seem an unlikely pair of attributes. I propose that it is exactly the recklessness of a designer who can act without sentiment upon nostalgic material that allows for her compelling engagement with nostalgia. The discovery of possibilities for use in nostalgic material can be read as another instance of bricolage. In other words, the nostalgic impulse at
The discovery of possibilities for use in nostalgic material can be read as another instance of *bricolage*. The nostalgic impulse ‘at hand’ is identified and turned to one’s own needs. The wilful meddling with cast archetypal curves of the PS Jonsberg IKEA vases at Jongeriuslab is one instance.

Hand is identified and turned to one’s own needs. Jongerius’s wilful meddling with the immaculately cast archetypal curves of the PS Jonsberg IKEA vases is one instance. By riddling the slip cast vessels that reference the typical proportions of antique vases with holes poked through with a pencil, she confounds the exactitude of industry standards in deference to voicing her own criteria of workmanship. Similarly unsentimental is GTF’s use of old-fashioned electro-luminescent circuitry for the signage of “Digitopolis”. Neither designer consecrates past forms; both seize what is discovered at hand for its agency now.

For all rebellious designers who work with nostalgic material, Walter Benjamin’s comparison between memory and archaeology is a constructive observation, offering guidance as to how we may develop this action. Benjamin writes:

> He who seeks to approach his own buried past must conduct himself like a man digging ... He must not be afraid to return again and again to the same matter ... for the matter itself is only a deposit, a stratum, which yields only to the most meticulous examination what constitutes the real treasure hidden within the earth: the images, severed from all earlier associations, that stand – like precious fragments or torsos in a collector’s gallery – in the prosaic rooms of our later understanding.¹⁰

Like the careful archaeologist, designers who draw on nostalgic ideas and techniques require meticulous and unsentimental discipline in order for their severed fragments to be recognised, well articulated and then re-contextualised in a voice that is appropriate to the contemporary chronometric period. Through this careful critique and reinterpretation, the work has an opportunity to triumphantly weather the criticism of a prosaic audience.

**NOSTALGIA AND HETEROGENY**

In architecture, an example of reworked nostalgia that is framed by the hyperactive lenses of post-modernism,¹¹ offers a clear illustration by which we can begin to understand how nostalgia may be used, albeit with a strong bias.
towards irony. Consider the post-modern pastiche of Charles Moore’s Piazza d’Italia in New Orleans of 1975–79. Individually, its columns, piazza, temple and campanile could be read as elements that refer to traditional bastions of elementary western architectural orders. However, in this project the nostalgia for historical European forms that could have been evoked is mocked by Moore’s orchestrated cacophony. The materiality and finishes he has selected, as well as the vehement formal juxtaposition and alteration in scale, simultaneously allows us to recognise a Doric or Ionic column, for instance, while feeling wry or shocked at his violent reintegration of supposed architectural absolutes. By dislocating traditional symbols of architectural purity, Moore provokes an ironic use of archetype.

Archetype and nostalgia have a shared but distinct relationship to each other and with the past that is important to delineate. The former hinges about the idea that it is primarily an age-old physical prototype, reference or specimen. Whereas nostalgia is an emotional response that may be caused by emotionally engaged subjects when viewing such known forms. In the Piazza d’Italia, archetypal architectural elements are plucked from their particular historical and cultural references and reinterpreted with distortion from their original scale and physical adjacency. Moore consequently creates an uncomfortable and clashing drama of Italian architectural elements.

Though Moore’s cynical expression brashly declares his dis-ease with architecture’s future the Piazza d’Italia is a catalytic example of reworked nostalgia. It represents how a designer may wilfully misconstrue ‘original’ references through altered content, context and scale to a pronounced effect. This awareness is particularly resonant for current architecture and design in response to the perceived face of globalised, capitalist blandness. We can also read parallels between Moore’s method of ‘haphazardly’ incorporating nostalgic reference and Rowe and Koetter’s preference for the unpredictability of bricolage that they promoted in Collage City. Though their proposals are distinct, these architects share an ambition towards heterogeneity and difference in a ‘post-modern’ climate that was to resist modernist homogeneity.

ERSATZ NOSTALGIA
In contrast with the highly cynical reinterpretation of archetype, which in Moore’s instance almost approaches a sort of neurosis about architecture’s future, an uncritical use of nostalgia leads toward a dangerously idealised historical path. When the present seems unsatisfactory, it is easy to elide nostalgia with misty-eyed romanticism, giving rise to the poor reputation that this emotional response commonly holds. Among others, Svetlana Boym and Louise Schouwenberg have pointed out that retrospective escapism appears to be especially alluring in a society that increasingly prioritises efficiency and technological progress for greater financial gain. There seem to be two main ways in which idealised historicism manifests in architecture and design. The first is through a simple repetition and continuation of age-old techniques such as roof thatching for instance. The second, and more insidious in my view, is the co-opting of nostalgic effect to satisfy a banal, populist and often commercially driven production of what Arjun Appadurai terms ‘ersatz nostalgia’. That is, the production of faux historical objects with a patina of olde worlde charm that is neither the emulated object itself nor considerate of how such charms could
be incorporated to be appropriate to a contemporary audience. Both Appadurai and Fredric Jameson are damning of this propensity to opportunistically recite past forms. The seemingly inexhaustible greed for ‘nostalgia’ that frequently ensues, motivated in part by mass merchandising and advertising, is the most damaging to the reputation of nostalgia and its positive reference for productive and contemporary use.

CRAFT AND ERSATZ NOSTALGIA

The idea of retrospective escapism that is fed by the consumption of ersatz nostalgia occupies a relationship to craft that is important to clarify here. What distinction can we make between ersatz nostalgia and craft if both are methods by which traditional forms or motifs are reproduced and thus conjure up a gilded memory of times past? As clarified by my discussion in the first chapter on what distinguishes craft, there is a general consensus that the repetition of a technique to skilfully produce form is an established expression of mastery and craft. The late Professor of Furniture at the Royal College of Art, David Pye, discussed this notion in terms of a Workmanship of Risk and a Workmanship of Certainty. This idea is a useful way to distinguish between the two, particularly when critiquing ersatz nostalgia. Pye writes:

I shall say as a first approximation that [craftsmanship] means simply workmanship using any kind of technique or apparatus, in which the quality of the result is not predetermined, but depends on the judgement, dexterity and care which the maker exercises as he works. The essential idea is that the quality of the result is continually at risk during the process of making ... The techniques to which the workmanship of certainty can be economically applied are not nearly so diverse as those used by the workmanship of risk ... The most typical and familiar example of the workmanship of risk is writing with a pen, and of the workmanship of certainty, modern printing.

Pye is suggesting that the idea of craft is integrally related to the amount of risk a maker must take as he works. Great risk creates the opportunity for great failure, while full automation – though potentially diversely undertaken – contrasts this fallibility for its workmanship of certainty. When producing objects for financially predictable results, certainty is almost always favoured.

Usually, what we will find is that ersatz nostalgia is a cheap pastiche of historical forms or pattern that are repeatedly and predictably produced by efficient mass-production methods; Pye’s Workmanship of Certainty. Ersatz nostalgia most often recites closely copied forms and this is unlike traditional techniques of making where an exact repetition of form does not usually occur due to the ‘risk’ involved in its making. Objects produced by craft often carry risk and uncertainty, particularly if they are prototypes. Consequently, these risks can be costly and unpredictable, and therefore not stable enough to economically sustain demands of the mass market. The lineages of noun-based craft also tend to reveal how the practice of a technique leads to alteration and innovation in form and practise. This is, of course, dependent on the craftsperson’s intent and confidence. However, it is clear that ersatz nostalgia seeks to repeatedly emulate an idealised form, rather than witness its gradual transformation through the practise of making – or crafting.
In a similar way, innovative design practice is constantly questioning and altering intent to produce a lineage of skilful design discoveries. Again, recall the example of innovation posited by Serres and Latour. In the current climate of efficiency, a question to consider regarding crafted practice when employing nostalgic reference is: ‘How can ‘inefficient’ or slower capacities of old-fashioned processes conjoin productively with contemporary production methods?’ In other words, ‘How can repetition and certainty be reconciled with nostalgia through digital craft?’

TIME PASSING AND THE RELATIVE PERMANENCE OF OBJECTS

The ability for designers to shift between techniques of earlier origins and the ‘now’ is potent because it can both engage with and provoke the audience. In part, this potency draws on the charged reaction of humankind towards the passing of time. We know that an awareness of time having passed is an inherent construction of nostalgic effect. However, the passing of time – and the human reaction to this inevitability – will always be a problematic relationship. Sylviane Agacinski identifies this philosophical dilemma, writing:

According to a long tradition – from which it is difficult to break – the passing [of time] has been conceived as the negation of the eternal and thus of being. From its beginning, philosophy has identified being with permanence, timelessness, whereas the passing, the ephemeral, is cast out into nonbeing and stripped of all value.

In many cases, as illustrated by the collectable nature of antiques, the fleeting permanence of time represented by the scarcity of a building type or a once-common object accumulates value for its absence and increasing rarity. Agacinski’s explanation of time and being offers an interesting problem for the contemporary designer working with nostalgia. How can something nostalgic – ephemeral, lost and displaced – be usefully employed in an environment that is also one in which, as architects and designers, we are usually compelled to bring new objects into being? How may the designer create things of relative permanence in a post-digital world whilst retaining the intrigue that the absent nostalgic reference originally incited?

Our post-digital environment operates with a reliance on machines and processes that are controlled by weightless bits to produce smooth, seamless and often invisible exchanges. It is riddled with a litany of wireless connections, self-regulating feedback loops, solar intelligence, responsive electric impulses and numerous other sophisticated systems that are frequently disguised beneath sleek unspeaking surfaces. By comparison, earlier objects usually communicated their use in a decipherable way through their carapace. So we can say that essentially, the increasingly reduced size of objects generated by modern technology contrasts with earlier artifacts, which obeyed an intuitive relationship between the size of the object and the complexity of its task.

It is clear that the processes of digital design highlight an attention to and greater display capability of surfaces. Therefore it could be argued that objects revealing fragments of processes by which extinct or rare systems used to work – conjuring up recollections of the past, or the nostalgic impulse – occupy a unique position in post-digital practice.
“Digitopolis” was a permanent exhibition at the Science Museum from 2000–2006. Designed by Graphic Thought Facility, it invited visitors to question ways in which new technologies were entering and changing our experiences of the contemporary world.

GRAPHIC THOUGHT FACILITY: “DIGITOPOLIS”
Though Agacinski describes the ephemeral and outdated as occupying a marginalised position, Huw Morgan, a director of Graphic Thought Facility, has observed a great deal of human intrigue in the process of how things are made and how they perform behind the scenes. Morgan’s impression has been accumulated over his years of practice, and he suggests that many of us have a voyeuristic desire to understand how things operate or are made. He comments: “People are all a bit interested in peering into that process. It probably goes back to watching Playschool, and seeing how milk bottles are made, which is much more interesting that just the milk bottle itself.”

As designers operating astutely within this economy, the “cast-off” edge conditions that look behind the scenes of outdated processes can invigorate and lend personality to new objects. To avoid mere replication of a type of ersatz nostalgia, this curiosity is most distinctive when paired with contemporary and efficient methods of producing and communicating designs. The work of Graphic Thought Facility exemplifies a knowing incorporation of techniques – nostalgic and otherwise. The studio is motivated by a desire to adopt production processes that are most appropriate to the task at hand, whether this invites new or old technologies. Most often, it requires a combination of both.

“Digitopolis” proves an instructive case study of how GTF drew on rejectamenta of the past to clearly evoke an idea that was relevant to the present. Equally, the materiality of the project creates a visual allusion to broader references, in this case the idea of “technology”. “Digitopolis” was a permanent exhibition at the Science Museum from 2000–2006 that invited visitors to question the ways in which new technologies were entering and changing our experience of the world.

The exhibition was housed in a darkened space and the signage was required to be illuminated in some way. As well as inherently incorporating a system for illumination, GTF wanted to respond to its commission for designing the
Electro-luminescent lamps are hardly new technology. Early in the twentieth century, electro-luminescent ‘sandwiches’ of conductors, insulators and phosphors were discovered to result in an efficient and long-lasting form of emissive display. This knowledge was refined for viable commercial use in the 1980s and typically the flexible, thin circuit panels provide lighted surfaces that are used in electric clock faces and on cover panels for electric switches. What GTF realised is that unlike an incandescent lamp with its filament, the panels are robust light tracers because there are no fragile mechanical parts to break. The panels are slim and light and the area to be illuminated can be precisely controlled by where the phosphor is printed. Also, they last a great deal longer and are more efficient power sources than fluorescent or incandescent lights.

It became clear that electro-luminescent lamps best answered the brief for an enduring, light, durable, colourful and graphically controllable light source. The fact that the panels looked a bit ‘eighties’ and ‘chunky’ compared with newer electronic discoveries also reinforced an obvious imaginative link to robots, technology, watches or radio alarm clocks. Therefore, in being old-fashioned, the panels provided visitors with a familiar visual analogy to technology. Once it had found its medium, GTF then proceeded to stylise and refine typography that worked with the necessary circuitry of the panels. The labyrinthine circuit creating the font is a kind of techno-cursive script; the alternating currents embedded in the script on each panel further prolonged the lifespan.

Because GTF looked beyond usual or ‘new’ solutions to the graphic problem, and it widely considered possible material resources, it found a punchy graphic solution that was economic and sustained the prolonged demand for circuitry in a permanent exhibition. Simply, the “Digitopolis” signage is a series of panels of electro-luminescent circuitry that is coded with graphic information, instead of following its usual application as a solid light source. Here, Latour and Serres’s idea reappears: the newly assembled lamps are an innovative solution derived from established technology. What we recognise through GTF’s amalgam or assemblage is proof that if we can “uncouple nostalgia from conservatism” it no longer warrants it’s bad name.
HELLA JONGERIUS: EMPLOYING NOSTALGIA

In a similarly inventive way to GTF’s re-incorporation of known materials, Hella Jongerius is also inspired by archetypes, objects that are known and familiar. From a point of familiarity, Rotterdam-based Jongerius communicates heterogenous notions of place and time through her industrial designs. She seeks to make unique pieces from industrial processes and her signature is often conveyed in a humble manner. Her design process is regularly informed by information that is particular to a company, such as its archival knowledge or established production methods. The extensive history of useful archetypal objects also informs her work. The breadth of these many sources are usually incorporated by her into new materials or techniques that firmly address a contemporary brief. We will see that when reappropriated and developed, the use of nostalgic reference actively contributes to Jongerius’s design process and her particular ‘voice’.

In her design of the “Repeat” upholstery fabric series for Maharam this is certainly the case: the textiles repeat pattern, tradition and material process. However, she plucks these references from one context, re-scales them, and re-combines them unexpectedly. Commissioned by New York-based textiles producer, Maharam – a company that produces high-end fabric for astute, design-focused customers – “Repeat” exemplifies Jongerius’s design method where old and new are deftly woven together. In this instance it is a literal warp and weft that meet to form a commercially successful ranges of upholstery textiles, called Classics and Dot. When designing “Repeat” she drew on remnants and knowledge of the extensive archive of a Swiss textile mill that once produced silk fabric for ties. After poring through the archives, four main patterns were chosen: a classic stripe, a hounds-tooth, a floral motif and a bird. Jongerius also drew out scribbles of technical data, such as colour instructions and material choices, that were previously used to instruct the weaving process.

While less esoteric designers may have regarded this suite of material as tired or irrelevant, for Jongerius, historic material holds a saturation of references to specific contexts and moments. As Boym reminds us, moments in history can provoke time travel in our minds: the remembrance of places and things past thus allowing a nostalgic moment to resurface. What Jongerius particularly likes about drawing on archetype and useful objects is that it offers people a place of familiarity from which she then distorts and articulates her own language. She describes her working practice thus:

The archetypical is something that becomes a personal dialogue ... a blank sheet that you can make your own, and put your own language on, and that, for me, is one of the main reasons why I use archetypes. Not because I want to deal with history so much, but because often after I’ve chosen the archetype/s, I do strange things with it or I take things away. If you do that on a very strange new form people won’t recognize it anymore ... you have to give them some familiarity before you take it into a different material or scale or whatever.\(^{23}\)

In other words, by thoughtfully critiquing the familiarity of preceding objects there is the possibility that we’re able to unite accessibility of memory with renewed, progressive contemporary design logic. In the “Repeat” series this is
What is especially compelling about “Repeat” is the unusually long pattern repeats. Instead of the usual one or two-metre-long repeat, Dot and Classic are not less than three metres long. Therefore, each chair, ottoman, sofa and so on can be read as a family of pieces that are similar but effectively ‘one off’.

found in the dislocation between expected scales and colour-ways of the classic patterns and the unfamiliar adjacency between motifs. In Classic, for example, we see super-sized patterns of a hounds-tooth loom in lurid hues, or a flock of geese flying linearly across the top of the fabric roll, while piercing white script scrawls super-sized instruction over restrained classic stripes and swirling vines.

The recombination of original forms is ‘new’, but what is especially compelling about this series is the way that Jongerius draws all these familiar yet distorted references into an unusually long repeat of fabric. Instead of the more usual one to two metre pattern repeat, “Repeat” is not less than three metres long. Normally, people expect to select ‘matching’ sets of furniture, but instead, because the repeat rate is extended, each chair, ottoman, sofa and so on can be read as a family of pieces that are similar but not identical. Each is rendered ‘unique’ as a consequence. As a result, the final products can be read as one-off pieces – with all the exclusivities of aura this encourages – as well as being a successful, mass-produced commercial product. This engages with a contradiction that Jongerius is highly aware of. Instead of denying one or other condition, she actively engages both, commenting: “I like the industrial process; art can’t compete with the scale industry works on. The commission I had from Maharam brought all these issues together nicely … the design work and the large-scale execution met with the demand for commercialism.”

PS JONSBERG
The desire to oscillate between the singular and multiple, while drawing on established references and mass-production methods, is also seen in her PS Jonsberg range of vases for IKEA. For this project she designed four vase types in a series of 100,000 for the low-budget Swedish homeware retailer. The vases have an identical shape that recall an archetypal vase or water vessel but were treated with four distinct ceramic techniques, resulting in inherently different appearances. Nevertheless, all were individually made by hand in an industrial Chinese factory. In the context of nostalgia, what is significant about
PS Jonsberg is the fusion Jongerius desired between an archetype that would recall established objects of certain places and times, and mass production. As with most of her work, her driving ambition for this project was, “To give every object a personal touch, by applying small modifications, or including deliberate imperfections.” The ‘imperfect’ result is important to her work. It allows for randomness, which she feels imparts a “personal touch to the industrial process.” It also allows her to sidestep traditional boundaries – of pattern, of use and of production methods.

An example of how she introduced this irregularity in the PS Jonsberg vases occurred at the Chinese factory. Jongerius was not confident that her ‘voice’ would be translated accurately by proxy. “I knew if I sent the drawing [to them] it would end up looking so perfect that I wouldn’t recognise my own writing,” she admitted. Accordingly, she travelled to the factory and ‘wrote’ her own work in acts such as the asymmetric holes she punctured with pencils into the fluid ceramic body mould. The factory owners were initially aghast at her ‘destroying’ the vase mould, but for Jongerius, this intervention allowed her to answer her key question of whether she could retain her own style in such a large edition.

In order to achieve its prized imperfection, her company, Jongeriuslab, draws on inclusive design methods. Jongerius describes that at the beginning of a project, detailed aspects are considered and then, “The team starts to draw, make pictures, take new photos, put them in the computer; work on it in the computer, make [physical] models again ... And then we go back to the computer; we flip and flop, hand making and the computer and that’s the way [our] products are developed and designed.” As we have seen with other working methods of designers in the case studies, such as Thomas Heatherwick, this oscillation back and forth between digital and physical allows a personal language to be developed. Equally, through digitisation, Jongeriuslab can more easily communicate with the wide variety of people involved in producing the work.

CONCLUSION
What both GTF and Jongerius’s work illustrates is a use of nostalgia that effectively circumvents Jameson’s critique of reconstituted matter as a sort of ‘mush of simulacra’. Both GTF and Jongerius selectively revisit material that is saturated with past references – the electro-luminescent panels or established weaving card patterns for example – and combine them anew. Their meshes of prejudice rule out the simple reproduction of found items. Rather, the intrigue of the original technique or found matter is united with a set of clear, contemporary questions it must answer. Neither GTF nor Jongerius is overly sentimental, but they recognise that there is efficacy to be found in drawing on existing material for answers that connect with the imagination of its audience.

Their careful incorporation of existing material embeds codes and signifiers in the work to activate a nostalgic awareness. This is similar to Saussure’s layered language of signs we considered in the preceding chapter, Bricolage. The case studies in this chapter exemplify how familiar, found and selected materials are called on to methodically make the layered connections relate in unexpected and therefore innovative ways. Once again, Serres and Latour’s observation that recombination creates anew is apparent.
Like *bricolage*, astute nostalgic references in architecture and design gesture to previous methods of production as well as lending themselves to the swift tools of mass production. The advantage of actively working with nostalgia and taking the reference beyond its expected stereotype is that a taut oscillation between the two may be created. A charged space exists when negotiating original references that comment on how things were made and how things may currently, differently, manifest. Deciding on useful physical negotiations and alterations between the two is what creates an energetic nostalgia that is dynamic and useful to the contemporary designer, rather than what I describe as the concept of a ‘nostalgia of inertia’.

In case studies of nostalgia and *bricolage*, there are clearly overlaps between the surface appearance of a form and what these patterns or motifs of form communicate. For example, think of Jongerius’s “Repeat” series or the golden cupola of Minifie Nixon’s AWHC. In the following chapter, Pattern, we will discover two central methods by which designers can also oscillate between known methods/motifs of pattern and new manifestations that a different approach to pattern may unlock. We will consider two main modes in which pattern can be used: as a tool that inherently organises and supports *structure*, and as a surface pattern that communicates through its *skin*. In relation to the latter mode, we will also briefly examine changed patterns of *use* from original forms that were developed for a different cultural audience.

The final chapter in this thesis continues to argue for an inclusive use of digital craft that is wrought through careful and selective re-combination of found material. As we have considered for *bricolage* and nostalgia, let us now turn our attention to two case studies that illustrate how pattern can provide an energetic catalyst for digital craft in a post-digital context.
Endnotes


2 The idea of a single identifiable epoch is difficult to reconcile with the fluidity of time, which is always passing and is experienced in multiple ways. Therefore, when epochs or eras are defined, they necessarily require us to participate in an overview that is organised according to a unique direction or a single meaning at the expense of addressing the continuous, contiguous, and different temporalities that are actually occurring simultaneously. Sylviane Agacinski elaborates on how the construction of an epoch relies on certain assumptions that must be made and the impact of this on our understanding of “being in time” in her essay “The Retreat of the Eternal” in *Time Passing: Modernity and Nostalgia*. New York: Columbia University Press. 2003, pp. 15–46.


4 Paul James spoke of this general perception of globalisation (a position he disputes) in his lecture the Theoretical Frameworks seminar entitled “Globalisation”. Presented May 2006. School of Architecture and Design, RMIT University, Australia.

5 For example, refer to the argument for late-modern globalisation posited by Friedman in *The World is Flat: A Brief History of the Twenty-First Century*. 2005. See also my debate of this generic idea in a review of the British Council’s travelling show “My World: the New Subjectivity” in *Craft Culture* Issue Twelve, pp. 14–46.


8 Anecdotal evidence in migrant case studies suggest that those who have left their country of origin often faithfully retain references to their homeland even after a significant period of time. Commonly, their way of life, décor or culinary practices, for example, are discovered to be more authentic (and possibly ‘backward’) to their original ‘homeland’ in comparison with those who have resided in that homeland throughout the same period of time and have gradually altered/updated their behaviours, environment and patterns of daily life.

9 Boy, Svetlana. Op cit. p.XV.


13 Professor Leora Auslander discusses the appearance or popularity of objects that provoked nostalgia in the context of the Jewish avant-garde in 1930s Germany. Auslander discovered that although there was a definite cultural move towards the contemporary Modern movement, especially in the collection of art, much of the material substance in renowned Jewish collectors’ homes almost exclusively remained filled with traditional furnishings, dining ware etc. See this discussion in “Beyond Words” at http://www.historycooperative.org/journals/ahr/110.4/auslander.html. From *The American Historical Review* vol. 110, Issue 4. Accessed 11 November 2008. Refer also to Romy Golan’s discussion on the resurgence of nostalgic impulse in France during the inter-war period. Golan elaborates on the crisis of confidence after WWI that initiated a period of cultural, political and economic reorientation that was then reflected in its self-image as a rural, feminine, feudal nation. See *Modernity and Nostalgia: Art and


16 It is ironic and yet prophetic that ersatz nostalgia is proliferated all the more widely through the agency of digitally dispersed media. The effect of coaxing customers to wish for something that they actually never lost is symptomatic of the greatly confused mêlée of consumption expressed by much of contemporary Western society.


18 In Agacinski’s opinion, the ultimate passing of time – death – has two possible responses. These are to reside in melancholy and thus to withdraw from present times, or, to love finite beings or things intensely in reaction to the hopelessness of their perpetuity. I suggest that these reactions are the extremes of the spectrum, along which we usually exist somewhere between mourning and abandon. See Agacinski, Sylviane. Op cit. pp. 13–15.

19 Ibid. p. 13.

20 These surfaces are often rendered in the cool universal logic of refined forms that we could identify as the language of blobs or folds that have come to characterise early digital computer design. However, the ensuing complexities of how these skins may be ‘thickened’ to allow inhabitation, yet to be fully realised at an architectural scale though Kolarevic gestures to it in his notion of a master builder, or to house miniaturised electronic components is a development that John Maeda has termed ‘dynamic form’. See John Maeda. 2000. *Maeda @ Media*. London: Thames and Hudson Ltd. pp. 24–25.


24 Ibid.


26 Ibid.


28 Ibid.
Pattern occupies a crucial role in craft and digital methods. Though pattern encompasses an extremely broad field of research, in this chapter it is considered in two main ways: first, as an active organising principle by which design decisions can be made. Second, for its traditional role in decorative art and craft where codification, history and hierarchies are communicated through surface pattern. Thus pattern here encompasses both *structure* and *surface*.
DECORATIVE AND GENERATIVE PATTERN

We can consider pattern to be a method by which designers can organise and compose varied sequences and materials of a design. As illustrated in the earlier chapter on Bricolage, Minifie Nixon’s Australian Wildlife Health Centre for example, uses the brick skin as both a decorative pattern and as a generative design strategy developed from the analysis of biological behaviours of birds in flight. Similarly, as we saw in the preceding chapter on Nostalgia, the relationship between nostalgia and pattern offers many potential layers that can anchor a design in both a contemporary context while provoking links to stories or memories at a chronological point of remove. In part, Hella Jongerius’s work is interesting because it relies on her wilful and sophisticated use of pattern. She coerces objects for nostalgic effect while questioning the wholesale consumption of ersatz nostalgia.

When observing everyday endeavours of making, and in the formation and properties of natural materials, it is clear that we can consider pattern to be an active organising principle or tool for organising and forming designs. For example, the steps by which a basket weaver would select appropriate weights and lengths of cane to structure and form a woven volume illustrates how this structural patterning may occur. Another instance is a bricklayer who uses particular techniques that concern the physical logic of a particular material (brick) that is being worked when accreting a brick wall. These simple examples begin to introduce a key concept of this chapter: that we can inherently understand pattern as a methodical way to organise and assemble materials.

The traditional methods of making structures with pattern that I have just described are also shared with digitally wrought designs. In the digital realm, the use of pattern as a tool can be seen in operations such as CADCAM cutting-sheet instructions, also known as ‘nesting’. This relatively recent extension of digital tooling arranges constituent parts of a design on a physical plane in the most economical order for cutting. In this type of pattern use, Mies van der Rohe’s sober maxim, Less is More, dovetails with the financial advantage of thrifty material usage. Works such as NOX’s Son-O-House which we examined in the first chapter rely on this careful logic and economic instruction to physically arrange the separate pieces of an elaborate digital design.

In this chapter, the case study of Minifie Nixon’s Centre For Ideas at the Victorian College of the Arts in Melbourne will illustrate how pattern offers the designer structure and tools for organising a design digitally. For those working with the limits of atoms, such as the bricklayer or weaver mentioned above, a knowledge of how the atoms can best be arranged to avoid an irrevocable end point of destruction or imbalance is important. Similarly, a digital crafts person must be astute to the differences and opportunities available when using complex digital arrangements, such as the distinction between polygons and NURBS [non-uniform rational B-splines]. As we know, the process for reversal and rearrangement is infinite in the digital process. What is common to all these approaches is that underlying patterns inherently relate to how the logic of a particular material will behave. There is a distinct hierarchy as to how compositions are formed and what structural logic they will best follow – and how this may be judiciously interrupted.

Pattern can be considered as an active organising principle or tool for forming designs. For example, basket weaving, brick laying and CADCAM cutting sheets all utilise pattern to structure how a material will be worked.
However, we can also observe that the vast opportunity of digital methods allows the designer to stretch or distort the normal logic of materials. For example, in digital architecture we often see instances such as floor plates that appear to be taut membranes, or bridges and walls that exhibit such thinness that it undermines the convincing relevance of these pioneering design techniques to limits of physical materials and forces.

We touched on the burgeoning relationship between emergence and pattern in Digital Craft. Though I do not have the liberty to speak explicitly to these developing design explorations in the relatively concise bounds of this thesis, it is interesting to consider that the established history of pattern books reveal similarly informative and 'step wise' measures by which designs were tested and refined. This is especially the case for sample books from textile mills where changes to the alchemy of pigments for hue saturation, scales of patterns and popular taste are recorded in patterns of a particular era. So too, can we find 'step wise' and transportable instructions for the use and application of architectural pattern in canonical guides, such as Owen Jones’s *Grammar of Ornament* (1868). In other words, the role of pattern as a method by which design decisions are tested, dictated, rebelled against and advanced has a substantial history and continues to affect design decisions. Through pattern we can often describe and identify the location, era and context of a particular design. Where, how and by whom was the design crafted? In this way, we are reminded of Paul James’s positive outlook for globalisation where multiple layers and conjunctions – patterns of use, tradition, locality and so forth – occur and may be disseminated universally.

In this regard, pattern can provide close associations and provoke a particular memory or act as an *aide memoir* of a certain era or place. As such, pattern often constitutes an important part of generating nostalgic references. The previous chapter on Nostalgia illustrated how contemporary work by GTF and Hella Jongerius operates in this way, avoiding direct repetition by employing...
knowing and ironic alterations to traditional motifs and materials. As illustrated, Jongerius’s “Repeat” series is an accumulation of text, geometric forms and motifs in the fabric that act in several ways: they provide a decorative patterned surface, they recall earlier hole-punch production methods for weaving and they refer to distinctive emblems of the Swiss textile mill. They also announce Jongerius’s distinctive design authorship by the recombination across the textile surface of fragmentary references she has found and considered worthy of use. The multi-layered surface pattern with its re-scaled and heterogenous stories, or petit recit of past and present, commingle across the swathes of fabric.

Parallels between bricolage and pattern can be read in the work of practitioners such as Minifie Nixon’s Australian Wildlife Health Centre with its exploration of the brick skin and vinyl Costa vortices of the central cupola. In a real-scale expression of techne trouve that is at once decorative and functional, the somewhat unpredictable shapes and patterns that cloak and embed the project are achieved by exploiting the associative properties of computerised ‘flocking’ agents that follow rules borrowed from cellular automaton code. These influences colour the variegated brick façade while the parameters of the minimal, taut Costa surface create the framework for the cupola. In this chapter we will discover how Minifie Nixon’s façade of the Centre For Ideas (CFI) at the Victorian Centre for the Arts in Melbourne (2001) appropriates the geometric diagram of Voronoi cell theory. In this project, rigorous computerised processes were followed and the Voronoi was a central organising design principle. Its predictable pattern structure was used to reconcile technical instruction and economical material usage to create a distinctive façade.

At the more intimate scale of work by the London-based design office, Doshi Levien, we will also consider the role of pattern and its opportunity to encourage an overlap between ‘old’ and ‘new’ design motifs and production methods. Its Indo-Anglo directors, Nipa Doshi and Jonathan Levien, extract and abstract patterns that are ornamental and social from familiar and remembered cultural contexts. These associations are then re-contextualised in contemporary objects that carry new patterns physically and that also reinterpret the original patterns of use. Here, we find a third description of pattern – that is, where an existing or found intention of an object is reinterpreted for a different audience. There are clear parallels between the altered ‘pattern of use’ and the work of a bricoleur: both take and wilfully apply elements from found materials to solve
problems in different contexts. Again, following Serres and Latour’s argument, we can expand on this idea of reworking existing combinations to understand that a changed pattern of use is also a method to create anew.

Altering patterns of use is an idea that is especially relevant to Doshi Levien’s design office because it is always operating between Western and Eastern memories and audiences. Consequently, the office is continually adopting and adapting objects that, while remarkably different, are integral to each audience’s diverse habits of life. In the case study of Doshi Levien’s work, the surface patterns mentioned above conjoin with ‘patterns of use’ as primary concerns. Its “Charpoy” furniture series for Moroso encompasses elements that differ in their scale and production methods but are equally helpful in illustrating how complex superimpositions of pattern – surface and use – are achieved in its work.

COMPOSING LOGIC: PATTERN AS ORGANISING PRINCIPLE
Extending on what we have discovered about innovation in the preceding chapters on Bricolage and Nostalgia, the most convincing examples of digital craft in Pattern also engage with heterogeneous references in newly assembled ways. Pattern can be a distinctive surface by which the designer’s logic and preference for particular ornamentation can flourish. It can simultaneously be a useful and active tool by which design considerations such as the structural logic, proportion of panels or methods of production are instructed.

The often multi-layered use of specific geometric diagrams or patterns, such as Reynolds’s diagrams (which describe avian flocking behaviour) or tessellations (such as Voronoi cell theory) in architecture are also used for solving pragmatic concerns in everyday situations. Contingent spatial relationships that are present in primary physical experiences, such as how mud cracks, illustrate a primary instance of an emergent pattern. As we have discussed, they’re a current fascination that is used to analyse and solve questions of adjacency in architecture. However, it is not only in architecture that these ‘bottom-up’ strategies are observed and co-opted to make sophisticated technological choices. The placement of mobile telephone transmitter towers or the positioning of 7-11 stores in a city are examples where the known pattern and behaviour of a tessellation is used to decide on proximate locations of services. E H Gombrich suggests it is highly likely that our exposure to fundamental experiences in our physical environment, such as cracked mud, help us engage with this fundamental ideology when it is applied to architecture and design.

STRUCTURING PATTERN: MINIFIE NIXON
For Minifie Nixon, the property of repetition in patterns, especially those organised by mathematical or geometric equations, becomes an instructive design tool. In this sense, Minifie Nixon considers pattern to be advantageous because one part of a pattern ‘equation’ relates to another part: it sits in an identifiable, repeatable, spatial relationship. When experimenting with the pattern of the brick façade at the AWHC, for example, Minifie recalls how the composition hinged on finding a balance between the physical proportions and structural integrity of the brick and the skinlike pattern.

In this instance, the relation between pattern and structure concerned how the
particular masonry unit size could best be manipulated for visual effect while also behaving as an external wall. Minifie comments:

With an image, there’s a sort of magic point beyond which if you distort it too much it becomes unrecognisable. The kind of neurological magic that happens at that point can be explained and you can use that kind of criteria when dealing with abstract systems … If you go too high [have too many converging ‘birds’ in a ‘flock’ or bricks in a wall, for example] it becomes boring; it’s most interesting somewhere just above that threshold. Again, I guess it’s to do with elegance; having fewer means it’s less revealing about what’s going on. So [for the AWHC] the brick size was a crucial limitation and the resulting sort of granularity of the pattern was another part of the compositional decision.⁶

We can see that there are actually at least two analyses and consequent applications occurring in this example. There is the originating question of emergent biological behaviour borrowed from Reynolds by Minifie Nixon: How do flocks of birds interact with each other? By what logic do they relate to each other? Then, once these answers have been addressed and explained the architect has identified the inherent capabilities that an emergent relation will allow in the design. For the AWHC, the applied design question was: How can the known equation of flocking be used to negotiate between openings in the brick façade, obeying the physical limits of the bricks while also approximating an image of an animal’s skin?

IDEAL CENTRES: MINIFIE NIXON’S CENTRE FOR IDEAS
Let us now consider how the structural and compositional “elegance” generated with digital tools is co-opted as an organising design principle in Minifie Nixon’s Centre For Ideas (CFI). The project draws heavily on the properties of Voronoi cell theory for its façade arrangement. It provides us with a useful instance of digitally crafted architecture because established geometric principles unique
In Voronoi cells, there is a knowable critical angle by which granular material stabilises into a conical shape and is measurable (below). Voronoi solutions underpin Minifie Nixon’s design approach for the Centre For Ideas facade (opposite).

to Voronoi cells are systematically used as its fundamental design diagram. As distinct to the problematic relationship or conflation between computer techniques and representation in design that we considered earlier in Digital Craft and Bricolage, the CFI offers an intersection between the use of techne trouve and the resolution of built fabric. The found technique (Voronoi cell) is conjoined with architectural considerations (difficult site, minimal budget, encroaching existing buildings, efficient manufacture) to engage the techne trouve at a functional level. As we considered in Bricolage, this functional distinction is paramount. Minifie emphasises this relation commenting: “One of the important properties for this appropriation to work is that, in some way, the technique that you’re using [techne trouve] must actually be functional in some sense. It’s not [about] applying an impressionistic, representational description but it must actually be present in its use.”

WHAT IS A VORONOIJ

As highlighted and developed by the British sculptor, Jonathan Callan, what is particular to Voronoi cells is that they illustrate the behaviour of “the foamlike distribution of matter in the universe.” In other words, there is a knowable critical angle by which granular material stabilises into a conical shape and the relationship between cones is also predictable. When accreted, the conical Voronoi cells form a quantifiable, stable plane and this arrangement determines the shape of many naturally occurring phenomena, including constellations and sand dunes. These properties mean that the Voronoi solution is especially useful when applied to an architectural computing technique as it can be interpreted in a multitude of ways and it can also be accurately measured. How neighbouring solids meet, for example, can be solved with hundreds of variations simply by reorganising where the central ‘holes’ or points of convergence occur. For the CFI these points of convergence were decided on the basis of necessary apertures for light into the building as well as the more subjective favoured configuration, where over-sized reflective ‘buttons’ mark converging points of glazing to gain a ‘balanced’ composition.

While this subjectivity in arrangement invites critique of the ‘absolute’ functional role of computation insisted on by Minifie, the project is nevertheless distinct from the commonly accepted bloated, curvy forms derived from much digital architectural design. The stable, calculable parameters found in surface relations between Voronoi cells helps to avoid one of the problems found in
much computer-based work. That is, the enormous amount of effort required to construct such irregular forms. Blob architecture, as digital architecture continues to be colloquially referred to, could be described as inelegant and poorly crafted because it often involves a clumsy approach to resolving such design concerns. These concerns include how to represent it, how to build them and how to absolve the usual material wastage required to construct them. Of this wastage, Minifie comments:

The relationship between the idea and the materialisation [of blobs] required such effort that it seemed like because it required so much work to get there, it failed the elegance test. The other problem … is that with a double-curved surface there seemed to be no easy way of judging what was good or poor because essentially they’re all the same.11

In reaction to this inefficient sameness – the globalised architectural blob – Minifie Nixon was interested in discovering a unity between construction logic, materials and technical expression through computational methods. In this way, we can read parallels between its approach and those of progressive methods of craft. Both Minifie Nixon and rebellious ‘craftspeople’ – such as the designers GTF and Jongerius discussed in Nostalgia – desire to progress beyond the stable, accepted techniques of their discipline. Most often they instead radically re-think a part of the general conception to create innovative form. Here again, Latour and Serres’s model of assembling part of an equation anew for innovation arises. For Minifie Nixon, the idea of digital architecture being completed by an almost mythical craftsman (recall Kolarevic’s universal fabricator who merely needs to press ‘print’ and an entire building is manifest) seemed to eradicate one of the most interesting tensions of the discipline. The practice is most interested in engaging with digital architecture in terms of discovery and finessing of relationships between material, thought and form by drawing on techniques of rigorous discovery that the computer excels at.

BEHIND THE FACADE
The creation of the Centre For Ideas façade illustrates how “architectural unity”12 manifests for Minifie Nixon. The ability to create volume from facets of flat sheets seemed an “appropriate and elegant strategy”13 for the façade. It was a method that was at once three-dimensional and materially discrete. Voronoi theory offered the tool by which a diverse structural pattern could be created because the variable cells of conical, single curvatures could be resolved in two dimensions. As a result, the complex, three-dimensional façade was simply ‘unrolled’ and is composed of many flat facets of metallic panels.
CRAFTING THE VORONOI
It is instructive that an ostentatious precursor to the Centre For Ideas can be seen in the garish, lizard-like Voronoi scales writ large and small at RMIT University’s Storey Hall, completed six years earlier by Ashton Raggat McDougall (ARM). Although each project expresses the Voronoi technique differently, Storey Hall’s essay in Voronoi gymnastics significantly relied on Paul Minifie’s expertise as Design Architect for ARM. While Storey Hall’s exterior illustrates a three-dimensional sculpting of the plasticity of concrete the CFI façade draws on the efficient logic of accreting two-dimensional metallic sheets. In revisiting the Voronoi technique, Minifie’s line of enquiry exemplifies the notion of a digital craftsperson. This is because at both the CFI and at Storey Hall, the practised repetition and examination of a cellular pattern – the Voronoi – has been used to create structural diversity. As Sennett would intone, his practice is therefore a matter of craft: “Every good craftsman conducts a dialogue between concrete practices and thinking; this dialogue evolves into sustaining habits, and these habits establish a rhythm between problem solving and problem finding.”

ACROSS THE SURFACE: PATTERNING THE SKIN
In architecture and design we are accustomed to speaking about certain stylistic periods and one way in which these may be defined is through the associated use of pattern in architectural surfaces. Materials, colour, spatial arrangements, scale, exuberance of ornamentation and similar compositional concerns are constituent parts of this narrative. In part, this taxonomy is based on the physical skin that carries such patterning, but at the same time the carapace gestures to likely patterns of inhabitancy that the skin may contain. Distinct architectural epochs in which this relationship between surface and use can be seen are vast but include the appetite for jubilant sculptural plasticity of the Baroque, a style that immediately orients us to works of religious, lavish exuberance by Francesco Borromini or Gian Lorenzo Bernini. Or, by contrast, the apparently sober simplicity of the International Style which has the conceit of removing
Doshi Levien’s “Charpoy” series is a contemporary interpretation of an Indian furniture archetype (opposite). It illustrates an oscillation between old and new, east and west in Doshi Levien’s design practice (below).

Doshi Levien
The ability for pattern to span between ornamental and social patterns of use is one of the concerns explored in the work of London-based design office, Doshi Levien. Its Indo-Anglo directors, Nipa Doshi and Jonathan Levien, extract and abstract precedents from familiar and remembered cultural contexts. Their respective childhoods in Delhi and Scotland form diverse references. These associations are recontextualised in contemporary objects that draw on archetypes but are reinterpreted for contemporary patterns of use. A convergent concern of the design office is the shifting role of ‘craft’ and ‘digital’ methods of production, which is very much dependent on geographical location.

“CHARPOY” SERIES
A recent example that illustrates the oscillation between old and new, east and west in Doshi Levien’s design practice is seen in the “Charpoy” series. It is a contemporary furniture range that re-interprets an Indian archetype. The legacy of the charpoy – which means ‘four legs’ in Hindi – is infamous as a place of respite, play and trade for shop owners. It is also known as a site from which Indian ladies of leisure may gossip and conduct their affairs. Doshi Levien’s “Charpoy” commission by the Italian furniture manufacturer, Moroso, illustrates an affinity between highly patterned design, reinvented patterns of use, and production by digitally driven machines and handwork. When re-interpreting the charpoy for what is essentially Moroso’s moneyed Western audience, Doshi Levien wanted to translate aspects of everyday Indian life into a day bed that would appeal to the European market. Re-scaled and enlarged, the embroidered beds and cushions of “Charpoy” evoke idiosyncratic Indian experiences, such as the traditional game of Chaupar which is often played on charpoys, the tools used by a chai wallah to concoct the ubiquitous milky drink that fragrantly permeates the Indian air, or the accoutrements found in Doshi’s aunt’s hand sewing collective in Ahmedabad: shears, cotton reels, needles and pins.
Rather than copying the traditional stringed hammock slung between four pillars, Doshi Levien designed a series of robust four-legged platforms with sculpted feet that were created primarily through computer softwares. The wooden bed frames were also finessed this way and both components were milled in Italy using computer numerically controlled (CNC) machines. The fabric bed that cushions the CNC base bears traces of Indian life. Each is embroidered in vibrant hues of cotton and fine, hand-detailed buttons along the edge secure the cushion cover. The patterned beds are layered with assorted loose cushions (also hand-embroidered) that recall diverse narratives redolent of Indian life in fabric, colour and detail.

As pieces of furniture, the “Charpoy” series provides information to its western audience about different uses of a day bed in India. These everyday observations are central to Nipa Doshi’s upbringing and can be described as one of the ‘meshes of prejudice’ she brings to her design practice. Doshi Levien is materially speaking to a Western audience with the knowledge and incorporated skills of an Eastern one. The “Charpoy” series also exhibits a fine balance between Pye’s Workmanship of Risk and of Certainty that we considered in Nostalgia. There is a tension between the undulating hand-made stitches on the cushion covers and mattresses, and the precision and accuracy of height, scale, materiality and spring of the mechanically produced base, legs and inner.

While much of Doshi Levien’s recent work is distinguished by hand-embroidered patterns on sumptuous Indian fabrics, the design office is not sentimentally dismissive of contemporary techniques for manufacture. It is most interested in what is appropriate and contemporary for the design and the context for which the design is produced. For example, CNC milling was the most effective technique to produce precise elements such as the wooden frames of the “Charpoy” frames or the milled marble tabletop in an earlier esquisse for “My World” (2006). At the same time, Doshi Levien recognise that what may be considered ‘old-fashioned’ or is unfeasible to produce in the west may not necessarily be the case elsewhere. As Levien pointed out recently:

Our design approach is forward-looking and optimistic. There’s often an assumption that [something] hand-crafted is something of the past. In Ahmedabad, where the Moroso products are made, handwork is a viable, thriving and contemporary method of production, not just a theme or style. We are using the hand to produce the textile designs because they cannot be produced to the same quality by machine. On the other hand, the wooden underframes are CNC machined in Italy because that is the most efficient way. Craft does not imply looking to the past. An aeroplane is crafted, an Hermès Birkin bag is crafted, Foster buildings are crafted, F1 racing cars are crafted. Handmaking is modern if you’re creating things that can’t be made any other way and if the work is relevant to contemporary life."

As with the work undertaken at Jongerius’s studio or at Thomas Heatherwick Studio, for example, for Doshi Levien the design process most often involves testing in an oscillation between physical materials and digital models. Doshi Levien is observant of contemporary conditions where the exchange and trade of information that is ‘ready to hand’ may be enriched and expedited through a
combination of production methods. In this regard we can again recognise the theme of *bricolage* in its practice.

One way in which this physical/digital oscillation may happen is that Doshi develops a sketch or an idea for a design brief in drawn or collaged form, without necessarily knowing how it could be made or how it may translate into the final object or installation. Levien may then interpret her drawing and create a digitally manipulable form that Doshi would critique. The process is not always as linear as this and Levien’s thoughts about the alternating process are telling. He comments, “The way in which those ideas are translated is where the innovation happens quite often. The meeting point between Nipa and I is the drawing in a sense – it’s where we come together and bring our respective expertise.”

Although Doshi Levien could have turned to full computer use some time ago, they have resisted this. For them working with full digitisation would mean that they would have lost an enjoyment in their process of making. Levien suggests that this delight in making, “is reflected in the final object and that [our] enjoyment is through coming into contact with materials and sculpting and enjoying form … whether that be for something that is made in huge numbers, or something that is more singular.” While its affinity for materials is clear, what is also integral to its design process is the ability to read patterns of use and surface treatments with a unique Anglo-Indian perspective. This allows the work to span between ornamental and social patterns of use in Western and Eastern contexts.

CONCLUSION
Through the work of Minifie Nixon and Doshi Levien, we can clearly regard pattern as an active organising principle or tool with which crafted designs are formed. Pattern can be read not only as a surface treatment that issues a designer’s bias – or ‘mesh of prejudice’. Pattern also often configures how a design is structured and this intimately relates to how it is produced. As we have seen, structure and surface are often integrated through pattern.

Though Minifie Nixon and Doshi Levien have a different approach to employing pattern, what is shared in both practices is an understanding that underlying patterns of use inherently relate to how particular materials can be treated. There is a distinct hierarchy as to how compositions are formed and what structural logic they will best follow – and how they may be judiciously interrupted. At the Centre For Ideas we see the appropriation of Voronoi cell theory as a tool to create accurate two-dimensional panels that are assembled like petals to form metallic cones of assorted diameters. For “Charpoy” a combined logic of machined and hand-produced work creates a union of structure and comfort while illustrating an eastern narrative.

Like the *bricoleur*, we can argue that through their interest in pattern, both Minifie Nixon and Doshi Levien, “speak not only *with* things, as we have already seen, but also through the medium of things: giving an account of [their] personality and life by the choices [they] make.”
Endnotes


3 James, Paul. May 2006 “Globalisation” lecture for the Theoretical Frameworks seminar, School of Architecture and Design, RMIT University, Australia.

4 The term *petit récit* is used here as an expression of an alternative, more modest narrative to the meta-narrative or grand story that is accused as being distinctive of the modernist project.

5 Here we can begin to see parallels between Minifie Nixon’s criteria of use for employing *techne trouve* and how these criteria manifest in structural patterns.

6 Excerpt from a forthcoming essay by Rebecca Roke with Paul Minifie, “Techne Trouve: a discussion on the architectural application of found techniques in the work of Minifie Nixon.”

7 We could argue that this is an extension of Sir Karl Popper’s ‘searchlight theory of the mind’ whereby an organism [human] is actively, constantly scanning and searching environments and drawing on previous found references to make sense of its surroundings. E H Gombrich compares Popper’s theories of the mind in “Order and Purpose in Nature”. *The Sense of Order. A Study in the Psychology of Decorative Art.* p. 1.

8 Again, the use of this adjective here is less about an idea of style or grace but relates to the notion of an ingeniously concise or simple way of creating form.


12 Ibid.

13 Ibid.


17 Ibid.

The premise of this thesis set out to discover the relevance of digital and craft practice for designs created in a post-digital context. The thesis asked whether the ideas and techniques of digital and craft production could coalesce with the intention of forming a constructive and mutually borrowed design logic. Craft and digital practices are often assumed to be approaches that are divorced in their attitudes to design and making. However, in the exploratory, heterogeneous terrain of post-digital practice now, it is suggested that we have a compelling opportunity to imagine a shared, benevolent relationship of digital craft.
This proposal for digital craft champions the crafting of innovative and digitally derived design in a post-digital age. In part, this synthesis of digital craft relies on a careful understanding of what each term – craft and digital – is understood to mean. As we discovered, by understanding craft as a verb rather than as a noun we access the active possibilities of doing. Craft is considered in this thesis to be an act of masterful design practice that is applicable to all techniques of design – both computer-based and physically rendered. This comprehension of the ‘doing’ of craft does not negate the interesting and materially rich lineage of noun-based craft. Nor does it concern itself with the negative associations of old-fashioned production that craft is often accused of. Instead it focuses on the dynamic possibility of designing, making – doing – design which is relevant to contemporary situations as pointed out by designers such as Jonathan Levien previously in this thesis.¹

The digital, too, has been specifically understood in this thesis. Though we have discussed its inherent explanation as a binary operation, we have more usefully considered its application in collocation with other terms. Hence the extensive use of the phrase ‘digital craft’. ‘Digital’ is a common short-hand term in design and architectural practice and colloquially speaking, it refers to designs created through computer softwares. In collocation, the digital becomes usefully harnessed to better describe how computer-based work is manifest. Digital Craft is a phrase that expresses a mastery of making with analogue and digital resources. The case studies that we have considered illustrate this digital mastery which, like most masterful knowledge, relies on skilful practice to know what a particular technique or material is and is not capable of. The case studies also illustrate the need for careful thought about how a design is created: What softwares and hardwares will best translate ideas from bits to atoms without a loss of intent? Or, if the intent does alter, how can this be usefully accommodated and refined? In other words, how may a design manifest in physical materials whilst drawing on the expediency of relevant software programs?

By locating the thesis in a ‘post-digital’ age there is an accompanying suggestion that the discrete binary constructions inherent in digital practice – the zeroes and ones that Sadie Plant writes of – are overlooked for practices that are more continuous and inclusive. That is to say, in a post-digital realm, because we have largely unveiled the illusory perfection of digital tools, there is the possibility to examine areas outside of ‘normal’ software uses. We can be less respectful of ‘proper’ or intended uses of digital data or production processes. Instead, we are encouraged to become a bricoleur of the software world. Processes of the techne trouve exemplify this: when useful geometric data is found and appropriated for another use. However, what distinguishes techne trouve work such as that by Minifie Nixon from much of the gamut of emergent work (also largely techne trouve) is the fascination that the designer has with how the stolen digital data can be usefully put to work in the physical realm. In other words, Minifie Nixon remains concerned with many of the qualities that characterise traditional architectural production while remaining alert to digital techniques for design.
The orchestration of constituent parts of design is consistent in digital and analogue states. Without an accumulation of zeroes and ones, binary systems are nonexistent. A similar necessity for assembling parts to form wholes is present in physical instances – the accumulation of atoms that constitute the material world is a primary example. How parts accrete anew to make wholes is also an underlying theme of this thesis. This process is discussed by Michel Serres and Bruno Latour. In their opinion, innovation occurs through newly combining things already at hand. They write, “The ensemble is only contemporary by assemblage, by its design, its finish…”

Latour and Serres’s idea of achieving innovation by re-combining found or existing parts is closely allied with the practice of bricolage. Both bricolage and innovative recombination as proposed by Serres and Latour draw on materials ‘at hand’ and combine them in an approach that is distinctive and unique to each bricoleur. Remember Lévi-Strauss’s description of the act of bricolage: “The rules of [the bricoleur’s] game are always to make do with ‘whatever is at hand’, that is to say with a set of tools and material which is always finite and is also heterogeneous.”

As we discussed, the potential of bricolage in digital craft practice lies in its possibility to encourage designers towards inclusive, heterogenous design solutions. It also increases the likelihood that varied answers may be sought from disciplines that are traditionally distinct – engineering and art, for example. When this miscegenation occurs, we are more likely to resist the monotony of known, stepwise and predictable practice. Instead we are provoked to consider new ideas, new design methods and often unexpected material solutions to design problems. That is, a system – or series of systems – is ‘bastardised’ or appropriated for a use other than what it was initially designed for. This encourages what Serres and Latour describe as innovation. The disruption of methodical order is also a characteristic that has been used to describe our current era, with its moniker of a ‘post-digital age’.

MESHES OF PREJUDICE
Instances of how this heterogenous, exploratory practice can occur in architecture and design have been usefully speculated on in the six principal case studies illustrating my meshes of prejudice: Bricolage, Nostalgia and Pattern.

BRICOLAGE
In Bricolage we saw how Minifie Nixon grafted a relationship between found properties of digital code and materially diverse physical results: a taut golden canopy and a variegated brick wall at the Australian Wildlife Health Centre. Similarly, though it was designed by a process that had less to do with found digital data and more with the opportunities offered by material rejectamenta, Thomas Heatherwick Studio’s “Bleigeissen” presented an instance of digital craft production. For the AWHC Minifie Nixon grafted techne trouve design methods with the physical characteristics of the project to create a materially specific type of digital design. For “Bleigeissen” Heatherwick’s studio was less concerned with the originating idea being digitally derived, but consistently followed a process of oscillation between material and digital testing to refine and realise the sculptural object.
The idea of *bricolage* as a design tool is not new; Rowe and Koetter's treatise in *Collage City* positioned *bricolage* processes in opposition to the totalitarian regimes of Modernist architecture. What Minifie Nixon, Heatherwick, Rowe, Koetter and many other artists and practitioners share is a curiosity about how the non-linear design decisions that *bricolage* exemplifies can provoke innovation. This modest type of innovation is more resistant to overarching or grand narratives. For this thesis, the most compelling aspect of applying *bricolage* to design digital craft is for the shared inclusive range of tools ‘at hand’ that can be used to solve the design intent. We see this in Minifie Nixon and Heatherwick’s work: in the marrying of bricks of varying colour and the behaviour of bird-flocking patterns, for example, as much as is evident in the scaling and exploration of the scanned digital drip and many dichroic beads.

**NOSTALGIA**

What is the relevance of nostalgia in answering the central question of the thesis: the relevance of digital craft practice in a post-digital context?

A fleeting impression of nostalgia may dismiss this fusty, sentimental longing for ‘home’ as an irrelevant matter to explore in contemporary digital craft practice. My argument for designers to attend to nostalgia resides in the ability for it to be used to connect with emotionally charged sites. From this point, the designer can take rebellious action, *without* sentiment. This contrasts with ersatz nostalgia, which exploits the return towards the comfort of nostalgia, particularly during historical upheaval. An active, energetic use of nostalgia allows for an engagement with historic material that holds a saturation of references to context, history, culture and so forth while also challenging expected assumptions by articulating the nostalgic material differently.

For Hella Jongerius nostalgia is helpful in her work because after identifying an archetype to work with she often does strange things to it or recasts it in an unusual material. In her opinion, “If you do that on a very strange new form people won’t recognise it any more … you have to give them some familiarity before you take it into a different material or scale or whatever.”

In other words, designers can revisit material that provokes nostalgic impulses while simultaneously conjoining these sites of retrospective escapism with contemporary concerns. Graphic Thought Facility’s strategy for the signage of “Digitopolis” illustrates this. GTF selected the material of electro-luminescent lamps because it recalled a nascent idea of ‘technology’ but was also functionally perfect for the illuminated signage requirements. Again, we see the innovative design gesture as proposed by Serres and Latour in both Jongerius’s and GTF’s work. For each, the reworking of familiar material and alteration of a *part* of its normal use significantly shifts the work away from the metaphoric nostalgic reference toward a newly imagined use, without entirely losing the ‘charge’ of the original material.

**PATTERN**

As I have noted, pattern is a notoriously large terrain to begin to address yet it is an important means by which a designer’s logic and bias is expressed. Therefore in this thesis the value and use of pattern is limited to a discussion about its application as an organising structural strategy and for its decorative
role in design. That is, I have considered the relation of pattern to digital craft as it is conveyed through structure and surface. Minifie Nixon’s Centre for Ideas (CFI) is read as an ongoing investigation in the structural expression of a Voronoi cell. The Voronoi is a lozenge-shaped pattern that forms naturally and that Minifie has been especially interested in for some time. At the CFI the Voronoi does the logical work of figuring out an ‘elegant’ assemblage of two-dimensional panels. These dimpled metallic sheets are then accumulated in precise conical patterns to form a full metal jacket for the façade of the Victorian College of the Arts.

Nipa Doshi and Jonathan Levien’s interest in celebrating the cultural hybrid and exploring the synthesis between technology, storytelling, industrial design and craftsmanship is also discussed through pattern. The ability for pattern to span across ornamental and social patterns of use is one of the concerns explored in their work. They often recontextualise associations drawn from Indian life in contemporary objects, drawing on archetypes that are reinterpreted for contemporary patterns of use. The “Charpoy” series is a sophisticated range of day beds that recall the Indian origin of the form but are reworked to appeal to a western, contemporary audience. Methods of manufacture depend on appropriate locations and also inform how Doshi Levien’s work is produced. Therefore, a convergent concern of the design office is the role of craft and digital methods of production in relation to specific geographical contexts.

DIGITAL CRAFT PRACTICE
As well as revealing idiosyncratic design languages, the case studies representing bricolage, nostalgia and pattern exemplify the conjunction of digital craft practice. The designers refine and hone answers to their design questions by drawing on a broad range of resources and techniques. When selecting these examples, I revisited McCullough’s quote suggesting that craft in the computer age is a proposal to participate skilfully in some small-scale process. Though he was referring to the minute and repetitious keyboard craft of a computer master, I have found this idea to be useful when selecting the case studies. The statement is not meant to suggest that modest proposals are superior to large-scale ones, but recognises that often large-scale designs such as architecture borrow software and applications from other disciplines that operate at smaller scales. It also realises that large works are most often composed of an assemblage of several smaller parts.

This thesis was also an investigation that sought to understand how careful, practised, specific design processes could clearly express a designer’s ‘voice’ while also using the helpful universal design logic afforded by digital softwares and associated production processes. In part, the idea of ‘voice’ has been addressed by the meshes of prejudice: bricolage, nostalgia and pattern. What has become clear is that objects and spaces created with ‘new’ digital tools can efficiently narrate a designer’s bias. The discovery or realisation of this conjunction of efficacy and characterful materiality links with a relatively recent area of recognised scholarship, known as material culture.

Broadly speaking, material culture can be understood as, “The relationship between artefacts and social relations, which draws on a range of disciplines
including anthropology, archaeology, design studies, history, human geography and museology.” Lorraine Daston’s introduction to Things That Talk, a recent book discussing material culture in art and science expresses my developing interest well. She writes: “It is not entirely arbitrary nor entirely entailed which objects will become eloquent when, and in what cause. The language of things derives from certain properties of the things themselves, which suit the cultural purposes for which they are enlisted.” This sentiment parallels the discoveries made in the case studies that examine how and why each designer followed a particular line of enquiry. They have a specific set of prejudices and therefore their outcomes are not ‘entirely arbitrary’. However, the unusual properties each design expresses is a consequence of carefully considering the context, materiality and production of the work and is something that is not easily imitated or predicted.

This thesis, Bits and Pieces: Crafting Design in a Post-Digital Age, has attempted to understand how designs produced amid the heterogeneity of a post-digital age can ‘talk’ about the varied purposes for which they were imagined. At the same time, small and large, the work discussed reconciles the designer’s voice with processes that, while not obviously ‘stepwise’ or obvious from the outset, allow for distinct ways to solve digitally crafted design in a post-digital age.
Endnotes


6 This is an abbreviated description of what is represented and discussed in the Journal of Material Culture and is a helpful synopsis of the field. See http://mcu.sagepub.com Accessed January 2009.


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