

**An analysis of traditional and digital methods for producing
three dimensional artworks**

Warren Andrew Reilly
Grad. Dip (Plant and Wildlife Illustration)
BaVA

Submitted for
Doctorate of Philosophy - Design
October 2009

STATEMENT OF ORIGINALITY

This thesis contains no material which has been accepted for any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying subject to the provisions of the Copyright Act 1968.

NAME..... DATE.....

Warren A. Reilly

26/October/2009

ACKNOWLEDGEMENT

I would like to express my sincere thanks to the following, without whose assistance this work would not have been possible, in its current form:

To my darling wife Anastasia, for her relentless support and tolerance of me locking myself in the studio for months at a time to get through the work. She was most often called upon to act as combination art critic/sounding board/psychiatrist when things were not 'going to plan'.

To Dr Trevor Weekes of the School of Design, Communication and Information Technology, The University of Newcastle. I strongly believe, were it not for the continuous mentoring and guidance from Trevor, this research would have faltered and become complacent. Also, to Michael Dickinson of the same department, for his highly valued input and counseling on the technical aspects of the study.

To Denise Spalding, the Workshop Manager of Newcastle Studio Potters for her judgement-free support and advice on the physical clay builds and for her continued willingness to make the entire process easy, for me anyway.

TABLE OF CONTENTS

ABSTRACT.....	4
INTRODUCTION.....	5
CHAPTER ONE.....	11
1.1 <i>Beginnings of the research.....</i>	11
1.2 <i>The choice of the human figure as subject.</i>	12
CHAPTER TWO	
Glossary of terms.....	15
CHAPTER THREE	26
Autoethnography of the figurative sculpture process.....	26
CHAPTER FOUR.....	32
The role of sculptors in utilising ‘new’ materials	32
CHAPTER FIVE.....	38
5.1 <i>The Conceptual Intent for the works in the Creative Presentation-</i>	38
5.3 <i>The conceptual underpinnings of each of the works-</i>	47
5.4 <i>The Additive Fabrication Works.....</i>	72
5.5 <i>Conclusions about the subject shown in the Creative Presentation.....</i>	79
CHAPTER SIX	82
The analytical process - Experiencing the difference between physical	
and the virtual properties	82
6.1 <i>Tracing the differences between the virtual and the physical.....</i>	82
6.2 <i>Tracing the differences in usage between physical and digital.....</i>	93
CHAPTER SEVEN	97
CONCLUSIONS - Subjective and objective results from analysis	97
7.1 <i>Objective observations on the process of sculpting with clay.....</i>	97
7.2 <i>The use of Additive Fabrication</i>	100
7.3 <i>Subjective observations on the process of sculpting with clay.....</i>	103
7.4 <i>The object as the state of dynamic equilibrium between artist and</i>	
<i>artwork.....</i>	106
7.5 <i>The translated object.....</i>	107
CHAPTER EIGHT	110
8. BIBLIOGRAPHY	110
APPENDIX 1.0 – The process of constructing the reference sketches.....	113
APPENDIX 2.0 – The design process – compromises and	
combinations.....	129
2.1 <i>Considerations of the new space being shared between artist and</i>	
<i>the artwork</i>	129
2.2 <i>The relationship between artist and artwork</i>	129
2.3 <i>Stages in the artists development.....</i>	131
2.3.1 <i>The role of the reference sketch.....</i>	134
2.4 <i>Stages in the artworks development.....</i>	137
2.5 <i>Stages in the definition of space</i>	139
2.6 <i>Subject matter as a device for spatial definition</i>	141
2.7 <i>The criteria used to deliberately control space</i>	143
2.8 <i>The allocation of mental capacity to problem solving.....</i>	145
2.9 <i>Schematics of spatial decisions</i>	149
APPENDIX 3.0 – Reference Systems.....	155
APPENDIX 4.0 – Concept, Systems and Detailed Design Phases	158
APPENDIX 5.0 – Descriptions of spatial considerations.....	160

An analysis of traditional and digital methods for producing three dimensional artworks.

Warren A. Reilly

ABSTRACT

This document is an investigation into the tools and processes used by artists and designers to convert their mental ideas into three dimensional space. Limiting itself to the field of sculptures using the human figure as the central subject, this research covers the techniques and tools used and the potential for recent engineering technologies to offer some advantage. The paper makes two major assertions: that a number of identifiable criteria are used by artists to control the forming of space, and that the recent emergence of haptic devices and additive fabrication may offer a relief from the constraints of some of these criteria.

The research involves the creation of artworks using two separate sculpting techniques and cross analysing the processes used and the results being produced. The first sculptural technique involves organic clays formed using manual hand tools, compared to the second technique of utilising computer generated virtual clays formed using specific software applications and a desk mounted haptic feedback device as substitute for the manual tools. The research concluded with an exhibition of the works created and the submission of this exegesis.

INTRODUCTION

The following exegesis, in combination with a sculptural exhibition, represents the results of my research for a Doctorate of Philosophy (Design) for the University of Newcastle. I originally began the research with a complex set of ideas about classical Baroque-style sculptures, however these various outside layers began slowly peeling away until I had revealed the ‘core’ of why I had returned to university (as a student) after more than 20 years. At the centre of it all was a need to understand more about how, whenever artists and designers imagine objects in their minds, those ‘images’ were then converted from an idea into physical reality? How did they do it? Was it something explainable?

I had set out with the intention of structuring the research based on interviewing practicing, ‘successful’ sculptors in order to understand more about how they did it. However, in order to have a greater understanding of the thought processes behind the actions of sculpture, I needed to be able to experience it myself. In practice, this meant the research now included the need for me to learn how to: sculpt the human body using traditional clays as well as using a computer-based system, record the process of learning, and analyse the results from the information being created. In the following paper, I have broken the results into two sections. The first section, the body of the document, deals with the specific analysis and results attributable to the sculptures produced for the Creative Presentation. The second section contained in the appendices, is an expansion of the general analysis of earlier stages in my learning. I believe it was necessary to include this formative information, as it was the practice of returning to those fundamentals of spatial definition, analysing the observations and then articulating the discoveries, that grounded the discoveries of the final exhibited artworks. The appendices should not be read as a superfluous statement of ‘common sense’ practices, but rather as an exploration and expansion of the implicit knowledge of spatial determinacy involved in translating my thoughts into objects.

With respect to the subject matter for these sculptures, proportionally accurate sculptures involving the human figure had appealed to me for many years as I believed they surely represented a constant challenge for an artist to achieve with a degree of anatomical accuracy. From the outset of the study, I was to learn that major, but subtle differences in portraying the figure are important to ensuring that an artists’ intention (the original mental image or concept). These are somehow recorded in the sculptural

space to allow potential viewers to understand the context of the composition and what it is attempting to convey. As I had neither sculpted nor drawn artworks based on the human figure before commencing this research, the ‘learning curve’ was both steep and long and I soon realised that I had so very much to learn.

The paper also attempts to create simple schematics to show the ‘process flow’ between the various influences that may exist both outside and inside of an artist in order to determine if modern enhancements in both tools and techniques act to improve the process of translating imaginings into artifacts. Would the latest technology unlock more of the potential of artists to express themselves in three dimensions? Would the technical speed and efficiency potentially alter the process of defining ones own personal ‘space’?

The idea driving this research had been growing for most of my professional life. As a designer of components in commercial industry for more than twenty years, I have been fascinated by the apparent differences between approaches of multiple designers who often end up at a similar end point. This ‘end point’, in my career, has been the design of objects in a commercial sense, whereas this research was involved with the recording of learning a process centred around creating objects from a more personal, expressive sense. In the professional environment of designing objects for manufacturing, I had wondered if there were common elements, that once identified, may speed up the process of learning and teaching the fundamentals of how three dimensional (3D) space could be defined. As I was already from a strong computer literate background, I believed I needed to explore the physical, as well as the digital processes of creating sculptures as research experiments. This document is the reflection of that learning process and its practices.

I am aware of the existence of a range of computer based applications that were specifically designed for digitally shaping and rendering human figures. However, I am limiting this research to applications that strongly reflect those processes used when constructing sculptures using physical, organic clays. Consequently I did not use software that relied on altering control points on surfaces or sub-divisional surface manipulations. Instead, the chosen software was used in a way that was very closely aligned with physical construction methods, in order to ensure the two different media were controlled in very similar ways.

Because my primary interest was in the initial steps involved in turning a mental idea into a 3D object, I have focused the majority of the exegesis on the analysis of the

processes involved in the early stages of creating sculptures. My research focuses on the comparison of constructing sculptures using both organic clays and digital 'clays'. The intention of the paper was to review the act of figurative sculpture from a design perspective rather than a fine art perspective. It was conducted with particular attention to the mechanics and processes of spatial determinacy as it was the translation process from thought to object, that was being researched. The exhibited part of the research was allowed to span the entire process and the sculptures were taken right through to finished works. I further limited the scope, in order to keep it achievable, by not including any aspects of what constitutes good and bad design principles. If I had, I believe the study would have been distracted away from its focus and risked becoming too generalized or diluted.

Because the results of the analysis needed to come from understanding the thought processes that exist behind the actions, I needed to determine a method of recording these thoughts. This is supported by Newell and Simon's research into human problem solving, where they state that "in order to understand any behaviour, one must study the cognitive processes that underlie it." (Weisberg 2006, p.119). Potentially, this could have been done by interviewing artists after, or even during, the process of creating sculpture. I did not do this as I believed the results may have been questionable based on how accurately an artist could remember, or how faithfully they were describing, their thoughts. Instead, the majority of the information for this document was gathered using an autoethnographic methodology, which demands that the researcher themselves experience the full range of activities being studied in order to facilitate gathering accurate information. For this study, this method involved me learning the traditional techniques of creating sculptures using organic clays as well as learning the techniques for creating pieces using the computer based 'virtual clays'. Rather than draw on any of my professional history of designing more commercial forms, I chose to suppress this influence so I was not tempted to approach the study by 'doing what I have always done'. This was about analysing the process of learning, so the methods, the subject and the final objects needed to be new to my experience. The designs needed to develop from free thoughts and emotions existing within the artist, instead of complying with any potentially imposing, pre-existing technical drawings or written specifications that existed outside of the artist. It has been my experience that manufacturing design is a social activity whereas artistic design is more introspective and it is that introspective decision making, which is at the core of this document.

The sculptures created were done so for the sake of personal expression and were a logical choice of objects to create, as it allowed me to experience the process of deliberately constructing objects directly from free mental associations, with little or no outside influence on how it should finally appear. My experience of commercial design was much different, where often a finite number of practical solutions to the design problems would be accepted, with little room for individual expression in the final shapes. So I needed the sculptures to steer away from the reconstruction of variations on any existing objects, instead the desire for this research is focused on discoveries about the birth of new, unrestrained objects that very few people would have created, (possibly only one). I wished to experience the processes behind the construction of objects that did not previously exist and if it were not for the specific and personal intervention of myself as the artist, would never have existed.

Exposure to this practice of learning was necessary to allow me to experience the various considerations of an artist when making decisions about how and why certain shapes need to be made and positioned, in order to communicate their intentions to an independent observer. This study was not to determine the ‘completeness’ of any systems being used, but instead to highlight the principles of those systems at work. The full definition of the systems would be impractical in this time frame; as a consequence, the focus was on constructing a series of fundamental understandings that may potentially be used to structure future ethnographies.

The sculptures that were created during the final year of my research formed part of an exhibition titled “Endosymbiance”. Endosymbiance makes reference to a scientific term describing two entities that are interdependent on each other, with one living entirely inside the other. I believe this may suggest the nature of the relationship between the sculptor and the artwork. The artist gains self-identity and field identity via the existence of the artwork, and the artwork gains its existence from the artist. This document and the resulting sculptures are the primary findings of the research and as such, they represent my understandings on investigating the formation of sculptures that form a visual language that could carry to a diverse audience.

With regard to the *physical* works, the pieces were hand-built using organic clays and shaped using a range of traditional techniques such as; creating internal support frames, using hollowed out forms and finally, firings within kilns to preserve their proportions from degrading. The *virtual* works were also hand built using ‘digital clays’ represented by computer programs. To maintain a high level of comparison

between the two methods, the virtual system did not make use of importing any existing material, nor would it be created by typing in any specific dimensions. All of the virtual work was achieved by strict interactivity from the artist, where the output must come entirely from the input of the creator. The software was not used to extend or interpret existing shapes. It was important that the program did not interpolate, correct, interpret, anticipate or extrapolate any geometry—rather, strictly record the history of interactions from the artist. In this way, it closely replicates the properties of physical world clay where the clay is inert, save for the settling due to its own weight, and its shape is also the result of the combined history of all the interactions with the artist. The comparisons between the two methods were then strengthened and the focus returned to understanding whether the mental process of defining space was different in the virtual world than it was in the physical world.

‘Clay’ was chosen as a medium specifically for this research based on its properties of being a malleable medium that is readily accessed. It can also be comfortably formed using simple improvised tools and can be fired to allow it to be transported and exhibited without being overly concerned about damage. Clays were also chosen because they are traditionally used in an additive process, starting with no clay at all, the final shape is created by a series of conscious and subconscious decisions about how, where and when to add features and material. The additive nature of forming sculptures this way holds a stronger association with the additive fabrication process used later in this research to translate the digital sculptures into physical objects.

The term, ‘additive fabrication’ makes reference to a computer driven system of building up objects by creating them as a series of layers fused together, this is explained in detail in the Glossary in Chapter Two. It was possible for both the physical and digital works to have been created using a *subtractive* process (where material is subtracted from a raw block), such as carving. Instead, the method of creating all of the research pieces was aligned with the *additive* fabrication process being used on the digital works, as it was the least modifiable technology included in the research plan and the highest commercial consideration. The physical objects were therefore built up using additive processes such as coils and slabs, and the digital process was built up from an empty file each time. It was important to keep the creative and fabrication methods for the physical and digital as parallel as possible in order to identify the shared factors and experiences.

For the creation of figurative sculptures, artists may choose from a large range of media, so this research needed to severely limit the choice of materials to keep the scope of work achievable. Physical world modeling clay was readily available from art supply outlets and the digital clay was effectively cost free while ever it remains within the computer system. It is only when the digital composition is translated into physical properties that it incurred costs. With these factors in mind, clay was chosen for its predictable material properties while being financially viable enough to allow the research to create as many works as were necessary, without the cost of materials restricting it from reaching its conclusions.

This research took place over a three and a half year period and is based around the activities within my own studio and the facilities of the University of Newcastle, Australia. While many physical and virtual sculptures have been made during this period, the illustrations and photographs included here are those that most clearly display the stages and attributes of creation being discussed. The earlier works, while I was still learning the basics of the physical and digital clays, are revealing within themselves however, the cornerstone of this kind of research was the creation of several pieces of a higher standard of spatial competency. These more competent pieces are specifically meant for exhibition and to support this exegesis by establishing that the observations made here are grounded on sound practical principles and understanding of the process of creation.

CHAPTER ONE

1.1 Beginnings of the research

In my professional life I have been driven to use computer based design programs referred to as Computer Aided Design (CAD) programs, by the demand for complex designs with tight manufacturing tolerances, and very short times to market. While my professional experiences gave me some fluency with computer based design tools, the system used for this research was completely new to me and needed to be learnt before commencing any detailed compositions. CAD files have an advantage of being digital, which allows the 3D virtual model to be transferred electronically to other parties or machines for review and manufacture. Reviewing the design of 3D electronic models however, has been historically problematic as it relies on high levels of computer literacy within any observer, or user of the programs, in order to understand the true nature of shapes being considered. To moderate this potentially negative influence, the digital files were not left inside the computer system, an advanced engineering process called ‘additive fabrication’ was used to realise the digital sculptures into physical dimensions for review and exhibition.

I repeatedly use several specific terms throughout this paper and it is important to define these in relation to what they mean in this context. The term ‘physical’ makes reference to the physical environment the artist is within. Care must be taken when using alternative terms such as ‘reality’ and ‘real’ as these are subjective terms and not considered for debate within this paper. Physical also includes reference to the existence of chronological time, gravity and feedback to the human senses of sight, hearing, smell, touch and taste. By contrast, the terms ‘virtual’ or ‘digital’ make reference to a synthetic and artificial environment that is created and maintained wholly within computer software applications. I believe that this virtual environment also constitutes its own particular form of reality and it is for this reason that I did not use the term ‘reality’ when describing objects only in the physical world. My assumption of a virtual ‘existence’ is founded on my observations that information within the program has several distinctive characteristics including: the ability to be modified interactively and preserve the modifications made to it, the ability to be archived and restored without losing any data, the ability to be unambiguously observed by multiple observers simultaneously and finally, the ability to respond to visual and tactile exploration.

Other specific terms will be explained in the glossary of Chapter Two, however it is important to note at the beginning, that I refer to the objects being created as occupying 'deliberate space'. Here the term 'deliberate' takes the meaning of supporting the artistic practice of creating 3D geometry with a specific intention. It is possible to create 3D geometry without specific intention in many ways, including: random shape creations, utilising existing shapes, the results of naturally occurring forces and allowing a manufacturing or designing process to continue without the control of the artist. For this study, I needed to deny the occurrence of any accidents or automations as there was no direct influence of the artists own mental image or individual influences involved in their creation, and any corresponding spatial decisions.

1.2 The choice of the human figure as subject

One of the themes that bind the exhibited works together is the inclusion of the human figure as the central element in each composition. The modern understanding of human anatomy is extensive due to hundreds of years of medical records and exacting details and photographs. I quickly developed a new found respect for the artists of previous centuries, who did not have access to such vast repositories, and their ability to make spatial decisions when representing the human figure with such accuracy. After attempting my first figure in organic clay, it became immediately apparent that I had a lot to learn about the connections and flowing lines of the human body. The anatomy of the underlying muscles and skeleton acted as a form of armature for the sculpture and that an artists knowledge of that armature would directly determine the realistic proportions of the figures. I needed to quickly increase my technical knowledge of the human bodies own biological armature and how it is linked together. The idea of using a mentally imagined armature inside of an object, to drive its shape, is typical in designing for industry, so I was familiar with this technique when applied to commercial designs but not to the human figure. As my understanding of the physical and digital processes increased, the challenge expanded from just mechanically measuring the proportions of different parts of the body in relation to each other, into learning why something 'doesn't look right' even when the proportions were accurate. Beyond the understanding of why the body appears the way it does, I also had to learn how to break down the many tasks needed to reproduce it, into a sequence of manageable stages.

When examining a figurative sculpture, observers of the work tend to have an acute eye for both detail and realism as it is an important quotient of human communication to observe and read the subtle body language of others. In retrospect, I believe I responded positively to the pressure that stemmed from needing to create competent sculptural works, in order to prevent me from settling back into merely recording aspects of commercial design that sat well within my 'comfort zone' of challenges. As a consequence of choosing the human figure for this research, I felt free to concentrate on the mental aspects of composition and definition without becoming distracted by needing to design the subject matter. The subject matter was the human form (realistically portrayed) and the compositional style would draw lightly from classical romantic themes. For me, the human figure was an exciting new inclusion in designing, as it immediately declares that sculptures were man-made objects and not the result of random or natural forces. It presented an observer of these sculptures with an understanding that someone had thought about the placement of every form to create a physiognomy of their own imagination. However, there was no escaping from the demands of achieving some competency in their construction, and I had to ensure that the proportions were sufficiently accurate enough to prevent disproportions from being visually distracting.

In Chapter Two of this document I will outline the specific meanings associated with the terms being used. It is important to explain as clearly as possible, my own understandings and intentions for the terms I am using, in order to minimise the opportunity for misinterpretation. Chapter Three will explain the methods and practices used to investigate the experience of creating sculptural works, and Chapter Four positions this research with regard to the historical aspects of sculptors utilising newly emerging materials and techniques. Chapter Five builds upon these traditional observations by outlining the specific contexts and materials used for the works created as part of this research. Chapter Six outlines the properties of both physical and virtual materials being studied and how these material values have a direct influence on the ability of an artist to shape the space they are creating. In conclusion, Chapter Seven explains how this research has attempted to create a deeper understanding of whether a number of identifiable criteria may be used by artists to control the forming of space, and how the recent emergence of haptic devices and additive fabrication may offer a relief from the constraints of some of these criteria. The appendices for this document provide an opportunity to both position this study with respect to practical foundations

demanding by complex spatial decisions and the theoretical considerations used by artists in their decision making process for constructing sculptures. The research revealed a number of important components that influence the experience, from the human aspects of memory and imagining to the mechanics of problem solving and conflict resolution within each composition.

CHAPTER TWO

Glossary of terms

This research was essentially about the internal experience of creation, and as I had no direct access to any internal experience other than my own, it stood to reason that I should record, in detail, my own experiences. From my own experiences the following pages are an understanding of the context of some of the specific terms being used. While most of the terms are expanded throughout the text in the context of the narrative, some of them require a more complete explanation before continuing with the document.

Physical Environment

For this document it is important to distinguish between the two separate environments in which the artworks are being constructed: the physical environment and the virtual environment.

I use the terms ‘physical world’ and ‘physical environment’ to describe the world in which I existed. This world has physical properties that determine and influence my experiences and limitations. These properties include: the passage of chronological time, the continuous presence of a constant gravity, specific density or mass, moisture content of the art materials and the three primary dimensions of length, breadth and height.

The distinction between physical and virtual is fundamental to the results of this research, as I am able to experience and relate to the physical world using a larger number of available senses. Separate to my human senses of sight, hearing, smell, touch and taste, my memories and recollections on how to communicate in space have been built up over my lifetime in the physical world. I am unable to transform myself into the virtual world and while I am able to interact with it, I have no personal experiences or memories based on ever having existing within it.

Virtual Environment

In comparison to the physical environment, the virtual environment is an entirely artificial environment, created and supported by computer hardware and software. This document references this simulated world as ‘virtual environment’, ‘digital environment’ and sculptures made within it as ‘digital’ or ‘virtual’. The interaction

between myself and the virtual environment was via the display on the computer monitor and to a lesser degree the manufactured sensation of touch. This sense of touch is simulated, rather than actual, and was provided by the haptic feedback device.

Haptics

Beginning with the term 'haptic', it is intended that this term is applied to the act of feeling a form as well as visually analysing it. Design research often refers to representing spatial information in the visual modality; with significantly less information dedicated to understanding that touch is also a spatial modality. Like vision, touch can be used to communicate the relative positions of multiple features to an observer and to each other. The term haptic in this study gives recognition of both tactile and kinesthetic information, as objects may be perceived using our understanding from muscles, tendons and joints (proprioceptive data) as well as just the sense of touch from our skin (subcutaneous data).

The kinesthetic data from our muscles give us information about the position and movement of our limbs in space in order to create a three dimensional map of objects and surfaces. Whereas the distribution of pressure on our skin gives us more localized detailed data about the surface qualities of objects. It is the combination of the subcutaneous and kinesthetic data which may be considered as the "haptic system" (Eilan 1993, p.191). Haptic information is an important bridge between the physical and virtual environments within this paper, specifically for the virtual system which otherwise is entirely visual and does not activate any of our other senses.

The haptic device, called an Omni, is a small desk mounted device that uses a pen-like stylus on the end of a linkage arm.



Movement of the stylus is registered in real time and reproduces the movement of the stylus within the three dimensional space of the software application. Additional to reflecting the movement of the stylus, the software increases and decreases the stiction of the joints to provide the user with the feeling associated with 'touching' the object that is rendered on the computer monitor. The user can then supplement their visual analysis of the object

by feeling the surface texture of the object. In this way, the process of interactively

deforming the surface and then kinesthetically analysing it closely reflects the use of similar methods to manipulate the shapes of organic clays. The tactile sensation available to the user through the Omni is continuously updating each microsecond and provides sufficient feedback to the user to allow them to feel the digital clay while they are deforming it using pressure applied to the stylus. This instant feedback also closely resembles the act of deforming organic clay and would not have been as available if using a sub-divisional surface, or texture map approach to the sculpture.

As with CAD, the history of haptic feedback devices (specifically for computer based applications) spans almost four decades. Initially designed as devices to extend the use of an operators arm and hand into dangerous or spatially restricted environments, haptic arms were used in industry as robotic arms. Engineering and science quickly adapted the developing technology for its own needs, such as allowing remote activation of the device (telerobotics) and precision analysis such FaroArm and Microscribe. The ability to scale the users movement up and down, in combination with advances in manufacturing tolerances, allowed industries such as chemical scientists and medical research companies to create very small and precise movements authored by the users own body.

By the mid 1990's the types of commercially available devices had spread into stereoscopy, head mounted displays and controls, motion capture devices for part or whole body, force feedback devices for entertainment applications and Co-ordinate Measuring Machines (CMM). Again, reflecting the lineage of CAD applications, haptic hardware was adopted by artists and designers as a new method of interacting with their computer generated graphics. Companies such as Inition in the UK and SensAble in the USA began going to market with devices with open architecture software to allow industries and individuals to program the devices responses and outputs for their own purposes. The Omni chosen for this research was selected based on its market position of having advanced functionality and sensitivity for less than \$4000AUD.

Additive Fabrication

This research used a specialised manufacturing process to convert the digital sculptures into physical objects, for the Creative Presentation. This process is referred to in this document as ‘additive fabrication’, however it was not always described using this term and was most often previously labeled as ‘rapid prototyping’. Originating from a demand in advanced engineering laboratories for aeronautical and aerospace industries, the then ‘rapid prototyping’ was a method of preparing physical replicas of CAD models for visual and functional inspection, prior to committing to tooling costs. It was quite literally used for the generation of quickly produced prototypes of intended or experimental designs. The term was widely accepted by industry from 1986 to approximately 2000, when the manufacturing process began to take hold for production items, rather than limited to the creation of ‘prototypes’ for analysis and approvals.

The mechanical process of additive fabrication involved building up the total shape of objects by allowing computer software to create horizontal cross sections through the object, commencing at its base. These cross sections were parallel to each other and created at spacings of 0.5mm and were generally done parallel to the base of the object. The library of these cross sections were stored within dedicated computer programs, which mapped their correct sequences and orientations to each other.

Once the library of all sections were defined, the database of cross sectional information for the entire object was subsequently supplied to fabrication machines, which are specifically designed for each kind of manufacturing process. Commencing at the base, each individual layer of the object was then manufactured directly on top of the previous layer, and in the correct scale and orientation to each other. The philosophy was to recreate the CAD model by building up the object in 0.5mm slices that were permanently fused together as they were generated. At the time of writing, there existed a large range of similar technologies available to convert electronic files into physical dimensions. Early approaches to the manufacturing demand utilised technologies such as Laminated Object Modelling, which involved cutting each layer out of paper, using directed lasers, with each consecutive layer adhered together. Successive technologies extended the capability of this layering approach by using specialised powders (Selected Laser Sintering-SLS) and acrylic or resin based liquids (Stereolithography-SLA). More recent developments in technology have brought the inclusion of metalized powders, to create metalized objects as well as exotic substances such as high grade alloys and carbon fibres. Each successive year sees the development

and release of enhanced technologies to create increasingly complex objects, refine their surface finish and lower the cost to the end user.

More recently, the technology has developed an approach to direct the material being solidified, using computer driven Numerically Controlled (NC) machines. This allows material to be built up in more planes than just horizontal and in layers that are not restricted to being continuously parallel. These processes, including Directed Metal Laser Sintering and Fused Deposition Modeling may allow future capability to append forms to existing objects or to repair existing objects, rather than the need to completely recreate them. It remains a target for the development of this manufacturing process to recreate the 100% density of material that can be achieved using more ‘subtractive’ processes such as NC machining from raw stock. At the time of writing, metalised powders still required material to support the process and carry the metal fragments into the laser locations, these tend to create small areas of non-metal substances throughout the object, which serve to reduce its mechanical properties regarding yield.

For the research in this document, the number of technologies was restricted to just two, as they were able to produce objects approximately 300mm high for less than \$3000AUD, which is comparable to overall costs of more traditional sculptural processes such as investment casting. The two processes used here, were Selective Laser Sintering (SLS) and Stereolithography (SLA). For Selective Laser Sintering an initial layer of powder is sprayed and the machines software directs the laser to trace out the outside profile (and its wall thickness) relative to the first 0.5mm thick slice of the object. The platform containing the object is then lowered by 0.5mm, the new powder is then screeded over the top of the object, and the laser traces out the profile of the next ‘slice’ of the object, and so on (Figure 1). The result was a chamber full of powder that contains the final object, where the unused powder was then removed to reveal the component.

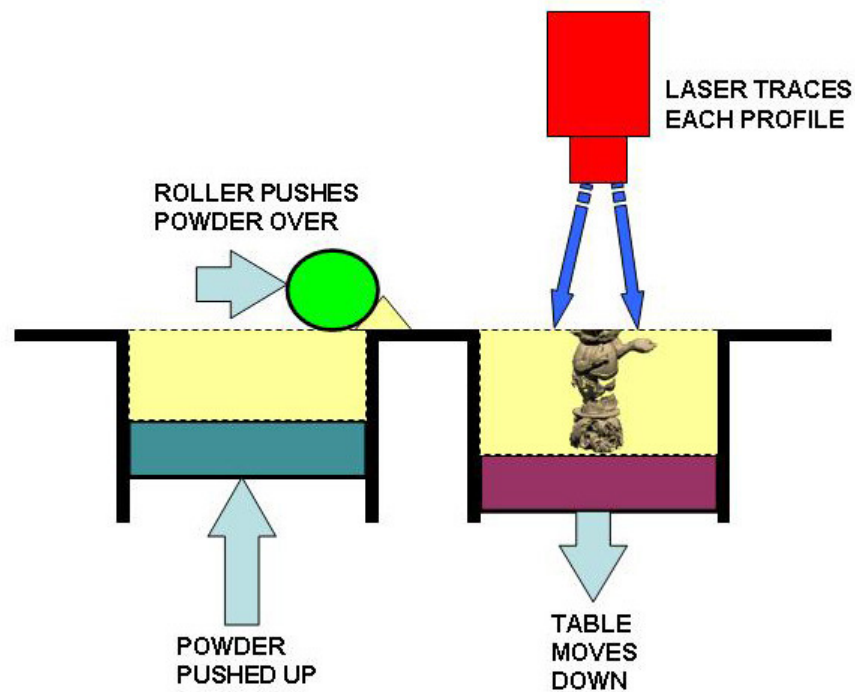


Figure 1. This simplified diagram shows the process of additive fabrication. The powder on the left side is pushed up and spread out under the laser. With each successive pass, the 'table' on the right side is lowered, new powder is spread over and the overhead laser traces the next profile. The emerging part can be seen on the table as it is built up.

Stereolithography (SLA) manufacturing processes use a similar technology, however the powder is substituted for a liquid containing acrylic resins. As with SLS, the chamber is consecutively lowered in between each pass of the laser to build up the final part. SLA components are generally of a finer surface finish, although generally less flexible which made them more appropriate for proving physical appearance for objects at the expense of the flexibility of moving or hinging parts.

One of the initial concerns for this research project, which was making reference to the use of 'advanced' technologies, was that the relevance of the research would soon become outdated as the technology improved and became redundant. This concern soon faded in its impact, as the research directed itself towards the usage of generic virtual systems rather than attaching itself to any one software, application version or specific manufacturing process. When this research began in 2006, the world trends in additive fabrication centered around the search for alternative methods of creating 100% density exact replicas of existing electronic files. This remained essentially unaltered over the course of this project, with no one uniform 'standard' of processes emerging from the range of formats and processes commercially available.

Advances in material science generated by research laboratories have expanded the choice of available materials for additive fabrication, towards more environmentally and economically sustainable materials and away from earlier materials which often made use of less dimensionally stable and potentially health impacting substances. The additive fabrication marketplace continues to propose, review and analyse the results of research into alternative processes with a tendency towards direct metal fabrications and away from infiltration-based approaches.

The commercial environment remained having its major influence based in engineering and medical sponsorship with only a very small percentage of universities and private companies contributing to its usage for artistic designs. Additional to the relatively high cost of the manufacturing process, the end products are currently limited in the maximum size for a single object. As a consequence, artists and designers whose products are suitable for this scale have begun using it, whereas large sculptural works have avoided it due to cost of process and materials. Jewelers, fashion accessories, surgical and consumer goods have embraced the technology, with this trend likely to increase as tool steels, exotic plastics and precious metals become available for use. The economic viability of additive fabrication over traditional methods, for large scale sculptural works had not reached its tipping point during the course of this study and remained more of a process used for research and development or smaller more mathematically expressive works.

Computer Aided Design (CAD)

As this research makes use of specialised computer driven software applications, it is important for me to explain the specific choice of the applications, from several hundred that were commercially available at the time of research. Development of Computer Aided Design (CAD) started from the fabrication industry and was quickly adapted into many fields, where specialised applications continue to be expanded, spreading its influence into increasingly diverse fields. In order to keep the choice of software being used here in context with what is possible, I will provide a brief overview of the development of computer applications for manufacturing considered for this research.

The term CAD has also been part of the commercial world of engineering and design for more than four decades and its development has grown significantly in the last 20 years. Once the dominion of advanced manufacturing demands to allow

machinery to create objects that were impractical to define in terms of drawings and dimensions; computation technology evolved and found its place earlier and earlier in the design process. Initially, computer driven applications and machinery were confined to realising design concepts that had been conceived using traditional two dimensional (2D) methods of drawings and sketching. With the development and availability of Mechanical CAD (MCAD) software applications such as Pro Engineer from PTC, Unigraphics and CATIA from Dassault Systems, the software evolved into 'parametric' driven applications that allowed the user to create digitally rendered 3D objects that were interactively modifiable using dimensions typed in via a keyboard. These 3D models did not originate from 2D sketches, rather they were composed directly onto specific planar diagrams in real time rendered three dimensional space. Early computer languages such as G-Code were developed to allow the user to direct machinery to use the 3D model directly as an instruction to control the tool heads. These were then, and are still, often referred to by the term Numerically Controlled (NC) machining.

The ability of the software to provide highly accurate visualizations of the objects and assemblies being prepared for manufacture, allowed the entire list of stakeholders in the production phase to review the models before committing to fabrication. All stakeholders were now able to 'pre-visualise' the object and take the benefits back into their own disciplines. Typically the sequence of these stakeholders commenced with conceptual artists and project managers, then through the early production stakeholders such as procurement and sales teams, through engineering and deep technical specialists, on through the manufacturing teams. Storage and wholesaler, product distributors and eventually the end user, were now using a single and unambiguous definition of the end result—the CAD model.

The detriment of these early applications was their cost of implementation. They were inhibitive to purchase and required a significant investment of time and money to implement as the software attempted to take inputs (and produce outputs) tailored for all of the different demands of the stakeholders. At this point in the development timeline, it would be impractical for me to provide an overview of the development history of all areas of CAD development, so I will continue to only follow the 'stream' of development that lead to the software used in this research.

Driven by cost and the demand for increasingly specific inputs and outputs, software applications were being developed by each individual stakeholder in

manufacturing. This quickly developed into the ability to create designs and direct machines to produce objects and assemblies of such fine tolerance and complexity of interaction that they could not be manufactured using traditional fabrication techniques. The most heavily influenced industries were aeronautics, aerospace, aviation and automotive. The development of computer interfaces that allowed users to interactively create and modify Non Uniform Rational Bezier Splines (NURBS) enabled manufacturers to use these free flowing and almost featureless surfaces within their designs. They did not require specific dimensions to be typed in via keyboard, rather the user could sculpt them by manipulating control points interactively with the computer mouse. These types of elements were infinitely modifiable and occupied very small files sizes to store them. More importantly, the NC machines could be driven directly from the NURBS surfaces without the need to create any language of translation, such as engineering drawings.

As the development of applications began to make use of these ‘surface’ models, the ability to render the surfaces also accelerated. The surface was no longer restricted to being one uniform colour, it could be interactively ‘painted’ in order to simulate the colour and texture of the materials it would ultimately be made from. These programs (such as ICEM-surf, Alias Wavefront and 3D Studio Max) became commercially viable in the mid 1990’s and developed into allowing customers to map actual digital images (scans and photographs) onto the surfaces. This, in combination with significant development in the ability to simulate different lighting conditions, opened the manufacturing industry applications into an entirely new domain, that of visualisation and animation for the entertainment industry.

By the end of the 20th century, computer generated imagery and special effects were common place in the entertainment film industry. Applications such as 3DMax, Maya, and Bryce were priced for availability to individuals and artists and designers began to embed these tools into their palette for conceiving and realising designs. However, it was the use of Computer Generated Images (CGI) for the computer gaming industry that attracted the largest investment from industry, many times larger than the manufacturing sector. Applications were specifically developed to increasingly reduce the size of, and complexity of, the underlying ‘surface’ geometry in favour of increasingly larger and more complex images rendered onto the surface. Computational capacity of the hardware creating the models was allowing the creation of computer

controlled animated kinematic skeletons, rendered in ‘real time’ with highly complex texture maps.

The next major development in the evolution of CAD for designers and artists came with the development and availability of software that allows the rendered image itself, to modify the contours of the underlying surface. This process used the ranges of colour and tone existing within the image to create a ‘texture map’ or ‘bump map’ for the computer to render and present to the monitor. The entertainment industry, in both movies and games, was such a market leader in CAD that it began creating its own proprietary software to distinguish itself from its competitors. Companies such as Warner Bros. Entertainment, Dreamworks, Walt Disney Pictures and Pixologic generated new philosophies of defining 3D space within computer systems. Often these were re-packaged for sale to industry and individuals in the form of open architecture products such as Maya and ZBrush. Developments in the philosophy and applications for CGI are keenly followed by artists and designers at technology conferences such as SIGGRAPH each year.

The number of different computer aided applications have increased to the point where the industry is often referred to as CAX, where “x” indicates the many different letters place here for the different industries.

The majority of artist oriented CAX applications for digital sculpture make use of a combination of sub-divisional surfacing and texture mapping. These technologies allow the artist to decrease the ‘resolution’ of the underlying surfaces in order to make subtle alterations to large areas of objects without disturbing the fine details built upon them. They also allow the artists to interactively modify the texture map that is driving the surfaces, so they are effectively ‘painting’ features into the model with the stroke of a digital ‘brush’ (often the computer mouse, or the pen from a stylus pad). Artists such as Meats Meier and Scott Eaton (pictured below) make use of combinations of the two processes to create their digital figurative sculptures.



Figure 2.
Prometheus – Scott Eaton
Sourced from
www.scott-eaton.com/



Last of the leaves – Meats Meier
Sourced from
www.3dartspace.com/

By contrast, for this research an application was sought that would remove the temptation to utilize textures, or to interactively alter the resolution of the file as neither of these material properties occur in organic clays. The application selected for this research was Claytools Version 1.2 by SensAble Pty Ltd. This application relied on a desk mounted haptic device to manipulate 3D solid models on screen. It was not able to use surface data in any of its forms and demanded that the user modify the ‘digital clay’ in a very similar method than that used by artists hand-forming organic clay using manual handtools.

Given the nature of the comparison of both traditional and digital methods involved in this research, it is necessary to outline the practice used to gather the information being analysed. In the following chapter the research methodology being used is expanded and defended with respect to its applicability in revealing the implicit knowledge behind both methods of sculptural production.

CHAPTER THREE

Autoethnography of the figurative sculpture process

As the majority of the data analysed for this research was being generated by the researcher, it is important to take the time to expand and explain the rigor upon which the research method was built. This chapter outlines the reasoning behind the choice of research method and offers technical support for the applicability of the research method to the type and availability of the information, being sought.

Ethnography is the study of a culture by identifying its implicit languages and making their cultural meanings explicit. With respect to this document, the practice of ethnography had been extended into an anthropological approach to immerse the researcher into the cultural activity being studied. Not just as a participant observer (Spradley 1980) but as a fully immersed actor in the socio-cultural activity. The study was a systematic structuring, analysis and explanation of the meanings behind the individual elements, in context to what is known about the entirety of a culture, from within the culture itself. It is this saturation into the practice that eliminates any filtering or interpretations that may exist if the practice was studied from 'outside' using a strictly anthropologic approach. I contend that, without the use of a Practitioner-Based Enquiry, access to the silent dialogue within the artist as they construct their 3D space could not be effectively achieved. This research was about the experience of using interactive mediums and relies on someone recording that experience. By allowing the researcher themselves, to record the learning and the application of this skill, a deeper understanding of the implicit meanings (the 'why') behind the results would be achievable. My research methodology needed to be structured and methodical in its approach in order to establish credibility for its findings. In addition to the rigor of the methods, it must ensure that all of the known influences of the activity are covered, as any omissions or misinterpretations would serve to weaken the structural integrity and act as a 'weak link' in the chain of analysis and conclusions being created. The results of the practice of sculpture was the creation of the artistic artifacts, so it stands that for this document to be grounded on credible principles, the competency level of the artworks created should be at least the level that a native of the culture would reasonably consider as spatially competent, in order to qualify as having actively participated in the culture.

For this research, this meant the repeated performance of every stage involved in figurative sculpture while exhaustively recording and analysing the information from each stage. Ethnographic research supports the ideal that both the questions and the answers must be discovered within the social situation being studied and the autoethnographic approach used by the author, maintains this premise. In order to determine the most revealing questions and answers, I had immersed myself in the activity of virtual and physical clay sculpture with the intention of directing the nature of the questions from generalized, to focused and specific. The end point of the information gathering for this document was the formulation of a hypothesis about the experience of creating sculptural objects in these mediums and the potential for technology to positively enhance it. In practice, this was a cycle of following each virtual and physical work from its original idea to its finish. The majority of the recording was via a headset microphone connected to a portable digital recorder, which was in turn connected to a voice recognition system to convert the spoken words into text. My professional life had taught me the inescapable importance of being organised when managing complex situations and I approached this research with the same understanding of maintaining strong but flexible procedures. The digital recordings began as simple free speech while sculpting, these 'ramblings' were then converted to text using specific computer based software applications within Dragon Naturally Speaking Version 9.5 from Nuance Communications Inc.

Once the session had been converted to text, I would then examine and analyse the text as if it were the transcript of an interview with another participant. The text was analysed for any terms or references that may prompt the need to know more about those terms in order to understand them. From these terms, a more traditional ethnographic interview could then be constructed in the way it would be done if the informant was not the researcher. Being both the participant and researcher meant that in each pass through analysis, the cycle of asking directed and structured questions would occur directly after the next consecutive block of modeling time. I was unable to be fully immersed in the practice of sculpting, for either virtual or physical media, and simultaneously conduct a question and response style interview without compromising the mental processes needed for either activity. The resulting list of questions that had arisen from the analysis of the previous vocalising during sculpting, would then be used to prompt further questions to create consecutively deeper understandings about the specific meaning behind any specific terms being used. This method was utilised to

ensure that information gathered in this way was essentially no different to an approach that would be used by an external ethnography as the dialogue took the form of questions and answers that began as generalised enquiries and developed into highly focused questions about specific topics. By replicating the methods of conventional ethnography argued by Spradley (1979, 1980), I believe I was able to manage the risks of using potentially flawed systems for accessing information.

As the data gathering became more specific, the questions evolved into determining the relationship between any of the patterns being revealed. In ethnographic style informant interviews, the semantic relationships between patterns or features are used to identify the existence of implicit domains within a specific culture. This method was transferred directly to my own autoethnography to attempt to exhaust the available information in the search for these domains. Analysing the information allowed me to capture some of the sequencing and interrelationships between implicit stages during the creation of clay sculptures.

The amount of information being revealed was also converted into simplified diagrams and flowcharts for higher level or more generalized domains and then onto more detailed schematics for the specific sub-domains. An example of a high level chart is shown in Figure 3.

MAKING AN ANALYSIS OF INDIVIDUAL FORMS

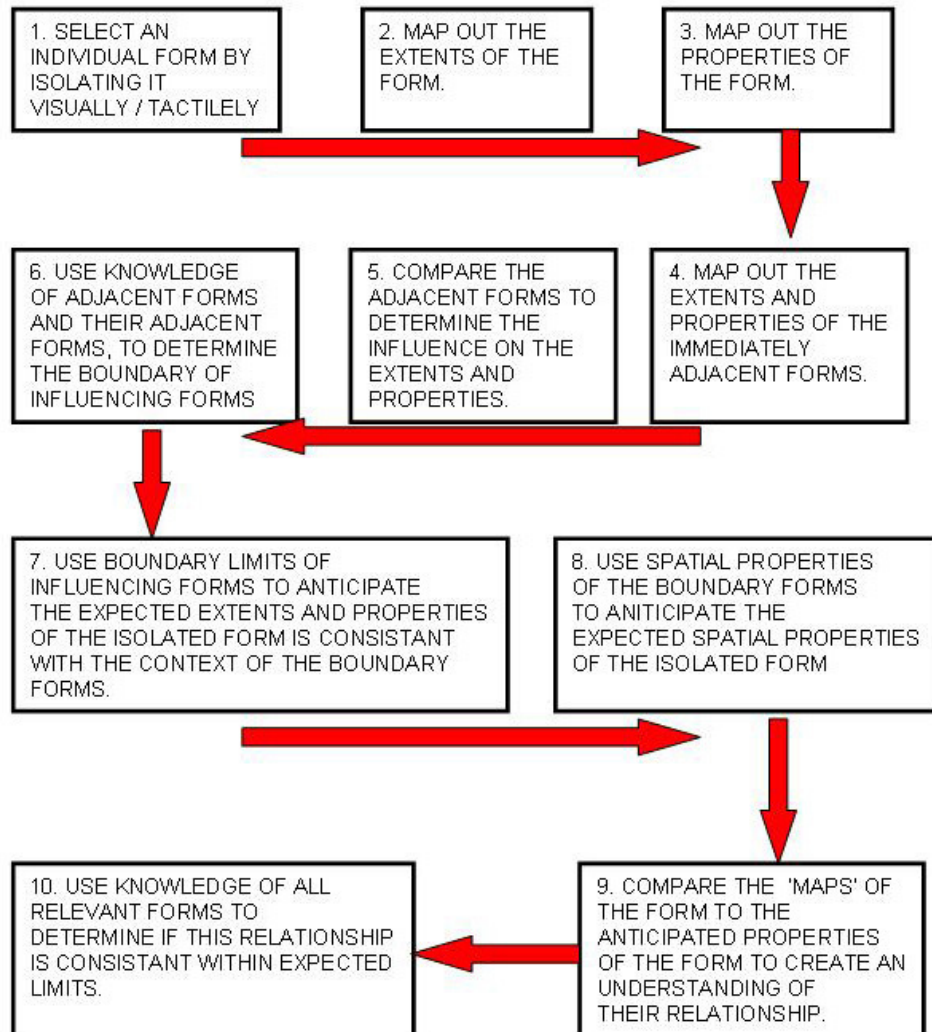


Figure 3. This is an example of a high level flow chart generated as a result of the structured questions and answers. Here, the process of analysing a particular form to determine if it 'looks right' is broken down into a sequence of decisions. Once this process is confirmed as a representation of the actual events, the individual stages are then treated separately to examine and expand their contents.

During the initial stages of this study I had concerns about the evolving methodology, these concerns centred on ensuring that the act of recording the mental processes behind specific actions did not alter the thoughts themselves. I was aware that in a typical ethnographic method, the researcher needs to consider the unreliability of the verbalising based on the informants perception of social pressures such as accuracy (the informant may be thinking 'is this a test?') and status (the informant may be thinking 'I should know this'). My initial concerns were unproven and it has been my experience that these areas of unreliability were mitigated by not perceiving myself

as needing the two separate identities of informant and interview, but rather as Reed-Donahay (1997, p.3) argues, for the performance of one role stressing multiple shifting identities. Further, I believe the digital recorder acted as a reliable safety net to capture traces of thought patterns as they occurred, rather than relying on my ability to swap roles and recall specifics about phrasing or emphasis, sometimes hours after the actual event. The recorder simply captured everything that was verbalised, without the imposition of the failings of human memory.

Within the framework of processing information such as vocalising thoughts, short term memory allocations are directly accessible to verbalise as they were very recently processed, whereas the information from long term memory allocations needed to be retrieved before they could be reported and processed. Short term memory has a limited capacity ensuring that only the most recently processed information is accessible, as a consequence the practice of recording emphasised speaking as soon as the thoughts were occurring, rather than disturbing the flow of ideas by attempting to analyse the data as it occurred. The information gathering was treated by two separate methods to optimise the evidence being captured; the digital recorder was used to search for new areas for potential domains or sub-domains from directly within the experience of clay sculpting, while the retrospective interview questions were used for prompting recollections and explanations about specific parts of the recordings. The analysis of the vocalising and interview transcripts was performed after the recording, as a formalised taxonomic review. In this way, I became more confident that the research was utilising the two forms of verbal report that claim to be the closest reflection of the actual cognitive process, that of concurrent (thinking aloud) for short term records and retrospective reporting where a durable trace is laid down for any heeded information during a task. These correspond to the levels of verbalization being put forward by Anders Ericsson and Simon (1993, p.17) during interview protocol analyses. To minimise the probability of corrupting recall with more recent experiences, it was important for me to conduct these interviews and retrospectives directly after the practical activities, to access the closest approximation of the actual memory structures that had occurred.

The majority of the questions were structured to be as objective as possible without straying from the direct subject and without leading the anticipated answers. Questions were usually prefaced by phrases such as: 'tell us everything you know',

‘what are all of the _____ you can think of’ and ‘are there anymore _____ than those you have already mentioned?’. This was done deliberately to minimise the chance of bias in the wording of enquiries and to allow the mental structures to reveal themselves. Had the research used ‘why’ type questions of myself, it ran the risk of retrieving a report on the general motives for explaining and predicting behaviour of this researcher. This would only find behavioral irregularities where the goal was to make the interview as objective as possible and to try and specify the cognitive mechanisms that generated the behaviour. Criticisms of this technique have questioned the likelihood of the verbalising being disassociated from the behaviour they are supposed to control (Verplanck 1962), and although these have regularly been countered since the 1970’s (Dulany & O’Connell 1963; Schwartz 1966; Frankel, Levine & Karpf 1970), the research rigor must be held to ensure objectivity in the recorded data.

For this reason, the digital recordings were used to provide clues for specific questions to be used in the retrospective interviews. I do not propose to completely remove the possibility of any bias in answering, however by allowing the recording to be free-flowing and without questions or analysis during the event and asking the focused questions as retrospectives, I at least will maintain the research rigor and minimise the influences from errors. The possibility of simply restating recent cues was raised by Schumann and Presser (1981), with regard to whether altering the order in which questions were posed, would yield different responses. I do not believe that this is applicable to this study as the task was not to test the consistency of recall over a period of time, but rather to exhaust the recollections from each interview session and then to move on. Subsequent interviews on related subjects were not set as a test of recollection but the desire to further reveal implicit knowledge. The reason for this is to attempt to discover as many aspects of sculptural behaviour as possible that do not vary between artists, yet give consideration for the discrimination between one individual from another.

In the following chapter, the historical role of sculptors in applying these behavioral decisions is explained with specific reference to the use of newly evolving materials and construction techniques. Beyond Chapter Four I will expand on the reasons behind the construction of my own works. In particular the need to include the newly developing fields of digital sculpture. In the final chapters, the conclusions that have been drawn from the entire process of converting the idea to the object are summarised.

CHAPTER FOUR

The role of sculptors in utilising ‘new’ materials

Artists and designers have historically been prompt in exploring and adapting materials in order to expand the palette of materials they use for their art. The exploration of media was often a search for materials and processes that have harmony with their particular form of expression and the willingness to consider and experiment with new materials. It has been the ability of artists to adopt new and emerging materials for their own purposes that allows them to progress and in turn, evolve the use of materials in society. This has been particularly evident with sculpture, with artists being some of the first peoples in communities to form and shape stone and wood for non-utility purposes. The early forms tended to reflect their understanding of the world around them and to capture their beliefs and cultures into votive objects.

Humanity’s development of mastery over metals had allowed the development of tools that were specifically formed for shaping raw materials such as stone and timber. This was a fundamental step in the evolution of sculptors as artists were now able to form impressions upon the hardest of stones and timbers to create objects that would long outlive the artist and may be used as cultural icons for multiple generations. As a consequence artists were able to add value to the raw material by ‘releasing’ the forms that were contained within the raw material (Figure 4).



Figure 4.
The Venus of Willendorf,
Limestone carving (21,000 B.C.) est.

Both stone and woodwork carvings were essentially subtractive processes, where the creation of an object most often required a single piece of raw material, sufficient enough in volume to include the desired shape, which is then selectively reduced to reveal the final work. However, it was the advent of fired ceramics, and later of the casting of metals, that freed the creative mind of the artist to build up the desired shape rather than carve it out. This simple advancement allowed sculptors to create objects that did not have their origins inside of raw material. Sculptures were free to be conceived and imagined without the restrictions of any limiting volumes stemming from available blocks of raw material.

Thousands of years of development of refinement in the treatment of metals for creating tools and techniques witnessed artisans' increasing ability to accurately and predictably carve and cast materials. Carvings in naturally occurring elements such as stone, reached high points in craftsmanship, with regard to complexity and accuracy during the 13th to 18th centuries. Here artists were once again utilising the emerging technologies and materials for creative purposes, where these advances were often driven by civil and agricultural demands. Robust materials such as marble and limestone were used in architecture and civil applications for their strength and longevity, however it took the artists desire to explore new media for expression and endurance to transform them from quarried foundation blocks to priceless social artifacts. As the development of ever harder grades and treatments of metals continued, artists were able to utilize even the hardest of stones such as granites and basalts.

The evolution of metallurgy has been contributed to by artists and designers as their need for more easily formable and robust materials began to increase. Social recognition of the sculpted forms as religious or historical icons, saw the raw materials used for sculptural creations, expand to include rare and precious metals such as gold and silver as well as precious stones and enamels (Figure 5).



Figure54.
Virgin and Child
Jeanne d'Evreux (1339)
Musee de Louvre, Paris

Evolving metal fabrication techniques such as machining and welding were pioneered by industry, however it was artists and designers who began to form more organic and free-formed objects for the sake of personal or socio-cultural expressions such as public monuments and large scale architectural decoration.

Sculptors were instrumental in combining sometimes disparate materials into objects. Industry rarely combined primary materials such as stone, metals and timbers for commercial usage, however the artists could allow each material to contribute to the contextual meaning of their artworks using its own unique properties. This was employed as an advantage to the composition as it circumvented any potential compromises associated with works made entirely of one substance. Stones and Carbon based metals, while durable and having high yield strength, were also heavy and required a level of a tradesman's understanding. Timbers, cuprous and precious metals could then be considered for application as ornamental or more expressive usage while allowing the more industrial materials to support and protect them.

The evolution of synthetic materials such as plastics, composite foams, polyesters and resins extended the malleability of materials with an increase in longevity and lowering of production costs. Sculptors were again quick to develop innovative

applications of the new materials for artistic expression rather than form driven by function. Manmade products allowed artists to form objects that were strongly influenced by their viscosity and make use of the vast range of available colour, texture and material properties (Figure 6).



Figure 6.
Expansion Series (No.6)
Baldaccini Cezar

The ongoing development in the precision of control in metallurgy was welcomed by artists as the newer materials offered increased ability to form shapes and further extended the available palette of texture and colour. In the 20th Century, metal processing witnessed creation of commercially available stainless steels, composite alloys and metalized plating and anodizing. Sculptors continued to express the potential of these materials to be shaped and treated (Figure 7) in ways that were not commonly experienced in industry. Industrial and consumer based products were absorbed into compositions to create novel applications, elements such as machinery, light sources (fluorescent, incandescent and LED).



Figure 7.
Rabbit, 1986
Jeff Koons, Stainless steel

The recently emerging materials that were used in the additive fabrications for my own research are essentially no different to other materials with regard to sculptural lineage. Industry and commerce have evolved a new method of fabrication and associated materials and it is now the role of sculptural artists to establish it as means of spatial expression. The relatively high commercial aspects of additive fabrications and the (currently) limited range of materials have resulted in a slower acceptance and usage of it as a sculptural medium. Artists such as Bathsheba Grossman (Figure 8) have already adapted to the process and the limited object sizes for their sculptural works. For many other artists using additive fabrication, it is being used in combination with existing methods to create objects, or parts of objects, for sculptural compositions.



Figure 8.
Alterknot,
Bathsheba Grossman, steel-bronze

For other artists, such as Keith Brown, the sculptural experimentation and expression has been directed at the spatial expression rather than the material properties (Figure 9). Brown, who is the founder and President of Fine Art Sculpture and Technology in the UK, has forged a position as one of the foremost digital sculptors working in Europe. It is the pioneering works of these sculptors that will pave the way for others as a conduit for experimenting with this process for their own sculptural works.



Figure 9.
Detail of Shoal
Keith Brown 1995

In the following chapter, I will explain the intentions behind the Creative Presentation for my own research, which includes the additive fabrications that were composed and constructed.

CHAPTER FIVE

5.1 The Conceptual Intent for the works in the Creative Presentation

The underlying connection between all of the sculpted works within the Creative Presentation was an exploration of creating physical objects that conveyed my understanding of what it means to the human experience, to possess an “age”. They were to portray what it means to come to terms with the passage of time and the realisation that the amount of time is finite. To illustrate this, I had chosen to explore the visual artifacts that suggest a particular supernatural identity, the figure of Satan. Satan was chosen, not because of any desire to promote or judge the character, but because this particular figure has come to represent a complex range of often contradictory aspects of our own humanity. I wanted to create a series of connected works that explore a range of physicality’s beyond any historic representations as a malevolent and immortal male figure.

The anecdotal history of this figure, as derived from texts and folklore, reveals a figure that was at one time an immortal and pure object of adoration, then via a series of self initiated incidents, finds itself cast out of both purity and immortality. The decline of this characters’ apparent honour did not decrease its popularity in human folklore—despite its wavering in status from being perceived as an ever present fearful aggressor to a more contemporary profile as an object of derision and suggestive of an unenlightened and superstitious era. For clarity and ease of understanding I will refer to the figure of Satan as ‘he’ in this text, though at no time did I, nor do I, believe this entity is restricted to being perceived as strictly male.

This figures’ ability to transform his appearance in order to persuade and direct humanity away from immortality was fertile ground for me to pursue a range of different ‘ages’ and genders, while exploring ideas of what it means to be human in the face of our own mortality. The exhibited work consist of eight earthenware objects that trace the classical narrative of a fall from grace and three resin based objects that explore aspects of the figures’ potential immortality. The earthenware sculptures were designed to represent both male and female genders in various states of contemplation about their mortality. Each work is based around representing only one subject that is predominantly human in form and in a state of mental or physical anxiety. The anxiety is a product of what I saw as the figures inability to come to terms with both its internal and external transformations.

Rather than just an attempt to define the truth about a fictional figure, I chose this particular identity to portray my understanding of what it truly means to be human. I believe that gaining an understanding of our own physical transformations due to age and knowledge are critical to us gaining an understanding of our potential spiritual transformations and knowledge. I had the desire to attempt to capture in a series of static, one piece objects, my understanding of what it means to navigate our way through the human experience under the burden of knowing that the experience is finite, it will end with no clear understanding of what lies beyond the transformation that physical death will bring with it.

Care must be taken when representing the 'idea' of Satan in a designed object, as there exists a series of paradoxes and contradictions traditionally associated with it. Satan may be considered as the embodiment of eternal death and yet he does not die himself, he does not corporeally exist and yet is perceived by many people as being ever present and directly influencing their environment. To navigate around the potential for inconsistent and unfounded concepts of this subject matter, it was treated as being more than just the embodiment of an opposing force, an eternal adversary. Instead, I have taken the perspective that this figure is the crystallising of what it means to make a choice and the value of making and accepting the consequences of it. I saw Satan as an accessible doorway for me to use to contact our primal fears of abandonment, guilt, justice and deception.

I have chosen not to make any commentary on the belief system that spawned this character nor those who advocate or oppose that system. I have selected this figure from the many figures of the various religions because of what I saw as a paradox of an entity being spurned and yet necessary for those that spurn it. I believe that ideas such as Satan are necessary for humanity for several reasons. Firstly, it is a temptation of our human nature to use a device (a scapegoat) to displace our negative behaviour upon. Secondly, by inventing an entity that we can blame as the source of our own faults, we displace the responsibility for both the cause and effect of our behaviour away from ourselves. And thirdly, that this entity can then be moulded and designed to keep divine goals in context, it is a dualistic opposite of enlightenment and therefore an important tool for the human mind to use to define the boundary of good and evil.

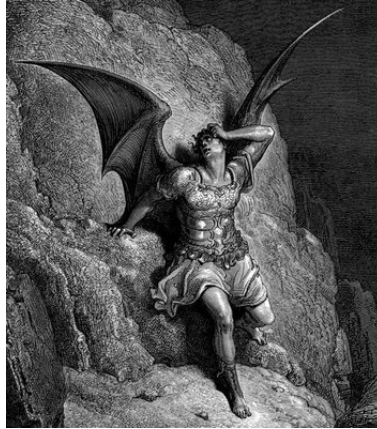


Figure 10
Plate 084 from *Paradise Lost*
Book IV 73-78
Gustave Dore

Satan is attributed as having questioned the absolute authority of his God and as a result was abandoned by his God and cast down into an eternal fiery abyss. Compounding this abandonment was his inability to communicate with the Divine, yet he is able to influence other creations of God via threatening and tempting actions revolving around earthly possessions. Satan is often described as having a desire to revenge his treatment by attempting to seduce other creations of his God (in this case humanity) to also question the authority of God.

For the purpose of my research, rather than drawing influence from classical treatments of the human figure in sculptural artworks, where the intention dealt with taking the human form and using it to suggest the Divine, these works were my exploration into taking a divine entity and associating it with the human. I wanted to place less consideration on the imposing, indomitable malevolent aspects of this character in favour of bringing forward more of a fragile and deflated cohort to mankind's own spiritual journey. My intention was to create objects that were less of the artwork as an object of beauty and aspiration, rather as an attempt at recording our own vulnerability and the potential for our own sense of impending death to alter and guide our behavior. I wanted to suppress the potential for Satan to be presented as something supernatural and removed from our experience in favour of portraying the subject in a range of experiences that were more readily identifiable for humans, and in the case of our own mortality, unavoidable. The whole point of Satan depicted this way was to bring that feeling of immortality trapped inside a mortal body within reach of our experience, to hold this character inside the flesh of man and woman.

I believe it is important to emphatically state that it is not, and was not, my belief nor my intention, to use these exhibited objects to make comment upon, nor to influence the opinions of others considering these representations of male and female figures as true and accurate renderings of actual people or as portrayals of idyllic or preferred physical attributes. Instead, the appearance of male and female bodies are purposeful devices used by me to facilitate an interpretation of the works as suggesting a physical manifestation of each sculpted subjects own deluded self image.

The compositions of the earthenware objects are centred on a single figure in each work. While some works have other entities in them, I used the other elements only as devices to enhance the central figure and support the context in which it was intended. The solitary treatment of the subject was intended to emphasise the isolation and lack of support; suggestive of a lack of authority, the lack of a backing and group associations. As a consequence I wanted to capture the subject when they were alone, unassisted and exposed. I have specifically chosen to show each figure in a state of deliberation. Contemplative poses were a strong theme through these works and it stems from my need to possess moments of introspection by the subject within the sculpture. I feel it is within these internalising moments that realisations of our individual contexts rise and fall most strongly in our consciousness. These works were intended to distill these moments of self awareness in the language of the body and its expressions.



Figure 11
Chactas Meditating on Atala's Tomb
Francisque-Joseph Duret (1835)
(Duby 2006, p.877)

I drew inspiration from many of the classical works such as *Chactas Meditating* by Duret (Figure 11) and *Young Greek Girl on the Tomb of Marco Botzaris* by David d'Angers (c.1825) which portrays the subject in introspective moments that suggest an awareness of the subjects own humanity.

While I make no allusions that the compositions or craftsmanship revealed in these works are beyond a level of reasonable competency, I do not believe this diminishes the intensity of their intended meaning or my desire for their collective creation. My awareness of my limitations is not used as a panacea to excuse any faults in quality within the pieces. I had chosen to learn a new skill set during the course of the research. Concomitant with that decision must lay the understanding that the objects being created will be restricted in quality as direct result of having limited experience at converting intended designs into physical dimension in this way. However, it is my firm belief that as the creator of the sculptures, it was the exercise of attempting to translate considered and constructed thought into physical objects that took precedence in the pieces for this research, rather than just evaluation of the quality of composition and finish in isolation. This was a premeditated act of attempting to step outside of my own internal experience and attempting to capture my intentions into three dimensional space. It was a purposeful and deterministic approach in the recording of the event of my efforts to move a dynamic mental ideal into a static physical record. The works were not intentionally abstracted on purpose, I was not attempting to see familiar forms in randomly generated shapes, they were constructed with a particular and focused intention.

Any formation of a 'style' across the works were guided by both the limitations of my own awareness of modeling with clay and the desire to represent the human physical condition with a standard of anatomical accuracy that was at least not visually distracting in its disproportions. I made no conscious attempt to replicate the compositions or treatment of the human figure from classical sculptures.



Figure 12
The Rape of the Sabine,
Giambologna, 1582
(Duby 2006, p.677)

Classical compositions of the 16th and 17th Centuries, often included dynamic torsion in the bodies of the subjects in order to create the impression of a frozen moment in a dynamic scene. Sculptors such as Giambologna (Figure 12), Benvenuto Cellini, Gian Lorenzo Bernini, Pierre Puget and Francesco Mochi displayed their mastery of rendering the human form in twisting postures with straining or flying drapery. In contrast, for the majority of my own works, I wanted the static nature of the subject to be brought forward and to imply that the particular pose was sustained over an extended period of time. I needed the works to convey the idea that they may be considered as exercises in portraying each subject being aware of their own flesh. In each work I wanted to convey the emotions felt by the figure becoming conscious of their exterior, the vessel in which their identity is being carried. The compositions portray each identity dealing with their understanding of their (mortal) flesh. Across the earthenware objects, these emotions varied from the pride and seduction of the exaggerated and gender-specific proportions of the 'younger' males and females, to the desire to be relieved from its limits and entrapments as the subjects' apparent awareness of their age sets in.

5.2 The use of ‘age’ and ‘flesh’ as a device for expression

To emphasise and extrapolate the context of each work beyond the posture of the body, I wanted to create a continuum among the works by representing the impact of a range of physical ages for each subject. To portray the passage of time on the subjects, the condition of their flesh was rendered in a state of unrelenting transformation. The devices of age and the condition of the flesh were important for me as I believe they are accouterments of transformation in our own human experience. It is in these states of transformation that the fundamental essences of objects are considered; that is not to say they are revealed, it is to say that an act of transformation generates an opportunity for the inner purpose of objects to become more or less apparent.



Figure 13
Skeleton on the Tomb of Rene de Chalons
Ligier Richier c. 1550
(Duby 2006, p. 703)

Classical funerary works would sometimes include figures that portrayed this transformation (termed *transi*) where the often recumbent figure was shown with the stigmata of atrophy and death. This was done, not to show the subject as having lead an austere life, but to maintain a link between the two facets of the same reality, that the terrestrial body and the eternal body were then seen as one and the same, where death only temporarily transforms into a *transi*. I did not want to display death in such

physical reality, where the interior of the body may become visible, such as the Skeleton on the Tomb of Rene de Chalons (Figure 13). At the same time, I consciously chose not to glorify it by rendering the body as youthful and beautiful such as The Dying Slave by Michaelangelo (Figure 14), The Martyrdom of St. Lawrence by Bernini, the Hellenistic work of The Dying Gaul or even the Pieta by Michaelangelo.



Figure 14
The Dying Slave
Michaelangelo, 1515
(Duby 2006, p.626)

The transformations these sculptures represented were conceived as both internal and external. Just as it is my understanding that the subject of Satan is a rich source of inspiration about the human condition, I also believe that characters that are in a state of flux or transition are more interesting and engaging over the same character in a constant condition. Internally, their transformation is working through the mind as well as the body, and the works are attempting to capture the externalising of that transformation that is taking place within the mind of the subject. The works were intended to be influenced by the visualisation of that internal transformation. I specifically wanted the subjects to be dealing with the acceptance of something beyond their control. Once the immortal figure had been wrapped in a mortal shell, I wanted the 'element beyond their control' to be the onset of physical age resulting in death. I saw death, in its many incarnations, as being their vehicle of inescapable change.

Philosophically, I needed the works to reflect my understanding of those human experiences and emotions that are frequently spawned by dealing with internal and external transformations. In particular, I wanted to record the transformation from a self image based on our current existence, into another, which is essentially unknown. This transformation from known to unknown was paralleled by the constant transition from young to old, from the way we look and feel now, to the way we will look and feel towards the end of our lives.

I do not wish to overstate the philosophical aspects behind the compositions, however I believe it is important for the intended conceptual meaning to be stated to ground the goal of this research. The goal was to search for patterns of thought and action when attempting to convert specifically designed compositions from their mental images into physical objects. As such, by clearly stating the intentions that moulded the original mental image for each composition, I hoped to visually analyse the resulting object to look for evidence of the devices used to translate these thoughts. For this research they are the devices of immortality dealing with impending death, and the traces of physical transformation that sponsor moments of contemplation about how each subject understands itself.

The inclusion of elements of animal anatomy among all of the works was to provide a visual foundation for an act of physical change. It also draws heavily from the traditional story of Satan and the fallen angels, who had their fall from grace declared upon them by becoming more bestial. The works for the Creative Presentation span a timeline in this story, which begins with the casting out of heaven and ends with the death of the physical body of an angel. Building upon the literal portrayal of this drama, I wanted to draw deliberate parallels between the emergence of the internal animal attributes of the fallen angel and mankind's desire to create this character as a way of dealing with their own internal animalistic behaviors. As a consequence I wanted the works to record a transformation that deals with the emotional aspects of a transition from an 'animalistic nature' that was always within (hidden from plain sight), to one that is external and undeniable. For this reason exaggerated proportions of the various gender representations were intended to highlight the contrast between 'beautiful' humans and the 'beasts of the field'.

5.3 The conceptual underpinnings of each of the works

The following pages offer an understanding of the intended thought process that lead to the creation of each work in the Creative Presentation. The works are dealt with here in the order that follows the traditional story of the fall from grace. The works themselves were not created in this order. The works were generally created in a sequence that matched my developing experience with the clay medium. The more technically challenging works were attempted towards the end of the research period.

The earthenware objects were exhibited with a surface colour of satin glossed Nimbus grey. The monotone cool grey colour was used to form a visual barrier that promoted analyzing the objects as designed objects, rather than the depiction of any 'warm' coloured flesh. The objects were created as experimental artifacts of a process and were never intended to reproduce the appearance or texture of living tissue. The high toned grey was chosen for its ability to suppress any form of individual 'identity' that may be a legacy of using any specific colour. This light tone is regularly used in commercial designs for its ability to fill shadows and suppress high contrasting changes in tone across the object. At the same time, the grey promotes a utilitarian sense to the object and removes the accuracy of rendering for any colour patterning as a potential visual distraction. The purpose of the sculptures was to promote the visual comparison of form against form in search for devices or methods for defining space and the flat grey proved a reliable tool for this.

The objects that were created using Additive Fabrication were left in their machined state and colour for similar reasons. By being left in their raw condition it promoted an accord with the monotone earthenware objects and projected them as objects rather than identities.



Falling – 700L x 550W x 900H

This is the first work in the series and was designed to represent the moment of being cast down from heaven. The subject was imagined as feeling the first pangs of vulnerability as a result of becoming aware of its new physical vestige. The subject has its corporeal body replacing its previous ethereal one and a new identity is borne and thrust upon it. In the narrative of the fallen angels cast down into the abyss from the realms of Heaven, this composition is drawn from the moment during the fall when the bottom of the abyss comes into view and the potential impact with the ‘ground’ becomes imminent and apparent.

This first part of the narrative is fundamental to the series of works as it sets the foundations for the transformation of the immortal archangel to the cursed and unclean Damned. From the outset of creating the earthenware series, I wished most fervently to develop enough ability to shape the clay to allow me to capture specific moments of human transformation. My own lack of understanding in forming the clay served, in its way, to inform the anxieties born of an inability to translate mental images into their corresponding object. This composition ably reflects my own inner tensions in creating the work.

The figure was rendered inverted to emphasize the absence of any settled comfort for the subject. The torso is tightened and straightened as the body prepares itself for

the impending trauma of impact, the tension created by understanding its immediate future serves to accelerate the transformation of itself from serene and relaxed entity into a tight and inflexible object. In contrast to the tension in the neck, upper limbs and torso, the lower limbs flail uselessly behind the 'projectile', acting merely as counter balance for the twisting head and shoulders.

The inclusion of drapery was used as a device to capture movement of the body through its new environment. As with the work titled "Tempt-her", the movement of air around the body presses the cloth onto the surface of the flesh. The fastening of the cloth around the subject's waist has disassembled to the point where the drapery is shown on the cusp of being torn away. The act of the cloth being lost was symbolic of a significant milestone in the degeneration of the modest and ethereal creature into an unrefined and disrobed beast. At this moment in the subjects progression, the mental transformation from being nurtured to being rejected, has overshadowed the subjects attention to any self consciousness about exposure of its flesh, by ensuring the cloth was held in place to maintain its own modesty. The wind driven linen is shown unfurling and held in place by the pressures of the streaming air onto the flesh. The cloth was conceived as holding the vestiges of self consciousness and vulnerability of the conscious mind to the opinions of others. As the fall from grace plays out, the figures attention to the lay of the cloth and its coverage is abandoned in favour of more primal instincts of self preservation and mortality.

To enforce the mental aspects of the transformation from beloved to deserted, the traces of the emerging animal begin to spread across the body. Small tips of cranial horns emerge from inside the skull and evoke traditional images of the Damned. The expressions of the hands are clawed and rigid and act as witness to the inner turmoil of the figures thoughts. Clutching and reaching, the straining digits of the hands were intended to claw at the air for purchase upon any form of surety or support. The upper limbs are out away from the torso in an effort to control balance, which was intended to be difficult in the thin air around the body. The inability of the subject to locate some form of resistance around it was symbolic of an absence of any form of security or support for the mind.

The elaborate base was designed to both promote a general impression of teetering balance and echo the dynamic curves of the whipping cloth. The small surface, upon which the work rests, supports the entire figure so it does not come in contact the ground and serves to promote the concept of a top heavy and unstable body

as it falls. The swirling curves of the base are deliberately non-symmetrical and draw attention to the angle at which the torso is presented. The rapidly accelerating curves of the base appear to compress and buckle under the weight, to promote the sensation of falling.



Fallen 650L x 600W x 900H

This object was composed in an attempt to convey that point of narrative in the fall from grace, when the subject is still new to be cast down. Wings are added to the back of the torso in reflection of the traditional imagery associated with archangels. The representations of the wings are heavily stylized due to my limited skills and knowledge of the clays material properties. The feathers borrow heavily from Gothic representations as, at the time of creation, I had limited knowledge of how to suggest the lightness of wings using clay as a medium. The two wings traditionally attributable to angelic figures are not both shown. Rather, I attempted to convey a sense of damage to the figure, from the act of being outcast or the impact of the fall itself, by showing one of wings essentially missing, leaving just a stump of its original connection to the torso. The absence of wings suggests a transformation from angelic to humanity and the consequent enslaving to the effects of gravity.

The portrayal of the subject was intended to convey the first feelings of physical pain. For the sake of this sculpture, I had imagined that such an immortal archangel may not have truly experienced a corporeal body before, and now the spirit must deal with being transformed into something that is solid and imperfect. The presence of physical discomfort was used as a metaphor for the human condition. For this reason the high and steeply angled shoulder, raises the right side as it remains undamaged and more closely aligned with its former angelic existence. In contrast, I had chosen to show the damaged side down facing down towards the ground and symbolically towards humanity. The descent of this spirit down to the ground is sponsored by most

of the elements that constitute its body. The spine is curved away from 'above' and poses questions about the presence of internal injury as the subject embraces itself in an attempt to provide comfort and prevent further injury. The face and its gaze are also directed toward the ground and symbolically away from its former immortality and potential salvation.

Continuing with the intention for the subjects' specific pose, the neck was to be shown tilted at a dramatic angle in an attempt to protect the damaged shoulder and show evidence of the feelings of sorrow. The vulnerable neck is exposed and acts to reveal the weight of the head under the effect of gravity. The chest was hollowed by bringing the shoulder joint forward; this was done to further invoke evidence of injury and serves to open and expand the wings and back to reveal the trauma that has occurred to the skin and wings. Only one arm is shown in full, the other is held to the side in an act that replicates a willingness to protect the ribs and internal organs. The partial arm is shown as limp and possibly injured and it, as with the figures head, now responds as a slave to gravity.

The overall 'age' of the piece was not intended to be specific, just youthful. To foster the idea of youth, the cranial hair is shown as thick and full bodied, the chin is shown as small, the facial features are smooth and refined and the hands are smooth and supple. While the overall evidence suggests the subject is male, I had intended on suppressing any overt masculinity in preference for a suggestion of androgyny. The subtle treatment of the figure is sustained by withholding the transformation into a beast, in favour of a more fundamental and significant translation from spiritual being to mortal human.

The primary shape of the work was to appear as 'top heavy' and reminiscent of an inverted cone. This was a deliberate device to foster an overall sense of instability a funneling and compacting effect from the open spaces between head and wing down to the arms and torso which are pressed together. The feeling of a dynamic squeezing and compression is extended by treating the lowest edge of the work with a different surface texture that appears to form a constricting band around the subjects' waist. The intention of compounding these elements of tension and constriction was to have an accord with the airy immortal angel being compressed into a solid and heavy human. The waist band exacerbates the sensation of binding by representing an unrefined stone, whose jagged surface completely encircles the figure and pulls it in tight as with a strap or ligament, to bind the figure and prevent it from relaxing.



Condolence 600L x 400W x 800H

In this composition I wanted to display two separate concepts overlapping each other. The two ideas were, firstly if Satan could change his external appearance to what ever he desired, how would it appear? And secondly, if regardless of his physical body he was not able to ever find true comfort how would it alter his appearance? From this conceptual starting point I attempted to show an exaggeratedly masculine figure being thrown off balance by its own inflated bulk. I also wanted to explore an influence from the environment itself in adding to the discomfort and mental burden from its physical transformation. Holistically, I wanted the overall composition to appear ‘top heavy’ and teetering on a small contact surface on the ground. This theme of an artificially high centre of gravity became a recurring influence across the earthenware pieces.

The environment which is ‘external’ to the figure itself was conceived as offering little relief or support. To convey this, the plinth was made angular and faceted and designed to be of insufficient size to support the entire body in repose. For further reason of discomfort, the top of the plinth was tilted away from the horizontal to cast the figures own centre of gravity forward and away from being positioned over the top of its pelvis for balance. The intention of tilting the platform was to have the subjects own body respond by creating a posture to prevent the body from succumbing to gravity and toppling off the plinth. The weight of the physical body is countered by bracing the

torso using the straightened right arm and hand. The overall result was intended to be perceived as a posture that could not be sustained indefinitely; I wanted it to look uncomfortable.

The tension within the emerging sculptural composition seemed to be reflective of my own experience in creating it. Small moments of being comfortable in the act of translation were often transient as the act of attempting to translate thoughts into space was comparable to the mechanics of creating the work in physical dimensions. Elements in an apparent harmony of definition and orientation while floating in mental capacity, become compromised and searching for balance as they become manifested into physical dimensions. The external environment of the physical world would impose itself on the idea as it was being realised, creating forces that needed to be repelled or utilized, forces such as gravity and material properties of the clay.

The human proportions of the subject are designed to be overtly masculine, this was purposefully done to suggest an element of self-absorption or vanity if Satan were able to alter his physical appearance as he desired. Several of the works in the exhibited series explore this ideal of an outcast figure being able to change their appearance to corrupt the minds of others. In this work Satan is attempting to redefine his inherent beauty in his own terms. However, I did not want the figure to have absolute freedom of appearance, I wanted the transformation from immortal to human and angel into beast to be inescapable and unrelenting. As a consequence, the bestial transformation is limited to the head, which I saw as the metaphorical 'source' of self awareness and self absorption. The cranial horns are swept back and close to the head to project an effect of being more 'ram' like than those of a bull. I felt that including horns that were jutting, pointed and jagged projections would have been discordant with the consistently rounded and fleshy forms of the body in such a muscular condition. So the horns being imposed onto this creature were formed as thick and rounded to reflect the nature of its torso. The horns, like the arms, were modeled close to the body to imply a level of the spirit externalising a need for reassurance.

The intention was to show this fallen angel at an extreme point from its condition from when it fell from grace. To contrast with the airy lightness, of how I imagined an angelic figure, the subject needed to be shown as heavy and ground-bound, bulky and languid. I relied on two major devices to attempt to convey this sensation; a harsh and tilting plinth and a large body labouring under the force of gravity. The musculature was modeled to appear over inflated and stacked on top of itself to reflect the stonework

it was perched upon, at the same time the stonework was to appear fractured and angular. The lines and seams of the stony plinth are discontinuous and interrupted, with strata lines that angle sharply downward in sympathy with the angle of the top surface. The body of the creature itself was posed, not in vain glory, but in a situation of sufferance under gravity. To project this, the loose left wrist and arm were paired with the loose left foot to completely submit to the endless force of gravity.

I wanted the work to have a settled contemplation about it, similar to Jean-Antoine Houdon's *Voltaire Seated* (Figure 15), where the limbs are at rest and the neck is twisted to direct the gaze away from the body. To extend the lack of movement, no drapery is included in the composition to indicate anything that is light or likely to be effected by the movement of wind. In effect I wanted the body to look at solid and fixed as the plinth it rests upon.



Figure 15
detail from *Voltaire Seated*
Jean-Antoine Houdon, 1795
(Duby 2006, p.833)

Gravity is an inescapable aspect of the human experience and was used throughout the exhibited works as a metaphor for humanity and mortality. Here the persistence of gravity was used to suggest that the figure may be so large and bulky that it is its own mass that tilts the platform it rests upon. So rather than a perception that the earth was deliberately tilting to “throw the creature off”, I wanted the composition to lightly suggest that this new found heavy and cumbersome body is so susceptible to gravity that its mass is threatening to crumple the plinth on one side and potentially collapse it.



Tempt-her 350L x 250W x 750H

In this piece I wanted to challenge even my own preconceptions of the physical appearance of Satan. To do so, I had imagined 'him' as experimenting with altering his appearance to that of a young woman. Rather than submit to the temptation to show this creature 'celebrating' their ability of metamorphosis, I needed to hold the figure in a state of inner turmoil, in an unsettled and even conflicting mentality. In this work I attempted to reveal the self awareness of the spirit emerging as a complex composite of self consciousness and confidence. So the body was positioned to integrate with the concept that flowed through all of the earthenware pieces, that is; to be self aware with respect to physical body and age, to be in a state of inner and outer transformation and to be uncomfortable or unsettled.

The final composition resulted in a complete suppression of visual evidence in the bestial transformation (although the feet are not revealed), in favour of testing my capacity to record a more subtle inner transformation. The transformation intended here was exploring the potential for the influence of the subjects own environment upon their psyche. In essence, I wanted to try and capture a sense of self-consciousness about 'his' physical appearance. While I recognize that there are no obvious prompts to suggest the subject may be satanic, this piece is consciously designed to attempt to portray another

potential variation to the physicality of this character. There are no elements of animalia, no impositions of horn or hoof; instead the intention was to explore the portrayal of self awareness in its most human form. The transformation is not from human to beast, it was from self conscious to self assurance. Philosophically, I had imagined that one of the devices used by Satan in the seduction of others to his will, would be physical seduction, and it was this self assurance blushing over the physical body, that was intended for capture in this work.

I am aware that, as with most of the earthenware objects, my handling of the proportions of each gender appeared exaggerated and over stated. I feel this owes, in no small part, to my own inability at the time to capture subtlety of poise using the newly acquired experiences of physical clay. The amateur nature of the attempts at creating figurative sculpture is evident in the portrayal of this work, witnessed by the necessity to over-represent the proportions of subtle landmarks of human anatomy, in order to prevent the occurrence of skeletal disproportions.

To promote a feeling of self assurance, the shoulders and torso were directed to aim at where the face was pointing. This was to convey a sense that, with the arms pulled back and down and 'her' spine swayed to push the breasts forward, the 'head' was turning to face the world. However, I wanted the 'heart' to create some inner conflict by having the desire to turn away. To convey this, the hips are turning away and the left hand retains some modicum of modesty by using the drapery for some privacy. The chin was lowered and the eyes were shut to reveal an internal shyness, stemming from the self consciousness about being so disrobed.

Drapery in this composition was a deliberate inclusion and was intended to achieve two functions; to be used as a device for the self control of the subjects' modesty and to have the physical body create turbulence in the forces of the environment. To achieve control of modesty, the cloth appears in soft and liquid folds at the subjects' feet and yet the figure has prevented all of the material succumbing to gravity by clenching the cloth in 'her' left hand, which shields the lower pelvis. To give a suggestion of the nature of the surrounding environment, the cloth which has not tumbled to the ground is shown wind-swept and straining. The force of the wind pushes the cloth onto her thigh and shins to reveal the nature of the forms of the hidden parts of the body and provide an implication of the winds direction. The strength of the wind suspends the weight of the material and lifts the cloth that trails behind the legs into a series of ripples.

Separate to the movement of the drapery, the figures own hair is pushed back from the face and jaw line, while the hair behind the head is gently folding over itself in harmony with the direction implied by the cloth. In contrast to the airy lightness of the cloth, I wanted the arms to appear heavy and relaxed to convey an internal serenity. Beyond a tool for creating consistency between the winds effect upon the body and the cloth, I purposefully wanted the wind to be trying to reveal the body. With respect to the treatment of the face and head, I wanted to prevent the hair from falling across the face to provide any protection from exposure. Consequently, even though the face is cast downward the full face and partial neck are revealed by the 'wind' pulling the hair back and together behind the head.



Condolence Too 650L x 400W x 800L

The next in the sequence of earthenware of pieces was this work which was meant to be the logical extension of the previous work. In this composition, the character of Satan is still using the vehicle of the female human form, with the distinction that the bestial transformation can no longer be hidden and semblances of self consciousness are falling away.

The overall proportions and configuration of the work was specifically designed to be the mirrored reverse of another work in the series titled 'Condolence'. The body postures are similar and the treatments of the plinth or pedestal are also similar. The differentiators are the gender of the subjects, the attitude of the subject and the use of drapery. Let me explain the intentions of these distinctions, beginning with the gender of the subject. Supporting and extending the use of a female human form to represent Satan, which was used in the previous work 'Tempt-her', the feminine characteristics of the body are again portrayed in overt and exaggerated proportion. The work also draws on the ideal from 'Condolence' regarding imaginings of how the subjects physical appearance would be impacted if allowed to be however the subject desired it to be. In 'Condolence' the concept was proposed that self assurance may drive the subject to manifest a male body of inflated masculine proportions, in this work the concept is supported within the female form.

The figure of the subject is overstated in physical proportions and represented as being completely disrobed. The physical transformation from angel to beast is witnessed by the subjects' feet appearing inhuman and cloven. The appearance of the cloven hooves were restrained and were intended to be more delicately represented, evoking parallels with the feet of antelope rather than those of larger bovine animals. The 'ankles' are held together to foster an interpretation of attempting to maintain a degree of poise and decorum. Otherwise, the figure is recognizably human and there are no cranial horns or wings as seen on other objects in the series. This was a conscious decision as the intention was to keep the focus of this composition on exploring the humanity of Satan in priority over the animalizing of Satan.

The second differentiator from the matching work of 'Condolence' was the apparent attitude of the subjects' body language. The pose of the female form was deliberately designed to explore Satans' attempts at influencing the behavior of others by use of seduction, as opposed to use of imposing, threatening or repelling behavior. I wanted this figure to be more confrontational and confident than the figure in 'Tempt-her'. To achieve this, the composition was designed to make use of a directed gaze, open chest and pulled back shoulders, as these attributes are often attributable to humans possessing elevated levels of positive self assurance and physical confidence. The neck of the subject was twisted strongly to the right with a slight lowering of the chin. The lowered chin was not meant to suggest shyness, quite the contrary as the eyebrows are used to 'hood' the eyes which are raised and possess an intense gaze. It is the combination of these elements that were intended to foster an impression of a purposeful and intense mood to the face. By twisting the neck and head to follow the direction of the gaze, the intention was to suggest that the subject had specifically positioned its body to be turned away from the object it was seeing, while the focused eyes and face was to convey that this subject is aware of what it is looking at, and is deliberately choosing not to turn its body to face it.

Building upon the ideal that the figure has deliberately left its body at a strong angle to the subject of its scrutiny, I wanted to infer that the subject was attempting to be provocative and even sexually suggestive towards the object it is watching. To attempt to achieve this, the lower half of the spine was curved in strong contrast to the stiff and straight treatment of the upper back and shoulders. By curving the lower spine, the pelvis was twisted to accentuate this curve resulting in the heavy volumes of the buttocks being lifted in a pose that may be interpreted as implying a degree of sexual

invitation. The intention of this body language was not for the sake of being explicit or profane; rather, I wanted to reveal some of the psyche of the figure as it explores the powers associated with possessing the appearance of an exaggerated female human form of its own creation.

The third differentiator of this the intention of this work over 'Condolence' was the use of drapery. Cloth was introduced into the composition as a specific device, more than merely to provide protection for the modesty of the subject. It was intended to perform multiple roles; firstly as an accomplice in the suggested physical invitation, and secondly as a method of revealing that the platform was not truly horizontal. Its role in promoting the attempted seductions of the subject was seen, literally, as an attempt to provide a soft cover that thinly disguises the cold and unyielding stone. Metaphorically, I saw the cloth as a way of the subject extending the seduction beyond itself. The softened folds support the concept of an attempt to cushion the stony plinth and act as a conduit to transfer the soft and rounded forms of the subjects' body over the more angular platform. It may be viewed as an allegory for the figure itself and its intentions.

Secondly, the drapery was used as a tool to draw focus to the incline of the platform and the influence of gravity on the scene being rendered. The platform top is larger than the one shown in the male sculpture and yet insufficient to support the entire figure if it were prone. To support the implication of discomfort among the works, I wanted the upper surface of the platform to be angled, but not so angled as to suggest toppling the figure off. The drapery was rendered as lying in true vertical to highlight the angle between the folds of the hanging material and top surface of the platform.

Gravity is witnessed in the sculpture by its effect on the soft material in the scene. The overhanging hooves are shown relaxed and pulled down, the wrist and hand of the right arm hang loose and relaxed and the unsupported cloth submits limply to the force of gravity. As stated in earlier text, I wanted to use the force of gravity to represent the lot of humanity and to transfer a sense of mass attempting to become static and settled.



Fat Satan 650L x 550W x 950H

This composition was to be the only composition, among the exhibited earthenware objects, which included more than one entity. The fundamental premise behind this work was considered and philosophical, rather than submitting to a more literal treatment, and my limited sculptural experience struggled in capturing the nature of the intention using just one subject. I wanted the spirit to be shown further along its de-evolution from immortal to mortal than the earlier works that show fit and young bodies. This piece was contrived to portray lazy disillusion, a willingness of the spirit to submit to the ravages of gravity and self indulgence. Consequently, the figure of Satan is shown as stereotypically male, obese and abusive to its surroundings.

In this work I saw the figure of Satan representing the lazy willingness of mankind to abdicate the responsibility for its own acts of immorality onto a fiction figure, created with the sole purpose of being a readily available scapegoat. The much smaller and abused 'children' were representative to the way mankind saw itself as innocent and vulnerable. The composition was carefully considered in its details, as it is not, and was not, intended to be deliberately blasphemous. It was intended to be thought provoking. The small baby-like figures were not shown with wings, to suppress any ready understanding of them as heavenly cherubs.

The composition is reflective of what I saw as the constant labour (and its exhaustions) involved in 'propping up' an old idea about Satan. The flabby untuned

flesh hangs loosely from its skeleton and the torsion from its shoulders to hips, threatens to topple the figure off its supporting servants. I wanted the figure to appear difficult to get a grip upon and tiring to uphold, as this was a strong parallel to my own concepts about the figure of Satan. I also wanted the work to look complex and involved, with many small dramas playing out around the central character, which I needed to appear as ignorant and uncaring of whatever efforts were required to support it. As well as the many hands and feet, arms and legs of the children, the central column was embellished with thickset and cup-like swirling elements. The reason for the opulent figure resting on a platform that was visually busy and complex was to promote a sense of needing to provide many resources and structures to support the icon of Satan.

The small baby-like children were intended to be uniformly rendered and function merely as human ‘cushions’. To transfer the intended meaning of ‘rewardless’ labour, the faces of the children are identical, with closed eyes, down cast faces and stooped and twisted bodies. I wanted to remove any opportunity to assign ‘identity’ to the children by rendering them of different sizes, genders, proportions or apparent ages. Their bodies are all facing out away from the main figure to allow an observer to see the similarity of their expressions and allow the weight of the figure to be borne upon their backs. Gaining purchase to grip the body of the main character needed to be difficult and precarious, consequently the children are shown under wrinkles of skin and rolls of fat that hang from the body of the weight they are bearing.

The tiny figures were intended to be bearing a heavy weight while they themselves were unsupported. To achieve this, the figures are connected to the sculpture, almost exclusively, by their backs and heads leaving their feet to hang in free air. I wanted them to have nothing else to rely on in the effort of supporting the weight, those figures that are in contact with the swirling central column get little assistance from it as the material bends and folds out of the way. The concept was to have the labour appear to be foreboding and unsustainable as this is the way I had interpreted the nature of the icon of Satan to impact on contemporary humanity.

There is an intended potential for ambiguity in the narrative an observer may glean from this work. As with the additive fabrication works (in the following pages), I wanted this figure to appear as both being offered up as something precious and merely being abusive of its surroundings for its own sake. In an attempt to achieve this, the figures right arm was shown lazily raised, with an outstretched hand and its head thrown back to raise its gaze to the sky above. The intention was to provide little visual support

for the context of these actions and to foster the question of why the figure was presented this way. The composition was designed to be read in two different perspectives; firstly, that the central figure was being boastful and abusive of its supporters by laying on them to prevent them from 'rising', while all the time laughing at those 'above'. And secondly, that the figure was relying on the efforts of many others in order to lift itself up and the arm was reaching out for forgiveness and salvation. Philosophically, the intention was closer to the first reading, although the second is still supportive of the central concept but with a different theoretical perspective.



Saint-he-cute 350L x 350W x 650H

This composition was composed to further explore the potential for this subject to generate deliberate alterations to their physical appearance in order to find favour among others. As with the previous work, the original premise was for an ambiguous composition that opened the number of interpretations up to include considerations of whether the subject is requesting something from the observer, or offering them something. The ambiguity is sponsored by the use of a formally treated plinth to display a less than formal treatment of the subject of Satan. Here, I wanted the stereotyped appearances of male and female forms to give way to exaggerated proportions, more closely aligned with being a caricature of Satan.

The underlying intention for this work was to construct an object to have the figure represented in 'cartoon like' proportions in an attempt to explore another form of visual appeal that Satan may use in order to seduce. It was envisaged that by offering an appearance that was more closely aligned with a baby than with an adult, there may be a higher probability that 'he' would be viewed as more innocent than conniving. By using the device of being more like a human child, Satan may attempt to be seen as more likely to be dependent on us, more likely to be non-hostile and more likely to evoke emotions of affection, tolerance, forgiveness and nurturing. I saw this as reflection of the deceptive nature of this figure that has been uniform in the description

of its desires and intents. The composition was further devised to be object upon which I could make commentary about my own observations on the human propensity to portray this figure as an object of affection and humour, in an attempt to transfer the potential power and control from Satan over humanity to become some degree of possession by humanity over Satan. The human proportions are preserved in as far as the creature is bi-pedal, standing erect with two arms and facial features reminiscent of a human. Beyond this, the individual proportions within the head, torso and limbs are less refined (in terms of human features), simplified and less anthropometrically accurate.

The head is disproportionately large with a deliberate asymmetrical treatment of the facial features. With consideration to the direction in which the object appears to look, the features of the face closest to the object of focus are artificially increased in scale in comparison to the corresponding feature on the opposing side of the head. This was intended to create a forced perspective to the face, when viewed from the direction of the outstretched hand. The oversized eyes are rendered as simple forms, with the eyelids covering half of the huge (in terms of the size of the head) ovoid eyeballs, intended to create an impression of having soft focus and to lower the intensity of the gaze. By comparison, the nose and ears are reduced in scale to be more closely aligned to the cranial proportions of an infant human. The size of the mouth is rendered as the largest feature on the face, and in order to lower the potential for a large mouth to appear predatory and aggressive, the mouth is closed, any evidence of teeth are covered and the overall treatment of the mouth was intended to appear large, soft and smiling. The soft forms around the mouth (approximating the human obicularis) are forced up by the mouth to truncate the lower sections of the eyeball to reflect and exaggerate the same phenomena occurring on a genuinely smiling human expression.

The body and limbs of the subject were handled with the same premise as the proportions and treatment of the head and face. The body was made shorter and bulbous to reflect the proportions of human infants. The arms and hands were simplified into rounded forms and the number and length of fingers shortened. The overall positions of the subjects' right arm and hand were positioned to facilitate an attitude of being unsure or even coy, while the left arm and hand is extended out from its side with the palm facing upwards. It was the combination of a perception of insecurity from the right arm and the 'request' from the left arm that was the foundation used to build in the desired ambiguity in the work. The lower limbs were reduced to

cylindrical stumps as I did not intend on them adding significantly to the expression of the body. In order to support the overall intention of the subject appearing shy and insecure, the subjects left foot has the heel raised and the 'toe' of the hoof turned inward towards the centre of the body.

The transformation into beast was signified by the inclusion of horns, hooves and a spade tipped tail. The intention was not to allude to these constituents being factual bestial elements, but rather to play further upon the historic representations of Satan by including those elements in a softly suggesting manner that is often portrayed in parodies and caricatures.

In order to draw attention to the simple forms of the head and body of the subject, the context in which it is portrayed was a formally treated plinth. The plinth was intended to have the appearance of a 'generic' base with deeply contoured scrollwork. By the term 'generic' I want to indicate that the curves and movement within the base do not reflect the curves or lines of the subject, it was intended to be an embellished base upon which 'any' object (as opposed to this specific object) could be placed. The reason for the disassociation between the object and its base was to support the ideal of an ambiguity in the portrayal of the subject. The intention was to create an object where it remained unclear if the purpose was to strictly glorify or deride Satan. Glorification may have been apparent via the presentation of the subject on a formal platform to infer that the object on the plinth is of some importance to warrant the presentation. This was a suggestion of the potential for some specific renderings to raise the image of the spurned and outcast figure into a revered and important artifact. By dislocating the purpose of the embellished scrollwork from the object it supports, the intention was to portray the idea that the filigree was there for its own sake. The scrollwork represented the efforts of humanity in offering support and resources to empower this particular creature that effectively added little knowledge of the subject, it merely represented attention to superfluous detail rather than understanding of the object itself.



Sad Portrait 500L x 300W x 700H

This composition was, for me, the keystone work in the philosophical concepts underpinning the exhibition. I wanted to create a rendering of Satan that showed the inner spirits desire to lift out of the body, to search for something outside of itself, for something greater than its own withering physical presence. I considered the object of Satan to be an easily accessible device for humanity to use to dislocate our own negative behaviour from ourselves and onto 'someone else'. I was interested in exploring the impact of the 'death' of that figure. I wanted to show the transformation of the immortal archangel into the mortal human in its penultimate stages. I did this to satisfy a need to explore if I would have any empathy for the character; effectively deliberating on whether the 'death' of a figure always associated with death would assist in our transformations from mortal being to immortal spirit.

It was never an intention of these earthenware pieces, nor this exegesis to estimate, or pass comment upon, the length of chronological time between the 'fall' and the 'death'. To me the length of time was immaterial in comparison to the importance of exploring the mental shift occurring within this angel that was effectively 'timeless', into a creature that must now become aware of its mortality and deal with its physical de-evolutions and the concept of the existence of something greater than itself.

The previous works in the series, leading up to this composition, were my own attempts at expanding on the visual effects on the physical body when the presence of any internal life force is superseded by the desire to honour the physical body instead. In this work however, the physical body is now being removed in a process (age) that is beyond the control of the subject and I imagined that the 'spirit' inside the body must now deal with releasing control of its physical appearance and transform into something else, something that may be unknown. The process of transformation from an infinite entity to a finite being was paralleled by a transformation from the human (scripturally considered as being in the image of God) into a beast of the field. It is for this reason that this piece carries the most weight in the exhibited works, for I wanted it to represent the accumulation of all of these transfigurations into one moment.

I particularly needed the work to attempt to evoke empathy from an observer; empathy for a figure that is associated with scorn and betrayal. I wanted the pose to reflect our own physical bodies in such times of grief and longing. Again, I feel compelled to clarify that this was not due to my desire to promote sympathy or glorification of Satan, the entire premise of the series of works was to use this fictional character to highlight the existence of our own human transformations.

With respect to the sculpture, I wanted the focus to be on the subject's plight; as a consequence the base was not complex or visually distracting. Rather, I wanted the composition to reveal the paring back of unnecessary objects back to the essence of the moment. Consequently, the base is restricted and simply rendered and implies the truncation of the physical body through the facets cleaved through the sections of the body. I saw this as analogous to the process of this subjects transformation, the concentration on physical attributes has become redundant, and as a consequence the base is simple and rounded, with no filigree or complexity, just enough to provide support for the body.

The posture for the body was intended to convey two ideas; the persistence of anxiety and discomfort and the yearning for release and direction. To render this, the shoulders are presented as angular to the horizontal base and twisted in comparison to the neck and head. The arms were pared back to be small stumps, and presented in only the minimum amount of the limb necessary to show its directions. It was important to show the physical body in the advanced onset of becoming decrepit. Recognisable witness marks of old age are evident over the body; its own internal armature is revealed beneath the atrophied flesh. The skeleton of the physical body was considered

as evidence of a 'framework' that had been provided by birth into physical dimension, it was upon this framework that the physical body had been built up in its many guises only to be removed by age to reveal the base framework again. I saw the skeleton as evidence of the mechanics of corporeal existence, the machinery upon which the flesh, and its associated vanities and infatuations, had been compiled. This was composed specifically to display the visual talismans of human (as opposed to supernatural) age, the skin is rendered as pinching, wrinkled and sagging, the flesh stretched thin over the frame.

The majority of the earthenware sculptures portrayed the human-like physical body with inclusions of angelic wings or animal horns and hooves. In this final work in the series, the wing stubs were viewed as symbolic of an immortal past, and were also pared back to be uncomfortable-looking wing stubs. The wings were presented in this way to give evidence to the ravages of time and physical forces on those vestiges, leaving only hollowed and useless remnants of experiential past. I did not want the presence of any wings to imply protection, I needed to show that this iconic figure had not been spared and that any manufactured physical appearances had not bought any more time. While it was not the primary reason for showing an aged and dying Satan, I am aware that it may be construed that it is his relevance that is on display here, once a necessary device for religious leaders to use in holding the faithful to the moral straight and narrow, he now finds himself with dominion over a shrinking fiefdom and holding little sway over the masses. From this unintended interpretation, it may be understood that his life had become less about death as a saintly archangel, and more about his final statement as the ultimate sinner.

The facial expression of this composition was not meant to reflect religious imagery, but more of a borrowing of the composition of a martyr with eyes rolled up towards heaven and its potential for providing salvation. The face is shown with open eyes and furrowed brow, down-turned mouth and eyebrows that evoke a sense of pleading. This was to support the idea of the final moments having uncertainty and regret. Had the expression been one of pleasure or happiness, it may have provided the impression of a celebration of old age and an implicit acceptance of physical decay. This was not the intention of this work or the series of works as a whole. The twisting neck was contrived to turn the subjects focus up and away from themselves towards a desire for release and escape. The strong angular displacement between the head and

the neck was to extend the influence of rendering the thematic elements of torsion and tension within the body, resulting in a discomfort of being within the skin.

The earthenware objects were intended to have a common thread of each subjects dealing with the intrusions of self awareness and vanity, to bind them together. Physical discomfort and mental anguish resulting from physical transformations were used as a vehicle throughout the works to express ideas of self-awareness and mental pre-occupations with physical appearance. Tension within the body was used to support the concept that self-awareness via the physical body may act as an initiator of pride and self absorption in the human experience. With this particular sculpture, I wanted to portray my understanding that there exists the potential for a fundamental mental transformation of the psyche if the spirit is able to disconnect the passage of chronological time from the concept of the death of itself. Degradation of ones physical properties and the occurrence of unrealisable desires for the appearance of the physical body can potentially uncover a need to rationalise a distinction between an observable internal 'life force' and an undeniable external/physical death.

5.4 The Additive Fabrication Works

The following Additive Fabrication (AF) pieces were restricted in overall size by two factors; the overall cost of manufacture and dimensional limitations of the machine used during this process. For this research the cost of manufacture for each work was restricted to approximately \$2000AUD. Using the SLS process the budget resulted in works of approximately 300mm in overall height. Using the SLA process was slightly more expensive and as a consequence the works were scaled down in physical size by approximately 25% to keep within budget.

At the time of the research the maximum practical size for these processes were approximately 350mm in diameter and 500mm high. Artists and designers currently utilizing these processes are able to make works that are larger than these dimensions by breaking their design down into pieces that fit within these limitations and then reassembling the individual pieces into the final assembly. I have had commercial experience with constructing AF components by breaking them down into smaller sections and scaling each piece up to the maximum component size and then mechanically re-assembling them using adhesives and resins. I chose not to use this process to make physically larger AF sculptures for two reasons; the overall cost would not have remained with a reasonable budget and I wanted to keep an accord between the earthenware objects being one contiguous piece and these components being one contiguous piece.

The philosophy behind these compositions was a deliberate deviation from that used for the earthenware works. I wanted to allow the AF compositions to display the potential for complex spatial relationships that come as part of their unique manufacturing process. I also wanted the AF components to reflect my own understanding of spiritual and physical existence and to focus on the 'larger picture' regarding the cyclic nature of birth, death and rebirth that may exist between these two forms of life. Essentially, I wanted the AF works to display an eternal cycle and the earthenware works to focus on the journey from eternal to finite. Harmony between the AF works and the earthenware works was founded on the inclusion of transformations between the human and animal bodies and the impositions of physical and/or mental discomfort.

While supporting the portrayal of the same supernatural character, the AF works were composed to explore the capability of the medium to provide spatial solutions that would be impractical or not possible using organic clays and hand built methods. The

research had revealed the existence of several specific advantages to the AF manufacturing method with respect to being able to spatially complex and detailed sculptures. The resulting compositions gave strong consideration to using these noted advantages, which included the following:

- Heavily cantilevered masses and volumes.
- Location of the centre of gravity high within the object.
- Extensive use of negative spaces, in particular close to the base of the work.
- Details that were fully enclosed, inside or underneath other features.
- Interpenetrating forms that have the very small physical connections to surrounding material.
- Details of small cross sectional area having the duty of supporting large sections of the composition.
- Details of small cross sectional area directly connected to large masses of material of large cross sectional area.



Klein 150L x 150W x 300H

This composition was driven by a need to have a continuously cycling representation to the material. I chose to be influenced by the continuous nature of the surfaces in Moebius strips and Klein bottles. The overall form of the composition settled on a revolute using a 'figure 8' cross section. In order to promote the use of negative spaces within the composition, a hollow central column was left by the revolution.

By embedding the human figure into this constantly refreshing loop, I hoped to suggest the repeating cycle of birth, physical death and rebirth. The figure was shown to indicate the direction of flow and to reveal that it was subservient to the current; it was not resisting or creating turbulence, just allowing its physical body to be carried in the cycle. The figure was still representative of a human form and a level of implied discomfort stems from the inability of the human frame to bend through the tight

radiuses demanded by travelling at the top and bottom of each cycle. The figure itself is shown with some areas fully fleshed and other areas with the skeleton revealed. This was done to provide an accord with the endless cycle of creation and destruction. There are insufficient indicators within the work to determine if the body is in a state of construction or decay. I envisaged the composition as being reflective of my own understandings of spirituality, and I wanted to impose this onto the theme elements within these works of anxiety and transformations. The looping nature of this composition was intended to express a blurred boundary between my own concept of mortality (release from the physical body) and immortality (being a state of continuous birth).

The intention of flowing material in the composition, was to create a system of altering speeds throughout each cycle of movement. To achieve this, the acceleration of the curves was altered from the base to the top. The nature of the flowing shapes at the top of the piece are more continuous, stretched and linear, to indicate that the 'current' beneath the forms was fast flowing and pulling the forms out in the direction of flow. In contrast to these, the nature of the shapes at the bottom are more contrived, terminating and circular, to indicate that the speed of the 'current' has slowed and allowing the forming of eddies and spirals. The intention for using interpenetrating and airy curves was to display the ability of the AF process to create objects that appear to be unattached and floating in space. Close inspection of the object reveals that entire sections of the work are supported by small connections to the top and bottom of the sculpture only. To exacerbate the spatial complexity, these forms penetrate through still other cantilevered sections of the sculpture without connecting to them to provide an overall impression of complete freedom of movement without the need to for support. The evolving nature of the curves and shapes from the base to the top was an attempt to allow the focus of an observer to be guided around the work at varying speeds; slowing down for the complex and terminating curves near the base, and accelerating sharply for the free flowing and continuous curves near the top.



Bound in vines 150L x 150W x 300H

In this composition, the transformation from human to animal is witnessed only by the imposition of small cranial horns. It is the interaction of botanical elements with the human figure that takes the visual dominance in this work.

The inspiration came from the application of the word 'upload' when applied to the supernatural character of Satan. I had contemplated on what the word would mean to this figure and asked myself 'what could this identity possibly have to upload, what new or updated information could they offer back to where they had come from? The work is not a literal exploration of the term, rather is served as the starting point for the composition. I did not want to title the work as 'Upload' as I was concerned this term may have an implication that the subject was in possession of privileged or authoritative information. These works were not about the glorification of Satan, they were about the exploration of the humanizing of Satan. As a consequence, the title 'Bound in vines' was used as I believed it provided a more direct understanding of my original idea for the work.

The use of ambiguity of actions within the AF works is supported here by my intention to compose the work that was unclear if the subject was shown in a state of apparent freedom or bondage. The pose of the subject is a dramatic central arch that begins between the shoulders and is continued by the stem of the 'plant' down into the root-like base of the work. The overall effect was of a large 'S' shape, reflective of the central forms inside of the other AF works. The lower limbs of the figure are restricted in movement by the winding vines that branch out from the main central stem. The purpose of the vines was to create a closer association between the botanical elements and the legs and feet of the subject. The torso of the figure is supported only on its spine by a large central tendril, so the vines around the legs act to blur the boundary between body and plant and promote a potential deliberation of whether the subject was being 'bound up' (restricted) by the plant, or whether it was being 'offered up' (released).

The nature of the plant-like elements were allowed to conform to a conventional understanding in the representation of a plant having 'roots', central 'stem' and 'leaves'. The upper parts of the 'plant' are rounded, vine-like and more flexible in appearance, while the lower parts of the plant are more knobbed, root-like and intended to appear less rigid. This was done to provide a physical context to the work and imply a connection between a ground (the root system) and the air (the winding tendrils). The leaf-like elements were included as a dual purpose, to display the spatial freedom of material possible using AF manufacturing techniques and to contribute and support the concept of a continuous cycle of rebirthing. The spatial freedom was intended by portraying the leaves and stems as having thin, tenuous connections to large and cantilevered masses. The leaves themselves have surface details sculpted into their upper and lower surfaces and are less than 1mm in thickness, the proportions of which would be very difficult to achieve using organic clays.

The overall form of the composition was intended as have a voluminous upper 'canopy' formed by the plant and the human figure, which necked down to a very thin stem and was finally connected to the ground via a flared out span of roots for an overall effect similar to an hour glass. To display the ability of AF components to handle large volumes supported on small connections, the 'roots' of the plant were elevated to have only the end points of the shapes in contact with the ground. Each of the four supports have details added to the underside surfaces to extend the display of technical capability from the AF material, within the limits of this research.



Spiders 180W x 150L x 220H

This was the last of the AF components manufactured for the Creative Presentation of this research. As a consequence, my familiarity with the virtual sculpting software had increased to a point where I was able to complete this more spatially and technically demanding composition.

The technical aspects of this work were intended to extend my understanding of the ability of AF components to support the use of negative spaces within compositions. Holistically, the composition portrays part of the mating ritual of a particular type of spider. The spiders are of the sub-order referred to as mygalomorph (often referred to as 'old world') spiders. This order of spiders were chosen because of their accord with being some of the largest and oldest known species of spider and the fact that their heavy legs and abdomens, facilitated the use of small internal details needed for this piece. The upper spider is representative of the smaller male and the lower of the generally larger female. The entire weight of the structure is borne by the six small contact points at the end of the legs of the lower spider; the abdomen does not touch the ground. To extend the display of the material properties, the weight of the upper spider is also only supported by six points of contacts at the end of its legs.

The positioning of the legs and bodies of both spiders were designed to support the basic 'S' shape in all of the exhibited AF pieces. The spiders were rendered with a reasonable degree of anatomical accuracy, as I believed that a visual complexity of forms would best suited by rendering all of the legs of each creature. I also believed that the inclusion of spiders into the exhibited works would add value to the research coverage for two reasons. Firstly, the overall shape of the forms of a spider are a central mass (body and abdomen) and many diverging long and thin appendages (legs), which leant itself to being composed in a manner that promoted my observations about AF materials ability to handle complex shapes. And secondly, spiders are often symbolically represented in folklore as being harbingers of death via entrapment and deception. I saw the spider, like Satan, as also being impugned with a reputation for bringing death via entrapment, yet both had an element of physical beauty veiled in the legacy of superstition and paranoia.

In this composition, I wanted to explore an idea that the mortality of the subject is driven by being 'born' inside of an existing natural creature, similar to the immortal spirit being released from inside of the human body. The supernatural subject matter is shown here as infantilized and represented by forming fetuses inside the abdomens of the two spiders (image required). The work was intended to support and extend the thematic element of transformation and mortality to associate the works with each other. As the AF works were designed to express a sense of eternal cycles of birth and death, this composition was designed to have Satan being born from inside this symbol of death and entrapment. A cycle of need and redundancy was thereby set in motion by using the physical body of the spider (a symbolic figure of death) as a vehicle to bring Satan (a symbolic figure associated with death) into the physical realm.

5.5 Conclusions about the subject shown in the Creative Presentation

Without redemption from the passage of time, this character that is often associated with lies and deception was intended to project the simple truth that humanity must deal with the evidence of our own mortality, which in turn draws awareness to the existence of some form of associated immortal spirit. The artworks that formed my exhibition were intended to put an observer in touch with their mortal selves via the unlikely device of a creature that was created to be deception, incarnate.

The construction of purposeful compositions intended to project specific meanings and ideals revealed that it was the act of looking around at the various

features (and combinations of features) within the object, which created the visual language from the object to an observer. The objects were designed to seduce the eye into moving around the object, and in the process, to selectively create a form of 'logic' between the observed features and the reactions and recognitions they promote within an observer. The field of this logic was forced into becoming selective due to the restrictions and limitations of what is practical and available within the object, both spatially and as a result of material properties. It is upon this contained logic that I maintain the intended 'meaning' may be compiled by an observer.

By selecting a particular character to sculpt and by preconceiving the accuracy, style and poses the character is rendered within, the intention was to limit the number and type of features within the object. This deliberate restriction was targeted to, in turn, restrict the number of plausible contextual meanings that may be understood by an observer of the work. If these plausible meanings could be centred around my original intention for the piece, then the fundamental components of attempting to convey specific meanings via sculptural forms may be more clearly understood. These works were a premeditated attempt to guide those practical interpretations based on the visual aspects coming from the object, to include my intended logic as the majority or highest percentage of information available. Further, these sculptures were an attempt to make the desired meaning more apparent by creating a set of homogenous visual prompts that 'get to the point' and support that point across the entire object.

I am aware that the ability to translate intended shapes from mental images into physical dimension is dependant on an artist's dextral competency, particularly if the features are rendered such that they are not readily recognizable/ identifiable or are inconsistently handled throughout the object. I am further aware that the results of this research is directly effected by the translational competency of me - as the creator of the artwork, to accurately capture and augment the intended designs. Additionally, to analyse and adjust the entire composition to support and convey objects and forms that strongly support and promote a deliberately restricted range of meaning. If the spatial definition of the object has (non-purposeful) contradictions or areas of vague and ill-defined features, interpretation of it may stop making sense to an observer. The mind of those viewing the works may use all of the pieces of visual and tactile information available to create a unified mental model of the object, and based on that model, attempt to compile the probable reason for the objects existence and the manner in which it should be considered.

Part of the challenge in constructing these objects was to promote an interaction with observers by creating objects, and more specifically certain parts of objects, that are visually engaging. This was done in an attempt to influence memory allocations within observers of the works, by creating persistent visual artifacts. This is not intrinsically dependant on complexity—as spatially significant elements may be spatially rendered as simple forms. It is the ability of those forms to invite visual analysis while supporting the ideal of the work that generates their priority.

Having outlined the intentions underlining the final works and the results of attempting to translate those intentions into three dimensional objects, the following chapter will turn its focus back upon the two separate methods being used to create the works. The mechanics of each method contains techniques and considerations that are specific to each environment and it is the human aspects of utilising those mechanisms that highlight the discriminating attributes between them.

CHAPTER SIX

The analytical process - Experiencing the difference between physical and the virtual properties

6.1 Tracing the differences between the virtual and the physical

By ensuring a consistent approach in constructing the sculptures, regardless of whether they were virtual or physical, the two processes could be analysed for potential similarities and differences. The analysis of the data recorded is summarised in the following table (Table 1). I recognise that these fields are not exhaustive and represent only the major objective distinctions. The simple summary in each cell of this table are explained in detail in the notes following.

DISTINCTIONS	PHYSICAL CLAY ATTRIBUTES	DIGITAL CLAY ATTRIBUTES
1.1 Time	Important factor Constantly drying out	Absent in virtual environment Impacts file date.
1.2 Gravity	Critical Factor Implies constant orientation	Absent No impact on compositions
1.3 Negative Spaces	Difficult Demands competency	Promotes usage Forms can free float
1.4 Object Dimensions	Dependant on cost, weight of material and kiln size. Minimum size dependant on material coarseness	No scale apparent No maximum or minimum dimensions implied
1.5 Internal Armatures	Mandatory for some designs	Not required for support
1.6 Material Properties	Brittle before and after firing High maintenance before firing	Simulated properties only – Including: coarseness, dryness and penetrability
1.7 Maquettes	Assists in controlling proportions of final piece	Not necessary. Model is always the latest version.
1.8 Cost	Low material cost, potential for wastage, low firing cost	Zero virtual material cost Very high tooling cost Very high physical material cost
1.9 Security	Difficult to destroy No chance of data loss	Easy to destroy Constant threat of data loss
1.10 Storage	Requires safe dry storage area	Fits in portable media
1.11 Usability	No training required Symmetry challenging	High training load Infinitely transformable
1.12 Space	Must respond to existing physical world spatial reference system	Free from implicit and explicit spatial reference systems. Deictic implied

Table 1. The components forming the fundamental discriminations between the virtual sculpting and physical sculpting experiences

With respect to the specific area of creating figurative sculptures, it became immediately apparent that the most significant distinctions between the two processes were based on the nature of the environments in which they are created. These environmental distinctions include: the virtual environment had no comparable equivalent to the passage of time, the force of gravity or the properties of material. In isolation and in combination, these major factors are a constant source of both advantage and compromise.

1.1 Time

The passage of chronological time was an important factor in creating physical world clay sculptures as there was a constant degeneration of any organic based materials. Few materials, commercially viable for use in figurative sculpture, are not degraded over time. The degradation is constant and the rate varies significantly from exposure to the natural elements and from the intrinsic characteristics of the material. Substances such as waxes and clays have lower dimensional instabilities that result in more rapid changes in proportion over time. Plasters, plastics and synthetics have greater dimensional stability, although they also demand the use of specific tools to manufacture and form them. The application of heat and the inability to mould the final finishes with the human hand caused me to look beyond them as the material for this research. Metals and stones have even greater dimensional stability, with the compromise of dealing with increased mass, more specialized tools and related commercial aspects of the material.

The virtual environment experiences the converse, it is time-neutral and elements do not degenerate due to the passage of chronological time. While the virtual environment may be immune, the system supporting it is not. The virtual environment was entirely artificial and demands the existence of computer hardware and software to sustain its existence. These complex and delicate systems were prone to the relentless progress of technology and availability of the software used to create them. Virtual sculpture software applications were proprietary and were not permanent. The virtual domain was experiencing some merging and standardising in the specific software file formats, it remains a consideration to the artist that while the virtual environment may be eternal the tools to access their creations are not, and artists are vulnerable to the proprietary products they are using remaining commercially viable. It remains a potential risk that artists may create virtual works within a particular software application that becomes redundant or unavailable, preventing them from accessing or reviewing their works.

1.2 Gravity

The presence of gravity was absent in the virtual environment and while it could be simulated in some advanced CAD programs it was not present in general applications or within the particular applications used for this document. Gravity, when considered in isolation, is an important factor in the construction of physical clays, it has

a predictable and constant impact on the dimensional stability of soft material such as clay. It acts to both force elements together and to try and tear them apart. Elements located above others are pulled down into contact with elements below and must be constructed in such a way that they do not collapse in themselves or collapse the element below—as a result of their weight. Simultaneously, elements that are supported from the sides or suspended by their contact to elements above them need to be constructed in such a way that they do not collapse within themselves and with sufficient strength to prevent them tearing away and falling, from their own weight.

The persistence of gravity forces the artist to include some form of support base at the bottom of the composition; a device to prevent the work from collapsing, toppling or moving. The presence of this base implicitly provides the physical work with an orientation; it has a base that is acting at right angles to its vertical, which implies its spatial reference system. I believe its implied origin is subsequently located at the intersection of this vertical and the base plane. Gravity, when viewed in combination with the passage of time, was an even more significant consideration for sculptors utilising organic clays. Specifically for this research, the passage of time caused a drop in the moisture content for organic clays creating a situation in which they were constantly drying out.

The absence of gravity in the virtual environment was a significantly different type of consideration for the virtual sculptor. In the virtual world, the absence of gravity allowed the expression of forms that were not in contact with any other elements and yet they remain as positioned, until they are interactively moved. Free floating objects remain static and dimensionally inert without the manipulation of the artist. I found it took a long time for me to consider that I did not have to keep creating sculptures with a base, as the virtual system can remove the sculpture from its ‘resting place’ on the plinth and allow it to be developed at any angle and without a pedestal.

1.3 Negative Space

Human observation of spatial relationships relies heavily on the presence of horizon curves and the occlusion, or obscuring they cause to elements in the visual background. While an observer is attentive to tracing the forms and horizons, to map the spatial arrangements of the composition, the artist may be able to use this process to control the focus point of the observer and to maintain their attention.

Negative spaces not only offer additional horizon curves, they also promote the sense of 'presence' to physical works by allowing the environment surrounding the work to penetrate it and become visible through windows in the composition. Here, the idea that space extends limitlessly in all directions around the work is controlled by the artist, by capturing a small bounded area of that same space within the sculpture. The ability of an observer to relate to the physical work is enhanced by the composition including within it, part of the same world in which the observer exists. As the observer moves their viewpoint, the environment beyond the work is revealed through these 'windows' in the composition and moves in direct synchronisation with the movements of the observer. This acts to strengthen the understanding that the observer and the work are within the same world and were therefore more immediately relatable. Negative spaces within physical works are typically difficult to control as the material above this space was influenced by the forces of gravity and time. The artist must have an understanding of the physical properties of the material being used, to allow the material around the space to be self supporting and not collapse. As a consequence, negative spaces can be used to promote a sense of lightness and freedom of movement as if gravity is negated. The artist uses this to control the observers understandings of bulk or lightness, static or dynamic, balanced or 'in tension', inside the composition.

1.4 Object Dimensions

The physical world also had a clearly observable relationship between the senses of scale and proportion. This sense was reinforced by the predictability of the change in apparent scale when an observer alters the distance between themselves and the physical object. As the viewpoint is moved closer to the object, the proportions remain consistent as the apparent scale is increased. By contrast, the virtual environment also has an observable consistency in its representation of proportions, however the scale of an object is separated from the physical distance between the observer and the object. For example, as an operator of the virtual software ‘zooms in’ on an object they are presented with a changing in scale, as if the observer were moving closer to the screen. However, their actual distance is not related, as they remain the same distance from the object (the display monitor) as the apparent scale increases. There was an observable emotional effect on an artist as a result of this; the artist may interpret the virtual work as being in its own environment and therefore not relate to the object as if they were in its physical presence. By contrast, objects in the physical world can only be increased in their ‘scale’ by the observer moving closer to them. The predictability and consistency between the ratio of the rate of movement and the rate of scaling provides a sense of security and stability for an observer.

The virtual environment is devoid of any visible limitations for object sizes in new and empty files. These file types have no pre-existing space, just featureless void with no sense of up or down, no ground plane or orientation. It is only when there are two or more elements presented within the virtual environment that the observer can obtain a sense of orientation and their resulting spatial relationships. In the event that only a single element is present, the observer may create a sense of orientation for vertical and horizontal from the implicit vertical of the objects shape. This vertical and horizontal may not correspond with the absolute vertical and horizontal contained within the software code. With only one element on the monitor, the sense of depth and scale is dramatically constrained and may provide no references to determine the fundamental elements of orientation in three dimensional space: a defined ‘world’ origin, a sense of the horizontal and the true vertical or zenith. By comparison, the physical world does have a constant environmental condition that orients the observer, where the force of gravity implies the vertical vector and the supporting plane under the observers own body, provides a sense of the horizontal.

The boundary dimensions of the virtual environment were only limited by the capacity of the computer hardware and software to calculate it. An artist is free to construct dimensionally vast and complex pieces that are stable and apparently free floating. The spatial freedom of being able to create massive works becomes compromised by the process of trying to realise the virtual composition into the physical world. At the time of writing, a range of processes were available to translate the virtual sculpture into the physical world. Some of these were essentially subtractive in their nature, which start with an excessive amount of material in a shape that allows the final composition to be wholly contained inside of it. Various technologies such as machining and melting are then used to guide machine tools to precise locations in 3D space, these locations represent the limits of the outside surface of the composition and in this way the composition is eventually carved out of the raw material. These processes are limited to the maximum size of the raw material, the accuracy of the machine locating the tool head, and minimum space required to get the machining arm (with its tool head) into position.

1.5 Armature

In the physical environment, artists may utilise supporting frameworks and armatures primarily to resist the influence of gravity on the developing piece, however the armature also played the role of maintaining the scale and proportions of the work. The armature acted as a form of three dimensional reference sketch, a controlling influence used to prevent the work from drifting too far away from the original intention. In this way the armature was used similarly to the original two dimensional reference drawings, used during the 'concept' phase. In the virtual environment, armatures and reference data may be used to guide the scale and proportions of the work, however the absence of gravity does not demand an armature for support. In the virtual environment, the scale of the defined space was infinitely variable as a single operation. The overall dimensions of the work can be interactively scaled in either positive or negative directions at any time during the construction. This flexibility is a strong contrast to the effort required to change the scale of physical world works. The scale of physical works can be altered; however this demands manually re-building all areas of the composition, including the internal armature.

1.6 Material Properties

Differences in handling of the material between the two environments are difficult to quantify, as the virtual pieces are built of virtual clay that can be altered to have the tactile response of a large range of different properties. This could be used to simulate the change in density caused by the drying of physical world organic clays. Organic clays have natural changes in consistency due to the density of other included materials such as grog, air or water and the same block of clay may have a variety of levels of moisture content and resistance to deformation. As a result, part of the competency of an artist using organic clays is to understand these variables and adjust to them accordingly. By contrast, virtual clays may have their simulated resistance interactively altered by the artist, where the material properties are entirely calculated with perfect consistency. It is the commercial aspects of the two clays, rather than their material properties that may have the most significant impact on the decision for which media to use in the final construction.

1.7 Maquettes

Some form of maquette was almost mandatory with physical pieces. They could be completed without; however the maquette eased the need to complete the work by using only memory and recall. For my own pieces, the maquette took the form of the virtual prototypes converted into images with gridlines overlaid on them. For other artists they take the form of scaled down models made from clays or improvised material, photographs or sketches. A maquette in its literal sense, was almost irrelevant to virtual sculpture. This was due to the absence of 'scale' in the virtual environment, therefore no corresponding demand for separate and scaled down versions of the intended design positioned next to the sculpture as it develops. Because the sculpture can be built over the top of the 'maquette', there is no demand for it to be smaller; it needed to be full scale at 1:1. The role was then evolved into more of an armature as it provides visual support, as opposed to support from the force of gravity, and the final piece could be developed around it. Even in this condition, I believe it is redundant, as the virtual environment now contains a 'full scale', correctly oriented replica of the intended design. It was more efficient to treat this object as the actual sculpture and simply add the missing details to the replica, rather than to unnecessarily recreate it. However, a form of maquette may still be used to control the proportions and orientation and may be valuable in the virtual environment. In this sense the device is

not strictly a maquette, more of a combination of reference sketch, armature and maquette. For my own virtual sculptures this device took the form of my hand sketches, scanned into the computer software and used as a visual guide.

1.8 Cost

Commercial aspects of the two sculpting methods acted as a strong differentiator. Physical clay sculptures had their costs compiled from the purchase of the raw clay, hand-tools and accessories, transportation, firing and post-firing treatments such as painting, rendering or glazing. The constraining factors associated with these would be supporting the weight of clay (as the pieces were increased in scale) and the maximum transportable and firing dimensions. All other aspects increase and decrease proportionally without any limitations. Physical works also have a certain degree of wastage; it was unavoidable as it was extremely difficult to complete an entire composition without some waste due to areas drying out too early or scraps falling away like swath during the shaping of the clay. The digital system had no concept of waste as the material is created only as it needed and can be deleted without any trace of it previously existing at all.

Virtual clay had no material cost in a literal sense, as the material is digitally generated on demand without limit. The overall cost of the virtual sculpture system is comparatively high with regard to physical clay modeling systems. To create virtual pieces an artist needs both computer hardware and software to generate the virtual environment to work within. Beyond the cost of the equipment, the virtual sculpting tool remains free of additional costs, unless a decision is made to add physical properties to the virtual sculpture. Converting digital to physical, involves connecting the virtual file (via a specific format) to either: numerically controlled machinery to effectively carve the required shape from a block of raw material; or build the object up using an additive process. Both of these processes require the reservation of scheduled time for the respective machines and usually engaging the services of a fabrication studio. Tool time can be expensive and may also demand the cost of a trained technician to operate the machinery.

1.9 Security

Security of material from damage and theft is a consideration in both the physical and digital environments. It is their digital existence that makes virtual works vulnerable to attack from computer based viruses and unauthorised access to the files. The security of the file may also be compromised by the artist, and entire compositions can be completely deleted by human error. Physical sculptures cannot be removed from existence by external forces such as program viruses, or by single action human error. Rather, the destruction of physical world clay sculptures requires significant and repeated, purposeful effort. Security from theft was also distinctive between the two environments, electronic theft of virtual works was pervasive and protection may take the form of costly technical applications necessary to protect the works. Electronic copies of files are an exact replica of the original and authenticity of the original cannot be established easily; by contrast physical sculpture copies are never exact and can be identified by the creator. The theft of physical works is also possible and like their destruction, requires premeditated deliberate effort.

1.10 Storage

The storage of virtual works was theoretically only limited to the capacity of the computer hardware and thousands of works may be stored on small and affordable portable media. The conditions surrounding the security and storage of a body of physical works are proportional to the dimensional stability and scale of the artifacts. The storage of as little as twenty physical works demands careful logistics to store, move and maintain.

1.11 Usability

The two disciplines of virtual and physical sculpture, have clear distinctions with regard to usability or 'ease of use'. The physical system promoted a quicker start-up time and allows the artist to begin improvising immediately. Training may vary from a few directive statements by an experienced artist to the formality of technical courses. It is practically plausible to begin using organic clays with no training at all. The virtual clay system requires specific training before starting, with a series of tutorials and exercises necessary to gain an introduction to the many functions and limitations. The system was driven by specialised computer hardware and software, and a medium to advanced level of computer literacy was necessary to be creatively autonomous.

The physical environment had no level of automation and each individual feature of the final composition needed to be crafted by hand. An attribute such as symmetry within the composition presented a significant challenge to spatial awareness and demanded the artist create each matching and mirrored component. By contrast, the virtual system had potentially high levels of automation within its functionality and an example such as model symmetry is semi-automatic. Further, the forms to be mirrored may be done so in whole or in part, without limit. The practical limit would be the ability of the computer hardware and software to calculate and render the elements.

1.12 Space

The three known dimensions of space correlating to height, width and depth exist within the physical and virtual environments. The physical environment has additional attributes of time and gravity (in sections 1.1 and 1.2 of this listing respectively) and a mandatory 'global' spatial reference system. Virtual sculpting environments do not impose a global system and an artist is not constrained by considering 'which way the composition faces', the composition exists digitally and is not influenced by the global positioning of the computer system. Its digital nature allows interaction from many locations simultaneously via multiple (connected) computer systems.

6.2 Tracing the differences in usage between physical and digital

Beyond the components listed in the table, this study revealed the existence of considerations that are integral to the definition and decision making processes of sculptors creating figurative works (referred to in Chapter 8). It therefore remains to determine if these considerations are also effected by whether the sculptural environment is virtual or physical. These considerations include:

Forms, Elements and Compositions

The physical and digital sculptural environments being researched here, did not affect the existence (or non-existence) of forms, elements and compositions. Additionally, the environment was not directly related to the ability of the artist to utilise these devices. However, the digital system revealed itself as having several distinct advantages with regard to how these ingredients were visualised and controlled. Simple forms were managed more comprehensively by the virtual system as it permits multiple elements to be co-located in space; this was not possible when using organic

clays. The ability to control separate forms independently even as they are employed within the element they are representing, promotes the freedom to alter the composition form by form, at any time in the construction of the virtual piece. This freedom therefore, flows on to the controlling of the corresponding elements and ultimately to the compositions. More complex and controllable compositions are possible digitally as the material supply was infinite, did not degenerate over time and was unaffected by the force of gravity.

It is my belief that an individual artists' ability to relate to (and utilise) these digital tools, remains a significant influence over any apparent visualisation advantages of the digital system.

The Criteria of sculptural space

The criteria used by artists outlined in Appendix 2.0 are inherently related to material properties and will therefore be influenced by the differences in digital and organic matter.

- Mass – mass is resultant of specific density, which in turn is driven by gravity. The negation of gravity in the virtual environment facilitates compositions that do not give consideration to centres of gravity, or balance points resulting from the effect of gravity on the mass of material.
- Stability – the synthetic nature of the digital material renders it immune to organic denaturing or movement due to changes in material properties driven by moisture content, time or gravity. As a result the dimensional stability of digital material is superior to organic material.
- Angle – angular displacement is considered on two independent levels: The first is on the basis of the mechanical properties of the material and the resulting engineering of the connections between forms. The second is on the ability of angled elements to direct the focus of an observer. Only the first level of these is influenced by the particular sculptural environment, as it deals directly with resisting the force of gravity. The absence of gravity in the virtual system allowed the artist to focus on the visual cues created by angular forms (the second level) with no regard to the engineering of construction (the first level).
- Complexity – the digital system promoted complexity. It did this by allowing an artist to consider creating very fine elements within the composition and allowing

the artist to use these details repeatedly via copy and pasting or by transformational tools such as pattern creations, symmetry and texture mapping. The organic system requires each of these tools to be performed manually in a time consuming sequence. While the organic system does not discourage complexity, the manual interaction and extended timelines, direct an artist to continually evaluate the need for any increase in complexity.

- Accuracy – under the condition that accuracy of rendering is related to improving the portrayal of elements in the sculpture, the digital system should offer greater freedom to a sculptor. In the event that accuracy does not positively influence the cultural meaning of the composition, the two systems are merely digital and organic versions of essentially the same media. However, from the perspective of how the artist interfaces with the artwork, the digital system offers a clear advantage of being able to interactively alter the apparent scale of the work in order to add accurate details. The software allows the artist to ‘zoom in’ on very small areas (sub-millimetre if required) of the composition without the haptic arm altering its scale of motion. By way of clarifying this concept, consider the following example of a typically small area of the human figure that demands accuracy to portray it correctly: the eyes of the subject being presented. In the physical world, the artist is constrained to the ‘real world’ scale of 1:1, where the accuracy of how the iris of the eye is formed depends on the steadiness of the artist hand and their ability to control the hand tool to create precise curves in something that may be less than 10mm across. By contrast in this example, the virtual sculptor can use the software to zoom in on just the iris until it is shown on the monitor as if it were 200mm across. The haptic arm remains in the physical world and although the iris of the eye is now digitally shown very close up, the movement of the arm remains proportional to the monitor not to how close the software is zoomed in on the object. This means that in order to move the cursor across the full diameter of the 10mm iris, the haptic arm now needs to be moved 200mm. At this point the haptic arm is used to sculpt the digital clay, and the tolerance of the steadiness of the artists hand and dexterity with the handtool are lessened as a stroke measuring only 10mm long, is now performed by the haptic arm over a distance of 200mm.
- Human traces – evidence of the working of an artist were possible in both environments. Witness marks were more frequent in organic clay due to the

complexity in degrees of freedom in the human hand. Assuming full functionality, the human hand can be trained to create fine subtlety in form and surface texture; on occasion this can be within a single stroke or scrap of a tool or finger. This subtlety was not currently viable using robotic haptic arms such as the Omni used in this research, as the device was not capable of the high number of degrees of freedom available within a fully functional human hand. As a consequence, tool marks from the haptic device are less sophisticated and more mechanical, resulting in the desire to often smooth and polish these inclusions out in order to render the each form accurately.

The process flow of sculptural construction

The schematic diagram shown in Appendix 2.9 is an understanding of the interrelationship between the artist and the artwork. The virtual and physical systems were indistinct in their ability to record and reflect the spatial decisions made by the artist during creation. The virtual system possesses limitations with regard to its ability to display the artworks to multiple observers. Traditionally, the virtual pieces are displayed on a computer monitor which demands that the observer be located in front of the display. Unlike the physical artwork which represents a fully self contained object that can be reviewed by multiple observers from any viewpoint. The inability to allow the integration of the artwork into the observers own environment would also the impact on the virtual artists' ability to display the digital works at exhibitions and would subsequently influence the fields' analysis of the works. Viewing was capable by other users of the same software; however this presupposes a high level of software-specific computer literacy.

As the research concluded, I became aware that there was more qualitative information being revealed than just from the taxonomic analysis of recordings. The act of creating unique sculptural works, that had their conception within my own thoughts and their birth via my hands, was also a journey inside myself. I will not distract this document by attempting to cover introspective psychological results, however to ignore the very humanistic aspects of the qualitative information would be to undersell the results of this ethnographic study. In the following chapter—the Conclusions, I will separate the personal and the analytical understandings generated by the experiments and their analysis.

CHAPTER SEVEN

CONCLUSIONS - Subjective and objective results from analysis

The results of the experiments, the data collection, the construction of the exhibited works and their analysis, produced a series of understandings on the nature of the implicit knowledge being accessed by sculptors. From the experience of creating the sculptures, a clearer picture emerges of the emotional commitments and communications that exist between the artist and the artworks as well as the specific advantages of the physical and digital environments. From the analytical rigor applied to the written data, a clearer picture emerges of the various devices and considerations used by artists using both systems and their commonalities and distinctions. This Chapter deals with these two layers of observations in separated, yet connected, sections.

7.1 Objective observations on the process of sculpting with clay

- Both the virtual and physical methods offered the ability to capture the implicit and explicit knowledge of creating three dimensional objects in space. Any technical limitations of the virtual system had only a partial impact on the management of spatial orientation. The organisation of time, shape, proportion and orientation of multiple elements in 3D space is a process of applying mental protocols that are distinct from whether the material being used was organic or digital.
- It was not only three dimensional space that was broken down for management, but also chronological time and how it was allocated and distributed across the sequence of tasks. The management of this time was revealed as being a constituent of experience and expertise for the practice of sculpture. This expertise includes the knowledge of the available tools and the confidence to recall their use, apply them and then analyse the results for further areas of improvement.
- Studio based experiments confirmed that artists and designers used a range of tools to allow them to visualise and construct their own renderings of space and that these tools were used to manage spatial orientation and to track the development of the work from the initial thoughts, through to the finished artifact.

- Artists used this range of devices in order to translate their thoughts and feelings into three dimensional objects. During the course of designing the final presentation of the work, the artist needs to interact with the representation in a variety of mental modalities. This phenomenon was the translation of what one feels and must be conveyed in terms of:
 - Forms and their mass
 - Compositional tensions and rhythms
 - Scales in relation to our own size
 - Spatial orientations between forms
 - The surface textures we perceive through our own hands and eyes.
- The translation of mental images to 3D objects began with the formation of some simple designs to capture the essence of the intended composition. In this research this was the creation of several 2D sketches to determine proportions and major compositional elements. This 'reference' information, may also take the form of physical scale models, called maquettes, or montages of texts and images.
- The role of the reference sketch was to consolidate the ideas and thoughts about the intended sculpture and to attempt to suspend the evolution of the idea to reduce the likelihood of new ideas influencing the piece away from the original intent. It was my experience that the conversion of free mental associations into approximate sketches was not enough to encapsulate a mental image, the sketches needed to be lifted into three dimensions. The process of sculpture included this demand of realising the three dimensions of space, and was influenced by the need to understand the spatial beauty of an idea in detail. The method used to create this understanding was to define it more completely, to ride and relive the original mental theme, to chase out the details of each form that required the interaction of the artist for release, for permanency, and for existence.
- The activity of creating the sculpture in its entirety, forces the artist to think about it in terms of its individual components. This appeared necessary in order to facilitate determining:
 - How the artwork will be separated from existing within the mind of the artist

- The sequence of creation
- The sequence of assembly
- The management of the construction timeline
- Ensuring that even the smallest details support and project the idea of the whole.

These components may be managed using a number of systems that act in coordination with each other to allow the artist to ‘analyse’ the sculpture and determine where it was along its construction timeline; was it still reflective and supportive of the original idea; and finally, which specific actions were next in sequence to help the composition to become manifested.

- The first of these systems to be proposed in this document were the divisions of ‘concept’, ‘system’ and ‘detail’ design. These simple segregations act not only to add some incremental stages between the start and completion, but also to mark major mental transitions of the emerging sculpture.
- Following these marker points in the compositions’ spatial evolution were the breaking down of spatial complexities, necessary to render the subject matter of the composition and the context in which it was presented. Here, space may be broken down and then reconstituted in terms of ‘forms’, ‘elements’ and ‘compositions’. The hierarchy of spatial breakdown is well structured with each level requiring the existence of the preceding one, although there may exist occasions where the final stage (the overall composition) may itself serve the needs of a single overall form, such as a pyramid, cone or sphere.
- To direct the focus and attention of potential observers of their sculptures, artists may also deconstruct the composition into areas of primary focus and secondary focus. More than just mechanical attributes, these considerations included the values relating to the existence of traces of human activity, clarity of meaning and visual interest.
- Once these subsystems were expanded, schematics of the artwork to artist interactions were constructed. Expansions of these devices and their considerations were made in order to more clearly understand if the advent of digital technologies may enhance or detract from the artistic experiences and the outputs. Multiple distinctions between the physical and virtual experiences were revealed and it was observed that the major discriminators between the two

environments lie in the ability to record fine details, the existence of gravity, ease of modification and adjustment of scale and proportions (Chapter Six). Within these specific areas, the digital system yielded more available capacity.

- The virtual system revealed itself to be a comprehensive tool set with the ability to replicate most compositions being constructed in the physical environment. The software usage has strong accord with physical methods with very little of the logistic issues – it was convenient and capable.
- The absence of degenerative forces such as time, moisture content and gravity, positively effect the consideration of making spatial inclusions when creating compositions. The major example of such a compositional inclusion produced by this document was the device of utilising negative spaces. Negative spaces in physical world sculptures were difficult to manage both from the varying rates of shrinkage and from supporting the mass of the clay above the ‘window’. These spaces proved much easier to use and control in the virtual world as there was no shrinkage or gravity. More than just a device used by artists to convey meaning, negative spaces act as a window through the composition to the environment beyond. This window introduced new horizon curves for observers to consider and acts to reinforce within the observer that the object exists within their own environment; they are in its presence.
- By strong contrast, the virtual system, while permitting great freedom for the inclusion of negative space, does not reveal the observers own environment through these vignettes and acts as a constant reminder that the observer is not in the presence of the artwork, it is merely projected artificially onto a computer monitor.

7.2 The use of Additive Fabrication

In order to convert the digital image into physical dimensions, this research investigated the use of additive fabrication to allow the artist to effectively, communicate directly with the manufacturing machine. By electronically transferring the spatial information from the virtual sculpting program directly to the input for additive fabrication, the resulting composition was untouched by any other operator except the sculptor. Even with this direct connection, the process of additive fabrication was restricted in the maximum size for a single object, and currently has a significantly higher commercial component than a similar composition constructed using organic

clays. This research was limited to the use of SLA and SLS processes. I was aware of other technologies such as NC machining and the use of metalised powders, however the direction of this document was towards the mental processes involved in sculptural design rather than a complete investigation into available technologies. SLA and SLS were used as they reflected the typical ‘ground level up’ build sequence of the physical works made for this research.

Outcomes from the analysis of the virtual sculpting and additive fabrication sequences included:

- The usage of the virtual software, in combination with additive fabrication, has the potential to positively influence the practicing sculptor on two levels. These two levels of sculptural creativity are:
 - The artistic/aesthetic ideations of the sculptor; and
 - The scientific/technical aspects of engineering and craftsmanship.
- Physical sculpture demanded the artist become familiar with manufacturing practices and material properties to the point that the artist becomes as much of a tradesperson as an artist, in order to construct their works. The advent of virtual sculpting and additive fabrication may act as a conduit to connect the artist directly to the engineered material while allowing more emphasis on creative expression and less on learning and practicing fabrication techniques and use of construction tools and equipment.
- At the closing stages of this research, more metalised powders were becoming commercially available which may provide the capability for artists to create metal sculptures using the virtual system. Commercial outlets within Australia were offering 100% material density for some metals, such as; Stainless Steel, Aluminium and Bronzes by using a two stage technique of creating Additive Fabrications using a combination of metal and synthetic materials, then ‘losing’ the synthetic material and infiltrating the object with metals to occupy the spaces formally taken up by the synthetics. This is a complex and expensive process with resulting costs approaching ten times that of resins. The maximum size of fully metal components was restricted by the maximum infiltration depths and at time of writing were approximately 150L x 150W x 150H.
- Additive fabrication was a single step process, from the artist’s perspective, and the construction time was set by the speed of compiling the various layers of

material. Construction time varies according to size, complexity and the specific processes, however the works created for this research took less than 1 day, representing a significant time saving when compared to manual construction methods. An important consequence of this process was that it permits significant changes to the design, right up until the time the file was passed through to the additive fabrication machine. This window of opportunity was lost when using traditional methods as the construction did not tolerate major changes once construction had commenced and the total construction time may be measured in weeks or months.

- I began this research with the assumption that these advances in technology would support the possibility of a novice to create competent sculptures more easily, potentially undervaluing the work of physical sculptors. What was revealed was not a 'triumph of the amateur' but rather another tool for consideration by already competent sculptors, which like most other 'tools,' may be used to alleviate issues associated with a limited range of spatial problems.
- The digital system presented itself as a viable and capable system that permitted more complex spatial relationships than would be physically possible or practical; however it still required the artist to direct the proportions, orientations and locations of each component in the composition. This ability was the essence of competent spatial awareness within sculptors attempting anatomically accurate figurative sculptures and the availability of digital tools did not supersede this requirement.
- I was aware of other virtual modeling technologies other than the highly manual system used here, such as sub-divisional surfacing, texture mapping and software that creates the human mannequin automatically. However, these were not relevant to this research which was directed to the process of converting mental images into three dimensions without the aid of pre-existing geometry or raw materials.

7.3 Subjective observations on the process of sculpting with clay

Analysis of the experimental results revealed the existence of mental processes that were present in both physical and virtual constructions. It may be safe to say that the construction of deliberate sculptural space requires a broader range of mental processes than just those that the empirical analysis has revealed. At the time of writing, a perfect, independent criterion for creative spatial competency had not been confirmed and this is partly because science does not have agreement on the nature of spatial intelligence. As a consequence, there is little merit in insisting that empirical analysis performed during this research must correlate with criteria that currently does not exist. Rather, I will state the observations as they were discovered without an attempt at formulating any metrics of spatial competency or the limits of the continuum it inhabits.

The early stages of construction

From the experiences in the studio, there was minimal evidence to support the existence of any major difference in spatial competency demanded by the early stages of design for either the virtual or physical works. The underlying premise of this statement is that the ‘concept’ stage of figurative sculpture was not focused on the demands of construction, but on capturing emotions.

Observations upon the initial stages of design included:

- Concept design is centered on expression and it was my experience that as soon as the mind begins to consider the connectivity of elements, it had already (although only temporarily) moved out of the ‘concept’ design stage and into ‘system’ design.
- An unpredicted blending of the two techniques emerged and this hybrid approach quickly established itself as my own default method. This was to use the virtual system for the creation of reference sketches, maquettes and the spatial information used for the specific purpose of guiding the final physical works.
- The ability to quickly produce multiple versions of concepts makes the virtual system a highly effective method of creating reference images and mock-ups. It enabled me to use the same composition and all of its elements in different combinations of movement and placement. While this could have been done physically using sketches on paper, the virtual 3D model offered the

irreplaceable advantage of being able to rotate the model to view the new composition from all sides as I was building it. I found that this ability to quickly experiment with different options and configurations to be much faster and more intuitive than the 2D sketches, as components could be moved to new locations for review, then instantly returned to their original locations using single keystrokes on the keyboard (for example, Control+Z).

- By moving geometry and undoing the movement repeatedly, the artist can toggle between one option and another ‘on the fly’ before committing to the best direction. This method proved itself to be far superior to creating photocopies of sketches and modifying them, both in terms of its speed and its promotion of experimentation during the process of concept design.
- In its literal sense, virtual sculptures were considered as the embodiment of 3D space without any matter at all, a notion that closely approaches the actions of the original conceptual thinking.
- At that conceptual thinking point, the sculptor needs to attempt to capture the 3D perception without the distractions, compromises or constraints of material properties. The task of this early phase, where the composition is still only within mental capacity, may represent the purity of the purpose without the fallibility of:
 - Objects
 - Material
 - The awkwardness of words and utterances or
 - The translation into any particular scale.
- Having used the virtual system to construct the maquettes, the artist may choose to save the data as images from an infinite number of specific viewpoints. If time and costs allow, the artist may consider the use of additive fabrications to create 3D replicas, to use as reference during the construction of the final physical composition.
- I believe it is not the role of the creative idea (or the artist who generates it) to filter what it produces by what is manufacturable. It is the role of the creative mind, to be just that, innovative, through freedom of association, complexity and subtlety of structures. If the purposeful creative mind was restricted by considering only that which is manufacturable, there would be evidence of these

more viable/manufacturable designs as a result of the ‘concept’ design proposals and a lowering of the resulting spatial compromises in the ‘system’ and ‘detail’ design phases.

- During the course of this research there was insufficient evidence to signify that the creative processes involved in ‘ideation’ and ‘concept’ design phases were considerate of the downstream construction requirements. As soon as the creative mind turns to issues of constructability, I maintain that the process had moved into ‘system’ design. It therefore remains my belief that the twin processes of virtual sculpture and additive fabrication may allow an improved ability to reproduce a close likeness to the original idea, by negating some of the spatial compromises that would necessarily be required when attempting to physically construct the idea using traditional methods.

The closing stages of construction

As the work progresses through its stages of evolution, the artist/creator needs to determine the finishing point, that juncture where any further modification would be taking value away from the meaning of the work. For my own works, this came to mean reaching a stage when as much as I could recall about the original idea for composition, was reflected in the object. A condition that Kant (1998, p.197) described as “the agreement of cognition with its object”. My awareness of when this occurred was more apparent in the physical works than the virtual, as this is a direct result of the ability to make changes late in the design process.

Observations upon the closing stages of design included:

- Virtual pieces are modifiable and transformable in scale and proportion in a directly interactive sense all through the timeline of construction, with the additional encouragement of being able to undo the modification with a single keyboard command to restore the sculpture to its ‘pre-modified’ condition.
- This creates an environment, where the artist is able to continue experimenting with the overall concept, even though the composition is nearing completion. This is in stark contrast to the physical works, where the ability to make changes to proportions and scale have a significant impact on the time to complete and the modifications, once made, cannot be ‘undone’. To return the work to its ‘pre-modified’ condition, often demands completely remodeling the work manually. As a consequence, the desire to make modifications to scale or

proportion are not encouraged and the piece is more able to reach that point where any further modification would risk removing value from the sculpture.

- One of the dividing conditions between the experiences of virtual and physical works was the apparent integration of the physical sculptures with my own physical environment; they are part of the world in which I lived.
- The virtual system revealed a technical advantage in its ability to convert its entire sculpture into a format that could be electronically mailed, and displayed, to anywhere in the world capable of internet access.
- As well as any socio-cultural meanings of the sculptures, I was aware they had become artifacts to establish that I had existed and had created a corporeal legacy. This was a different viewpoint to the expectation I had when I commenced the research, where I had assumed that sculptural creation was more detached and mechanised in its approach.
- The artifacts became a three dimensional response to my need to express a thought or feeling, it was no longer just an object, it had a story behind it, both the artists story and an observers own story projected onto it.

7.4 The object as the state of dynamic equilibrium between artist and artwork

This document proposes the existence of a pattern of sub-systems used by artists to attempt to convert a mental concept into three dimensional existence, which clearly defines all of its spatial details and complexity. I believe that a kind of dynamic equilibrium was in play during the ‘shaping’ of ideas. This equilibrium was a state where the ‘pressure’ applied from outside of the clay (from the mental concept being imposed by the artist), attempts to balance with another kind of ‘pressure’ from inside the clay as the criteria of practical limits and the nature of the materials imposed themselves.

The construction of the sculpture may therefore be a resulting stability between the forces of the environment in which the sculpture was made (which limits the level of definition and scale) and the forces from inside the work generated by the original idea (which demands the composition is as full and detailed as it needs to be). In the case of the physical works, the material properties of the organic clay imposed limitations on the practicalities of spatial definitions of ideas. The virtual works were not limited by material properties while the works were retained inside the computer software.

From this standpoint, I believe it may be a metric of sculptural competency to understand the existence and evidences of these forces and determine that moment, after which, any further modification to the composition will negatively compromise this 'balance point'. The process of sculptural design and ideation was iterative and continuous in its insistence to existence and to evolve. The skilled sculptural artisan would therefore be able to determine 'when to stop', regardless of the various capabilities of the tools at their disposal.

It was revealed that part of the tacit knowledge of clay sculpting was to implicitly know what to do, when to do it and the importance of performing those actions within practical sequences. Sculptural competency was not dependant on a separable ability to verbalise or articulate the solution to each presented problem; it was moreover having access to an experience-based database of knowledge and the ability to recall those actions applicable to each specific situation. As the artists' interactions with the work are based on a cycle of constructing, analyzing and planning, that exist between themselves and the artwork, the 'correct action' to take may not be from a memory of being explicitly instructed or shown what to do. Rather, it is the ability to adapt and apply known techniques (or novel combinations of known techniques) to new and potentially more spatially challenging situations.

It may be proposed that, generally, each work was not entirely novel, rather it was a unique combination of known spatial connections and variations to known spatial forms. Spatial competency during the construction of figurative sculptures may therefore also include an ability to analyse, determine, recall and apply these precedent 'spatial connection' solutions to new or novel situations. The iterative nature of design promotes a temptation to continuously adjust and modify the sculpture in the pursuit of the perfect shapes to forms and their surface finish. I believe that expertise, with regard to digital and physical clay sculpture, may not be limited to technical prowess and sound principles for construction; it may extend to include knowing when to stop the cyclic process of analysis and modification of the work.

7.5 The translated object

Finally, I was to learn that the practice of creating my own figurative sculptures was primarily an act of translation. The translations of what I felt about something conveyed in terms of mass and shapes, their scales in relation to my own size and the qualities of their outer surface. The artworks began entirely internal to me and were

borne into three dimensions by the combined application of tools, experiences and the desire to translate it from concept to object.

As I slowly drew back my own personal influences from the artwork to yield to what the object declared about itself, the translation from an ill-defined and elusive mental concept, to an unambiguous and independent object, was complete. The objects had gradually developed autonomy over time, to have an 'existence' of their own as part of the culture within which they were created. Specifically, in the case of the figurative works done for this study, I felt that this meant that the clay figure was both: detached from my own mind and at the same time transformed from the rectangular clay blocks from which it came.

This translation of my thoughts into objects had acted as a conduit for transferring knowledge via purposefully formed space. The result of the translation may act as a repository for the tacit knowledge of the artists' intended meanings for the composition. This knowledge was then potentially available to an observer for guiding and holding their attention. It was the transfer of two types of knowledge: implicit knowledge via its capture of highly specific forms and proportions; and of explicit knowledge from the material properties and craftsmanship.

With the physical works, any observer must be in the same environment as the sculpture, as it could not be replicated and viewed in multiple locations simultaneously. The digital works had the capability to be transferred (or replicated) to multiple locations, which negated the quality of one 'original' model being in one location. Each 'copy' was a new original, indistinct from each other, a perfect replication. I now understand that there is no substitute for being in the presence of a physical object. I am aware that, while translating any concept into physical dimensions may only represent one aspect of sculpture, it is an important one. Physical, shared presence may, in fact be its main characteristic, as to be in the presence of the sculpture was to automatically need to relate to it on some level.

My experiences in the deliberate construction of both digital and physical sculptures had revealed that the quality of physical 'presence' was a principle attribute of me considering the work to be 'finished'. The digital works were limited to two modalities (vision and simulated 'touch') for me to relate to them and, in retrospect, I felt the digital works took on the perception of being highly detailed 'ideas' as opposed to finished objects. It was the physical works that most importantly, enabled me to identify with them using all of my senses. Those physical objects of my own

construction revealed an unanticipated phenomenon where I felt I was both completely detached and also somehow connected. Detached, because they were now out of my head and existing on their own, and yet I was still intrinsically connected to them, as they were unique aspects of myself projected into the physical world.

CHAPTER EIGHT

BIBLIOGRAPHY

- Alderton, DL, Goldman, SR & Pellegrino, JW 1985, 'Individual differences in process outcomes for analogy and classification solution', *Intelligence*. Volume 9.
- Anders Ericsson, K & Simon, H 1993, *Protocol Analysis*, MIT Press; Cambridge MA
Retrieved (20/12/2007) from the University of Newcastle Library database.
<http://0-cognet.mit.edu.library.newcastle.edu.au/library/books/view?isbn=0262550237>
- Baddeley, AD 1996, 'Exploring the central executive', *Quarterly Journal of Experimental Psychology*, Number 49A, pp.5-28.
- Bolton, G 2001, *Reflective Practice*, Paul Chapman Publishing, London.
- Burnham, J 1968, *Beyond modern sculpture*, Allen Lane, Penguin Press, London.
- Butt, J 2006, 'Sculpture Today', Retrieved (29/05/2008) from the University of Newcastle Library database. http://0-proquest.umi.com.library.newcastle.edu.au/dissertations/preview_all/1438390.
- Cannell, CF & Kahn, RL 1968 'Interviewing', *The handbook of social psychology*. Volume 2, pp.526-595, Reading MA: Addison-Wiesley.
- Carpenter, PA & Just, MA 1986, 'Spatial ability: and information processing approached to psychometrics', in RJ Sternberg (ed.), *Advances in the Psychology of Human Intelligence*, Volume 3, Erlbaum, Hillsdale New Jersey.
- Clark, HH 1973, 'Space, time, semantics and have the child' in T.E. Moore (ed.), *Cognitive development and the acquisition of language*, pp.28 -- 64. New York: Academic Press.
- Csikszentmihalyi, M 1996, *CREATIVITY- flow and psychology of discovery and invention*, Harper Collins, New York.
- Duby, G & Daval, JL 2006, *Sculpture from antiquity to present day*, Taschen, Hohenzollernring Deutschland.
- Dulany, DE & O'Connell, DC 1963, 'Does partial reinforcement dissociate verbal rules and the behaviour they might be assumed to control?', *Journal of Verbal Learning and Verbal Behaviour*, Volume 2, pp.361-372.
- Eilan, N, McCarthy, R & Brewer, B 1993, *Spatial representation*, Blackwell, Oxford.
- Frankel, F, Levine, M & Karpf, D 1970, 'Human discrimination learning: A test of the blank-trial assumption' *Journal of Experimental Psychology*, Volume 85, pp.75-117.
- Goel, V 1995, *Sketches of thought*, MIT Press; Cambridge MA.

- Kant, I 1998, *Critique of pure reason*, Cambridge University Press, Cambridge.
- Lawson, BR 1994, *Design in mind*, Butterworth Architecture, Oxford.
- Lawson, BR 2004, *What designers know*, Architectural Press, Oxford.
- Levinson, S 2003, *Space in language and cognition*. Cambridge University Press, Cambridge.
- Logie, RH 1995, *Visuo-spatial working memory*, Lawrence Erlbaum Associates, Hove UK.
- Lohman, DF 1988, 'Spatial abilities as traits, processes, and knowledge', in RJ Sternberg (ed.) *Advances in the psychology of human intelligence*, Lawrence Erlbaum Associates ; Hillsdale New Jersey.
- Lyons, J. 1977, *Semantics*, Volumes I and II, Cambridge: Cambridge University press.
- Mackintosh, NJ 1998, *IQ and Human Intelligence*, Oxford University Press, New York.
- Martin, M 1993, 'Chapter 8 Sense modalities and spatial awareness' in Eilan, N, McCarthy, R, Brewer, B (eds.), Blackwell Publishers: Oxford, UK.
- Memorise applications*, Retrieved 19/02/2008,
<http://www.memorise.org/flashwords.php>
- Miller, GA & Johnson-Laird, PN 1976, *Language and perception*, Cambridge MA: Harvard University press.
- Muchembled, R 2004, *Damned An illustrated history of the Devil*, San Francisco CA: Chronicle Books
- Newell, A & Simon, HA 1972, *Human problem-solving*, Prentice-Hall, Englewood Cliffs, New Jersey.
- Nisbett, RE & Wilson, TD 1977 'Telling more than we know will: verbal reports on mental processes', *Psychological Review*, Volume 84, pp.231-259.
- O'Toole, M 1994, *The language of displayed art*, Leicester University Press, London.
- Pellegrino, JW 1986, 'Deductive reasoning ability', in RJ Sternberg (ed.), *Human abilities: an information- processing approach*, WH Freeman, New York.
- Portugali, J 2005, *Complex artificial environment*, Springer Press: New York
- Poltrock, SE & Agnoli, F 1986, 'Are spatial visualisation ability and visual imagery ability equivalent?', in RJ Sternberg (ed.) *Advances in the psychology of human intelligence*, Erlbaum, Hillsdale New Jersey, Volume 3.

Reed-Donahay, D 1997, *Auto/Ethnography – rewriting the self and the social*, Oxford International Publishers, Oxford.

Schuman, H & Presser, S 1981, *Questions and answers in attitude surveys*, Academic Press, New York.

Schwartz, H 1966, 'The random probe: A technique for evaluating the validity of closed questions', *American Sociological Review*, Volume 21, pp.218-222.

Shepherd, RN & Metzler, J 1971, 'Mental rotation of three-dimensional objects', *Science*, Volume 171, pp.701-703.

Smyth, MM & Scholey, KA 1992, 'Determining spatial span: the role of movement time and articulation rate', *Quarterly Journal of Experimental Psychology*, Volume 45A, pp.479-501.

Spradley, JP 1979, *Ethnographic Interview*, Harcourt Brace Jovanovich College Publishers, Fort Worth Texas.

Spradley, JP 1980, *Participant Observation*, Harcourt Brace Jovanovich College Publishers, Fort Worth Texas.

Sternberg, RJ 1977, *Intelligence, information processing and analogical reasoning: the componential analysis of human abilities*, Erlbaum, Hillsdale New Jersey.

Sternberg, RJ 1985, *Beyond IQ: A triarchic theory of intelligence*, Cambridge University Press, New York.

Sternberg, RJ 1990, *Metaphors of mind: conceptions of the nature of intelligence*, Cambridge University Press, New York.

Sternberg, RJ & Gardner, MK, 1983, 'Unity is in inductive reasoning', *Journal of experimental psychology: General*, 112, 80–116.

Verplanck, WS 1962, 'Unaware of where's awareness', in CW Ericsson (ed.), *Behaviour and Awareness*, Duke University Press, Durham NC, pp.130-158.

Weisberg, RW 2006, *Creativity: understanding innovation*, John Wiley and Sons, New Jersey.

Wohlers, Terry T 2006, *Wohlers Report-Rapid Prototyping and Manufacturing-Annual Worldwide Progress Report*. Fort Collins, Colorado. Wohler Association Inc Press.

APPENDIX 1.0 – The process of constructing the reference sketches

During the research for this study, I created many virtual and physical clay sculptures. I accept that over time any apparent competency of the works had increased from my most humble of beginnings and find myself most reluctant to show any of those first unrefined attempts to anyone. The early pieces were not so much disappointing, just frustrating as my knowledge of the virtual software and the physical clay material prevented me from successfully translating my mental ideas into actual articles. The latter pieces were much closer to being a replica of the original idea that spawned them and for that reason alone, were much more satisfying to create. A more detailed explanation of those pieces in the final exhibition is contained in Chapter Five, so here I will concentrate on the visual lineage rather than the contextual lineage.

The research revealed that each finished piece was actually a collage of influences and images that were offered up by my imagination and experiences. Capturing the visual ingredients that contribute to each work was challenging, as the speed of evolution is generally quite fast and may have elements of sub-conscious thought. In the case of my own works, the originating point from which the works evolved was primarily a need to record my philosophical concepts for the supernatural character I was illustrating. For other artists and designers, the origin point may vary case to case, or may more often be founded in a visual concept first, before adding the influence of any specific narratives.

As an example of how elements become combined for each artwork, when I recall the major influences on one of the works called ‘Condolence’ and how they were combined, the result is a schematic like the one shown in Figure 16. The process of combining the various influences was often quite fast and the influences shown below are only those that I could clearly distinguish retrospectively. The diagram shows a combination of inputs on the top level. From left to right they are: the lazily relaxed hand on another of my pieces called “Fat Satan”, a drawing of a sheep’s horns that I had done when I was only about 18 years old, the overly developed back on another of my pieces called “Rest in peace” and the remorseful posture on (the second piece I had ever attempted using clay) a work called “Bored”. The images across the top represent the major visual influences and the red arrow directs their involvement down into the first step, to creating the final object - which is the creation of the pose of the figure. This was often sketched roughly with a pen on a note pad, just to bring the elements together. As the sculpture begins to solidify from its influences, I have used the virtual sculpting

system to record a maquette, shown here as a series of images from the virtual model. The lowest level in this schematic is one of the hardcopy printouts from the virtual system, which I used as reference image when shaping the physical clay. They were usually pinned onto a board next to the modeling table for me to use as a constant guide. Although this image is small in the diagram, the actual image used was normally approximately 200mm high and I manually constructed a grid over the top of the image in pencil to use as a metric for estimating the scale of the many elements that make up the final figure.

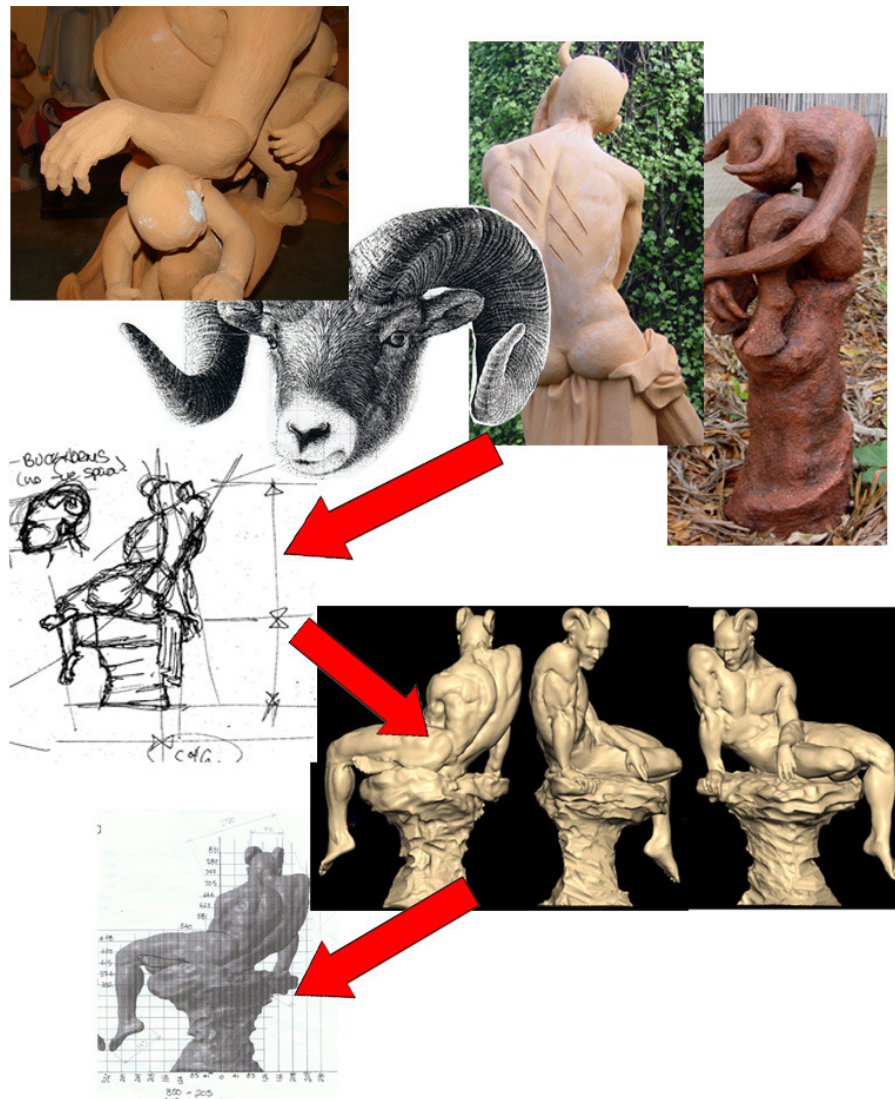


Figure 16. A typical schematic of the influences that can be recalled when imagining a final composition. This diagram, when read from the top to the bottom, captures some of the major milestones I used to record the original thought into one unambiguous document called the 'reference sketch'. This sketch is used as the target for proportions and overall scale for the sculpture throughout the final stages of shaping and connecting the clay elements.

1.1 The process of beginning construction

I had assumed at the outset that most of the information I was seeking would come from the results of existing, scientifically recognised ‘standard’ tests for spatial intelligence and that my research would be as structured as identifying the frequency with which those specific tools were being used here. This assumption was incorrect. While many of the IQ type tests for spatial intelligence were described as the ability to form or construct representations of complex shapes, there was little indication from the test results that lead to conclusions about the specific tools that were being used (Carpenter and Just, 1986; Lohman, 1988). I did not want to attempt to create some form of rating system, because to do so would presume that the rating was based on a complete understanding of the devices used. Instead, I focused on understanding the complexity and interrelationships that artists may use to construct a new shape in 3D space and whether the definition of these relationships may act as a conduit between the mental ‘constructs’ of the artist and the perceptual constructs of any independent observer.

It became apparent to me that at the simplest level, reasonably objective tests suggested that people operate on mental representations of external objects in much the same way that they would operate on the external object itself. The existence of these indices of human behaviour relating to human intelligence are argued by Mackintosh (1998, p.286). The idea that people generated a mental image of objects, that was complete enough for them to imagine rotating it in their mind in a similar way that they would rotate it in the physical world, was revealed by Shepherd (Shepherd 1971) in a series of studies on mental rotation. This was supported in the findings from my own research, in particular with respect to the dependence of the mental image to direct the reference sketches I was creating. Analysis of my reference data revealed that they often included images and objects portrayed from multiple viewpoints, which suggested that the mental image must be of sufficient detail to allow drawing it from all sides.

Construction of specific combinations of forms in imagined shapes were necessary to prevent the details from being too ambiguous. Detailed imagining of objects in 3D space may be very demanding on short term memory, particularly if the mental image includes many similar shaped objects. There is certainly potential for visual similarity to interfere with the short term retention of visual representations (Logie 1995). The human figure may be proposed as consisting of many like-shaped

forms, primarily cylindrical objects and their relatives, however this potential demand on mental resources was rejected when applied to the sculpted human form. I maintain that a sculptor does not view the human figure as a complex series of repeated cylinders and cones. Rather, the artist is using a different understanding of the human figure, looking beyond the external surface representing the skin and any simple implied geometry to a set of interpenetrating, and uniquely shaped forms. The sculptor is looking at the underlying individual complexities of the human anatomy, the presence of the skeleton, the muscles and fat, all of which leave their witness marks in the way the skin is shaped. For this reason, I believe that any apparent ‘similarities of forms’ are negated in the attempt to accurately capture the subtle and intricate sub-structure.

Once the mental image of a composition was becoming crystallised via the construction of a reference sketch, the building of the virtual and physical works were then used to translate the idea into an unambiguous description of space. In the studio, the virtual and physical works generally progressed at the same time and I most often deliberately alternated between the two methods, to ensure that my learnt progress in one medium did not advance at the sacrifice of the other. Each piece would be completed from sketch to the finished object in each system, before alternating to the other method. I did not work on virtual and physical works simultaneously.

1.2 Forming organic clay

Those works constructed using organic, physical world clays tended to follow a regular pattern of construction. Once the ‘conceptual idea’ for the work had been settled upon, the first major decision was to determine the overall physical size of the composition. Two factors become apparent when constructing the works using organic clay: firstly the maximum transportable size; and secondly, the maximum size for a sculpture that would fit in an available kiln. My studio consisted of a dedicated room in my house which was stripped out of furniture and allowed to become a complex scene of computers and clay tables (Figure 17).



Figure 17. The bedroom converted to studio. Note the digital clay computer system on the left and the physical clay on the table in the middle of the room.

I was soon to be unpleasantly surprised at just how messy the construction of organic clay pieces could be. Although the construction takes on a ritualistic feel as the process of preparing the room, in order to continue each day, involved the removal or covering of any electronic equipment and the clearing of floor space from chairs and boxes. The knowledge that this was a process to go through before starting each time was sometimes a deterrent and other times formed an important separator to the regular course of the day. Additional to preparing the room, was the mental preparation for what was to follow and once both hands are coated in clay there is little opportunity for anything else. As the work was closer to being finished, more care and time was taken to ensure that it was treated properly to prevent it drying out too quickly; the entire ritual may take 12 to 15 minutes.

Generally, the construction began with some form of reference sketch whether this was a hand sketch of my own or a series of photographs and inspirations. The hand sketches have a grid drawn over them to allow me to scale up the proportions to control the overall size of the work and to act as a guide during the construction. In the latter stages of the research I would use the digital clay system to create the reference maquettes and then print off a series of orthographic views to apply the grids upon (Figure 18).

Often the reference sketch was simple and done quickly without the need to progress into a 'finished' drawing in its own right. The role of the sketch was to consolidate the ideas and thoughts about the next sculpture and too effectively freeze the evolution of the idea to prevent new ideas influencing the piece away from the

original concept. The mental processes of imagining and forming the idea for any piece, in my experience, have been a rapid cascade of thoughts and images. Some images are from memory, some as a result of seeing other images and yet others stem from trying to distill some of the emotion and feelings that I wanted the work to portray. Consequently, the sketch could be left quite rough to allow some scope for further expression in 3D, it only had to stop the idea from being lead down still more avenues and potential compositions and to prompt the memory of the original ideas.

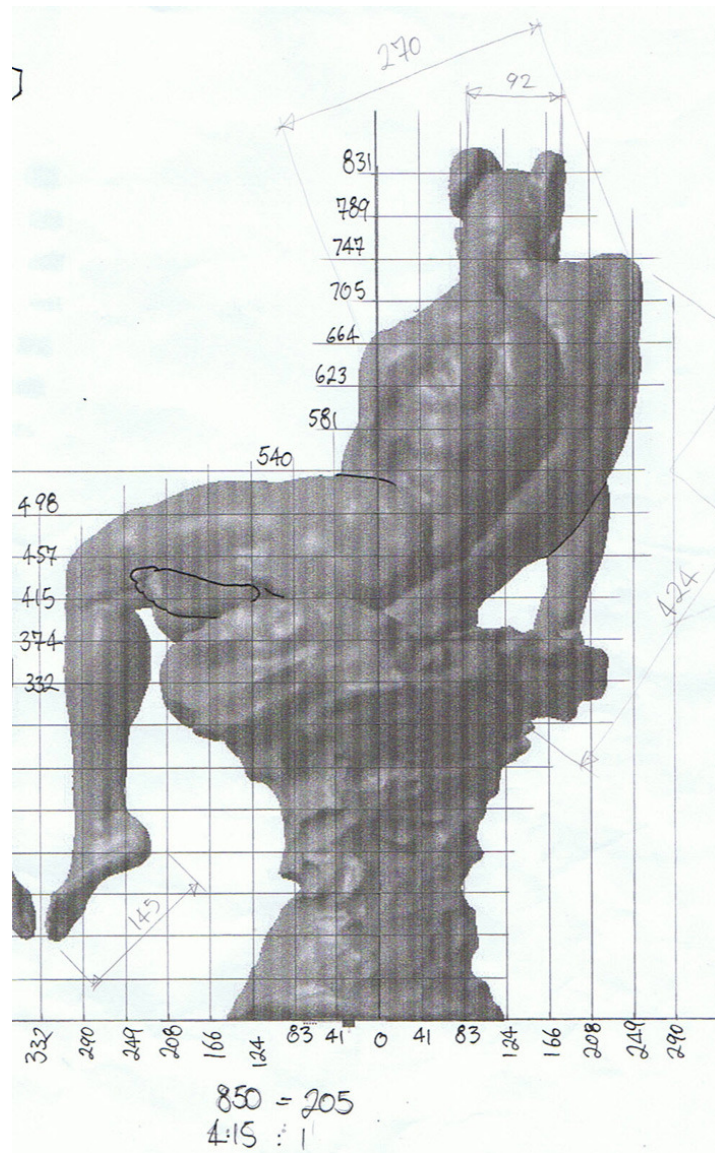


Figure 18. A typical image used as 'reference', note the hand drawn grid lines over the top of the view with the 'scaled up' dimensions written next to each grid line – both vertically and horizontally.

The overall composition was then analysed to identify how it needed to be supported and which areas needed to be made hollow to preserve clay and accommodate its weight. Experience taught me to ensure that the individual slabs of clay were very well connected to the adjacent slabs by scouring their interfacing surfaces and forcing the pieces into each other to become one continuous covering. Any areas where the clay does not join thoroughly would separate as the clay dries and contracts, the cracks generally increase in width during firing, as the clay continues to dehydrate and shrink. After creating several full pieces, the amount of shrinkage for the Raku clay being used was calculated to be approximately 10% in all directions. The shrinkage became one of the biggest considerations when deciding on the composition, as any negative spaces may separate and crack when the clay shrinks during the drying process. If the clay were to be left moist while a plaster mould was taken from it, the problem would not be so great, however as my pieces were generally dried completely and fired, the shrinkage could be very destructive.

Once the clay has completely covered any internal armature, the process of adding the individual features of the composition are systematically added until all that is left was the process of controlling the final surface textures to the various areas of clay. The evolution of the idea becoming realised into three dimensions tended to follow a regular pattern of three stages I will refer to as 'concept', 'system' and 'detail'.

Making physical clay pieces seemed to me to be more fun in the doing, in comparison to the virtual pieces. There was a lot of physical activity involved and it could get quite tiring and exciting at the same time. The individual blocks of clay are heavy to carry around and the physical labour did not stop at carrying the raw material into the studio, but continued during the forming of the clay into the final compositions.

But all of this effort was not without reward, as I felt I was actually doing something credible with the physical works, something that mattered. There was a level of satisfaction that generally goes with physical effort to achieve a goal, however this was magnified when I could see the progress of my efforts at the end of each session. Once the sculpture gets beyond a certain level, which I refer to within this document as 'Concept', the final composition can then be recognised in the simple shapes and as a consequence, the work takes on a momentum of its own. The work seemed to generate a need to have itself finished, to liberate it from the blocks of clay and have the original mental idea preserved in three dimensions for the world to see. It became more than just a combination of emerging shapes; the sculpture took on a physical presence that I

could feel when I was in its company. It had a cool and wet feel to it from the moist clay and had a smell of earthy soil; it is obviously heavy and it ‘lives’ in the same room I am in – the same world.

To prevent the work from drying out between sessions, they were wrapped up to seal them (Figure 19). Often when I was starting work on a piece again, I would have to release it from inside the temporary bandages and find myself just sitting and looking at the uncovered work. Most often these times were about determining what to do next, but other times I would just sit and look at it as if I were sharing the room with another living thing, half expecting it to move on its own at any moment.



Figure 19. An unfinished piece, shown wrapped in it swaddling until the next modeling session. When I was involved in the ‘System’ design phases I would try and work on the sculpture each day, so the cloth only had to be draped loosely around the clay. In situations where the sculpture would be left for several days, I would pay more attention to sealing it up, such as in this image where an additional bed sheet has been wrapped around the bottom edge to prevent any moisture escaping.

The apparent identity of the individual works stemmed from my observations that I was sharing the same environment as the sculpture. The importance of this was revealed by the digital works as the absence of a shared experience (being in the same world) between myself and the digital sculptures made them difficult to relate to and often less inspiring to complete.

1.3 Forming digital clay

The construction of compositions using digital clay had some strong similarities to physical clay in approach, but with some strong dissimilarity in subsequent material properties. The process of preparing both myself and the studio was very quick and clean, compared to physical clay, as the computer that was used to create the virtual works was left powered on continuously. Once the program had started, the existing file could be opened and was available for modification within 5 to 10 seconds. Building the digital compositions was done using a different kind of hand tool to those used for physical works. The simple scrapers and trowels of the organic clay were replaced by a delicate and expensive piece of equipment called an 'Omni' (refer to Chapter 2).

The apparent absence of any form of gravity within the virtual environment radically alters the spatial freedoms offered to the artist. Initially, this removes the necessity for an internal armature to provide support for the clay. The absence of gravity also results in the digital clay having no mass and no dehydration of its material. This factor alone negates the limitations of how to support the work around any negative spaces and the artist is free to explore compositions of near unlimited complexity with no consideration of balance points, centres of gravity or the strength of the material properties to support itself.

As with the physical clay, once the virtual work has all of its main elements created and positioned, the process of systematically working through the addition of the smaller details continues through to completion. The creation of the final surface finish was also the same, with the repeated selection of different tool types and techniques to continually refine the surface to the desired effect.

The digital pieces were much more convenient to create. Although, I often felt there was no ritual significance to unveiling it before each session, no ensuring that I need enough time to spare to make it worth the effort. Once I was seated and the program was running I could start, or continue an existing piece, almost immediately. This high level of convenience matched well with the artificial nature of the electronic sculptures, they did not need to be prepared or approached in any way, and they were available whenever they were required. I found this to be an uninspiring part of virtual sculpture, there was no ritual, no reintroducing myself to the developing work at the start of each session. I was aware that the sculpture was entirely of my own design and construction and that it 'lived' there inside the computer, however the computer also

housed many other types of files, including dozens of other digital sculptures at various stages. There seemed to be an absence of a unique individual identity associated with each work. As a consequence, over the three years of creating virtual pieces, I did not feel that they were in my presence; they were always distant and somewhere else - somewhere simulated and unnatural.

This is not to say that the digital is inferior to physical, not at all, just psychologically different for me to use. It was my experience that the digital system had many advantages over the physical, both personal and technical. For example, it was not physically demanding to use, I could remain seated at the computer for hours at a time without getting tired. All the time knowing that the work could be saved in approximately 10 seconds, after which I could just stand up and walk away without any clean up tasks.

Unlike the physical pieces, the work was always well lit by the software, no shadows that could not be removed with a keystroke, no craning my neck and squinting to see into dark crevices and hollows. Once I had become familiar with the software interface and commands, the work tended to develop at a faster pace than the physical pieces. On average, those digital works that could be considered as finished, took less than 25 hours to create in comparison to 40 – 60 hours for the physical works. I have added the qualifier ‘could be considered as finished’ for a reason, as there were many digital works that were started and never finished. This happens for several reasons including: abandoning one version of the file to save the same sculpture by a different filename and continue without ever returning to the original, experiments in surface finishes that were kept for reference but never advanced any further and copies of incomplete works that were archived onto computer hard-drives, CD’s and DVD’s for security against data loss. These files are still sculptures, still hand crafted deliberate works of art that exist within the virtual world, it was their ability to spawn and duplicate themselves which rendered them of less value (to me), than that one central version that was chased out in all its details.

The digital sculptures were technically superior to the physical equivalent in many areas. The principle reason behind this statement was the absence of gravity in the virtual environment, as stated earlier. To me as an artist, this simple difference allowed the spatial decisions for the composition to focus entirely on the intended meaning, with no regard for internal dialogue about ‘how will I make this?’ Individual elements may interpenetrate each other with no consideration necessary about how to access the

hidden areas with hand tools or the fingers (Figure 20). The digital ‘tool’ is continuously variable in its size from sub-millimetre to larger than the entire composition, so tool and hand access is no longer part of the planning of the construction sequence for the work. This planning is critical for physical clay and I believe that a generous contributor to the artistic competency of a physical world sculptor is the ability to predict and plan for the assembly sequence that allows for the best access to all areas of the composition to control proportions and surface finish. Similarly, the virtual system allowed for the creation of elements whose equivalent would be very heavy in the physical world and allows them to be connected by small tendrils of matter or left entirely unconnected, just free floating, stable in both their dimensions and their orientation to the rest of the composition.

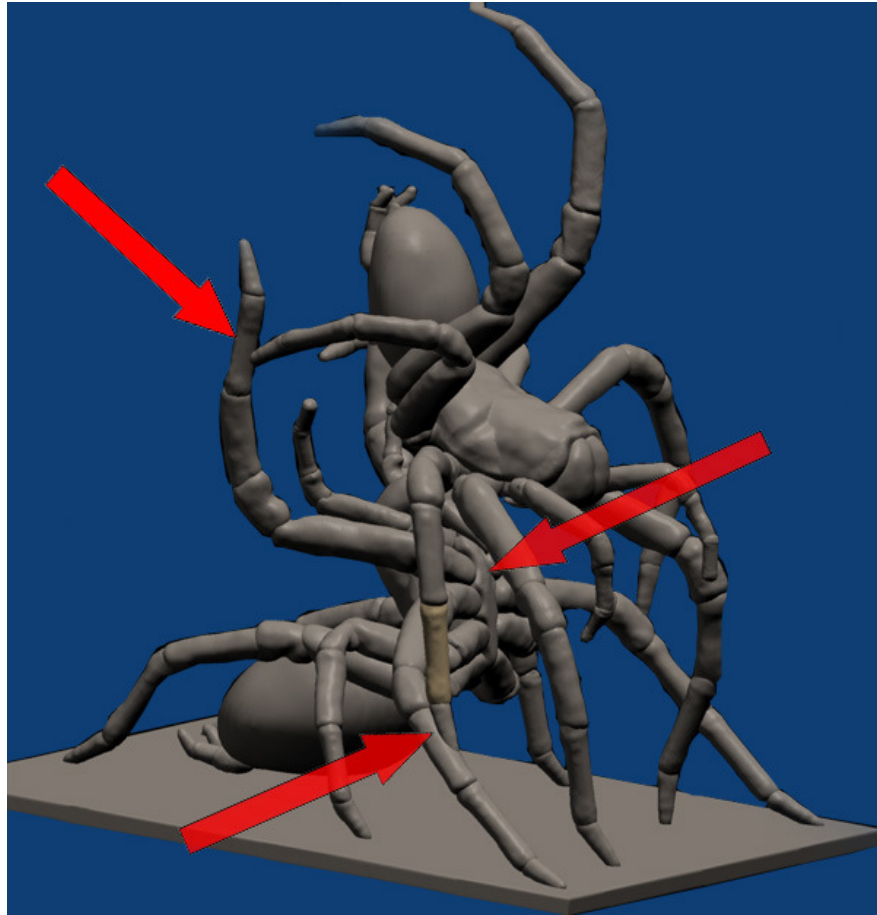


Figure 20. This image shows a virtual sculpture which includes areas where the space between objects was not affecting the ability to access the spaces and create details. The arrow at the top shows an area where the connection between two elements (the two different spiders) was allowed to be as small as necessary with no regard to whether it would 'support' the sculpture. The middle arrow (on the right hand side) indicates an area between the two spiders where details have been formed without the need to consider the ability to allow 'tools' in to access this small area between the spiders. The lowest arrow reveals an area where the forms are allowed to wrap around each other, in the physical world this joint would need to be modified to allow the joint to support the upper spider against the force of gravity.

The user-related flexibility of the virtual system extended to the ability to alter overall proportions of the works even though the work was near completion, with its entire final surface finishes added. This was simply not possible in the physical world. Physically, after the work had all of its elements added and oriented correctly to each other, the final stage was to revisit all of the visible surfaces of the clay to ensure that the surface texture was modeled as it was intended.

Separate to the absence of gravity, the next major contributor to the technical superiority of the digital system was the all-encompassing power of the 'undo' button. This function was common place in most computer based applications and allowed the previous interactions to be undone in the reverse sequence to the way they were

performed. In digital sculpture, this takes on new importance as the artist is free to try modifications to the work, safe in the knowledge that the modification can be reversed if the desired effect was not achieved. This was also not possible in the physical world, where small modifications can be repaired by attempting to remodel them as close as possible to the way they were—although never exactly the same.

The digital sculptor now has the power to make radical changes to the work, regardless of how close the work is to completion, with the ability to accept the changes by continuing or rejecting the changes by selecting ‘undo’. For example, the artist may question how the central figure would look if only half of it were represented in the composition. At this point the artist is free to remove 20-30 hours worth of work with a few simple actions, review if this improves the composition and simply select ‘undo’ and continue. However this sense of freedom also had its detriments, for it was my experience that this ability to freely modify the proportions of the work, tended to depersonalise it. While I still gave the work the respect that I believe any object of focused creativity should be given, I knew it was not delicate or fragile. Unlike a physical work, the digital is almost immune to being irreparably damaged and as a consequence it does not feel as vulnerable, it does not feel as much like the ‘living’ thing that I perceived from a clay figurative sculpture. The physical piece was very difficult to completely repair if it were drastically modified or damaged, this was not so with the digital work. In fact the entire file could be accidentally destroyed and I was safe in the knowing that it could be quickly restored from archives or previous versions stored separately.

The digital file was not indestructible and great care needs to be taken with some aspects of creating electronic sculptures. Initially, the learning burden was high and the chosen software may take 80 hours of usage to become fluent with the basic commands, although this of course depends on the computer literacy of the individual. The software chosen for this research was relatively intuitive, in comparison to similar CAD programs and responded to the basic PC principles of file structures, formats and saving of modifications. As with any PC exposed to the internet, the computer and its systems were vulnerable to attack from computer viruses and file corruptions. Accordingly, the individual sculptures needed to be regularly archived to either: other hard disks or removable media such as CD, DVD or USB memory sticks. If a regimented backup routine were not in place, it would be possible for computer systems accessing the internet to have the digital sculptures corrupted with no method of restoring them other

than recreating them from scratch. By contrast, physical world sculptures may also be vulnerable to damage but the material from which they are made could not be inadvertently removed from existence.

During the course of this research, the digital sculptures I had created allowed a level of peer review that had significant logistic advantages over the physical world pieces. The digital work could be saved as a specific format that allowed it to be electronically mailed to other parties for review or analysis. In the physical world, the observers had to co-locate themselves with the sculpture in order to see it from all sides, whereas the electronic models may be rotated and freely inspected from all possible viewpoints from which ever locations the recipient had chosen to open the electronic mail. Extending the capability of this idea, those digital works selected for additive fabrication for this research, were converted to a specialised file format. This format, referred to as an '.stl' file, was saved as a copy of the original digital sculpture and electronically mailed to the additive manufacturer for review. The final file was saved to a CD for safety and sent to the manufacturer; however this could easily have been electronically transferred without the need for the artist to move from the studio. The finished additive fabrication was couriered from the manufacturer, back to the address of the studio in a large cardboard box packed with foam, without the manufacturer altering the file at all. In effect, I felt I was communicating directly with the fabrication machine, which in my case, was more than 1000km from my studio.

The digital sculpting process by its implicit nature provides new methods to explore space in comparison to physical clays. For example, the composition does not have to be built from the 'inside to the outside and 'bottom to the top' as with physical works. The artist was free to construct the composition in any order, free from the demands of gravity. This freedom however, did not extend to altering the natural evolution of the work from its concept to the finished object; the artist could not start out with the final work and work backwards to the beginning. In this way, the two methods are aligned in the need to methodically construct space, the connections of elements to each other and then the final surface treatment. Instead of altering the timeline, the digital freedom in sequencing comes from the ability to work on the construction of individual elements in any order. For example, the artist may start at the top of a composition (the head of a standing figure) first and leave this element apparently suspended in its location to work on other areas of the composition (Figure 21).

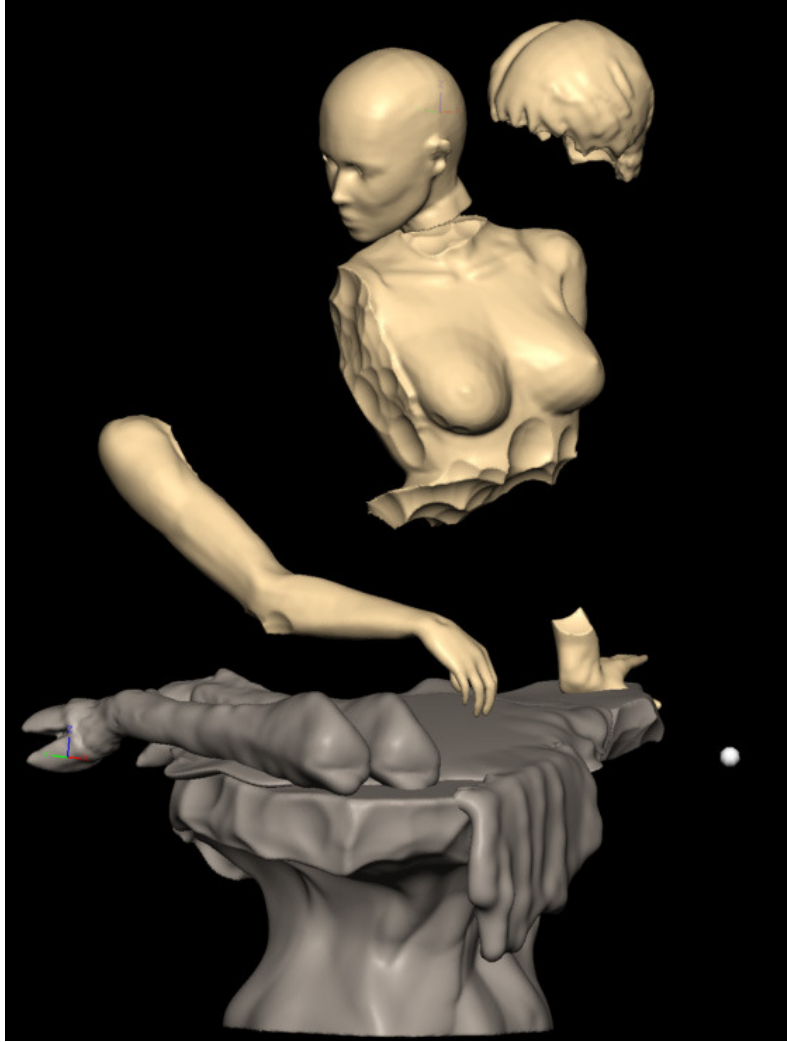


Figure 21. In this image from a developing virtual sculpture, the upper torso and head have been started without the need to support them. Note also the figures right arm which can be developed to a particular stage and then left floating in space until it is required. The form in the upper right hand side represents the figures hair, that was started and then abandoned, it also 'floats' until it is finished and attached.

Alternatively, the artist may model a limb as a separate element and drag it off into free space away from the composition. If this element is then later required, the previously modeled limb can then be 'picked up' using the haptic device and maneuvered into its proper position, within the composition, using the six degrees of freedom that the haptic device allowed. The software program chosen for this research was typical of most other related CAD softwares, in allowing the user to interactively decide if multiple objects within the one file are maintained as separate entities or joined together into one object. It was at the discretion of the user whether any separated elements needed to be combined with the main body or needed to be temporarily left as a separate entity. By contrast, the physical world does not permit multiple elements to

occupy the same position in space at the same time, whereas the digital system permits an infinite number of separate elements to be co-located.

Building upon the flexibility of the digital systems assembly sequence, the CAD software also allows the user to apply modifications to individual elements or joined elements simultaneously. Using the example above of a separately modeled limb, fundamental changes can be made to the limb that do not effect any of the other elements within the same file, overall scales can be controlled in three separate directions (length, width and height) as well as localized or general deformations interactively applied by the user using the haptic device and a variety of 'tools'.

At the beginning of the process of constructing a composition (the Concept design stage), the digital system allowed me to store multiple versions of the sculpture within the same file for comparison. I was then free to choose which versions to have visible at any time and continue to swap between the different versions to continue developing each one in turn. For this reason the digital system became my default method of creating maquettes for physical world pieces before commencing their build sequences. With respect to figurative sculpture, different versions of postures can be positioned over the top of each other to compare and combine until the final version was selected to complete physically. At this stage, the previous iterations could be deleted or have their visibility turned off and left in the file for future reference.

Once the equipment and tools for both the virtual and physical works were available, and I had knowledge of the basics of their usage, the process of recording the sculptural experience would begin. Breaking my concentration to clean up and write out salient points would be disruptive to not only the process of creation, but the candid nature of the original thinking may be lost (Anders Ericsson & Simon 1993, p.17). So a simple technique of using a digital recorder and wearing a microphone while drawing and sculpting allowed me to simply vocalise the thoughts I was having with no regard to stopping or altering what I was doing.

APPENDIX 2.0 – The design process – Compromises and combinations

2.1 Considerations of the new space being shared between artist and the artwork

My research revealed a pattern in the approach I had taken to define both the simple and more complex constituents of space, whether in the digital or the physical environments. Defining space was a mental problem and in order to solve these complex problems, there was a need for me to break the overall task down into smaller, more manageable parts. I could work out a solution to one form, hold on to it mentally and/or physically, while working out a solution to the next form, and so on. This resulted in combining all these forms and element ‘solutions’ into a spatial answer to the problem as a whole. This ‘answer’ is effectively the shaping of the final composition. I observed that these manageable parts include:

- The stages of a sculptures evolution between the initial mental image and the finalised three dimensional forms
- The separable aspects that make up the structure of a ‘deliberate’ space
- The mental processes used by the artist during the activity, and
- The interim stages used by the artist to control how the space is defined.

The following pages represent my understandings of the meaning of each of these individual influences and how they interact with each other during the creation of sculptures created during this research.

2.2 The relationship between artist and artwork

Beginning with the stages of evolution, (from the original thought to the finished object), an important distinction must be made. The artwork needs to be considered as being separate to the artist. This seems like a simple statement and somewhat obvious in its nature, however this is a significant first principle of defining deliberate artistic space. The artwork is not always separated and does not always exist outside of the artist. The artwork can remain within the artist, existing within their mental processes, of imagination and recall. It is only when an artist attempts to realise this idea into 3D space that specific decisions need to be made using combinations of identifiable criteria. At the point of conceiving the mental image of the ‘concept’, a certain level of spatial awareness was necessary to make the mental constructions, retentions and manipulations while the representation is still internal—as they were not yet physical representations. Specific research into the correlations between mental imagery and

spatial ability conducted by Poltrock and Agnoli (1986) revealed that one condition did not freely translate into the other. This was particularly relevant to the virtual sculptures I was creating, as my prior impression of this computer technology was that it ensured things would be fast and accurate. These assumptions proved to be ill founded and the decision making process within virtual sculptures was essentially no different to those processes used in physical works.

Using the understanding that the artwork and artist need to be separate, the potential for influences outside of both these entities can then be considered. Current understanding of socio-cultural activities supported the idea that artworks were extremely difficult to create in isolation and that there was a socio-cultural component to their creation (Csikszentmihalyi 1996; Spradley 1980; Weisberg 2006). As a consequence, the relevant domains and fields have an influence on the artist. The degree of influence a field has upon an individual artist is debatable and will be expanded later in this Appendix. This research has focused on revealing the technical values used by participants during the act of figurative sculpture and while I was aware that there was a need for an increased understanding of any socio-cultural aspects of sculptural creation, this document will not review this in depth. However, it remains relevant to note, that as an artist I would be affected to some degree, by any exposure I had to the relevant domain and its fields during the study.

The influence that the field has upon an artist may include the apparent social 'value' placed upon the artwork. System models of creativity such as those proposed by Csikszentmihalyi (1996) argue that the value of an artwork is contributed to by the relevant domains. I maintain that such systems models may only have a limited application with regard to sculpture, as any value assigned to the artwork by the artist/creator is potentially independent of the domain. The value of a work—to the artist who created it—is not rigidly set and may vary over time; however this value may be entirely different to any value proposed by the domain and its fields. Fields may influence the artist's own perception of a sculptures' value 'post production' once the object has been offered for review. Before this however, the only tangible value may be pre-existing notions within the artist.

Returning to the nature of the relationship between the artwork and artist, and building upon this understanding that the artwork and the artist are separate entities, is the knowledge that they were not completely independent and that a permanent and dynamic relationship existed between the two. It is a relationship of interdependence, a

form of symbiosis. Here, the artist brings their own individual influences to the artwork, and the artwork also offers its own influences back to the artist. I believe that the result of these interactions is the sculptural object itself. If the event of creating sculptural works was repeated, the result will be an artistic body of work, which historically the artist may consider using for exhibition to observers and as a consequence, exposure to external influences such as the domain and its fields.

2.3 Stages in the artists development

If I focus specifically on how the individual artist influences the work (the works influence over the artist is described in Section 2.4), initially a number of subjective factors emerge. I considered these to be subjective in their nature as they included variables that were difficult to quantify and were linked directly to the individual nature of an artists' personality traits. By way of example, personal experience was a factor that an artist may offer to the artwork, the degree of experience was specific to each individual artist and yet had a direct influence on how the work was defined. One such result of experience was an apparent fluency with the interim stages necessary for the end result, based on the ability to recall specifically related aspects of prior learning, cultural heritage and exposure to related activities. This particular experience was also related to 'expertise', however this relationship was difficult to value in sculpture, as it had been my observation that individuals with similar experiences may exhibit different levels of apparent expertise. Expertise was revealed as playing a critical role in higher level mental problem-solving skills. This leads to the possibility that expertise was important, more generally, in creativity which involves problem solving, which has also been argued by Weisberg (2006, p.154). Sculptural expertise was not developed merely by repeating similar tasks many times. It is my belief that this was based on a structured process of facing new and more complex challenges to deepen the knowledge being accessed.

Additional to these factors of expertise and experience, individual emotional states at the time may alter the nature of the mental processes being accessed during the various evolutionary stages of a sculpture. Emotions in combination with motivations, self confidence, desire and personal intentions place heavy demands on the artists' mental capacity and may interfere with the effective allocation of mental resources being used for spatial determinacy. It is not the intention of this document to define and catagorise all of the relevant, individual attributes affecting this kind of sculptural

practice. It is relevant however, to recognise that these qualitative aspects were present in every occurrence of the event, and were linked to the individual personality and psychological profiles of the sculptor. Therefore they should be considered as constituents of influence upon the artist during the creation of the artwork.

Maintaining a high level review of the interaction between an artist and their sculpture, the artwork also has some level of influence back onto the artist. This influence may be restricted to the sculptures' ability to act as a repository, a single and unambiguous source of all the 3D spatial decisions made by the artist up to the most current point. I believe the specific decisions involved in the orientation of individual elements to each other are the start of capturing the cultural meaning associated with the work and that these decisions, with the resulting spatial relationships, are effectively informing or encoding the work. The encoding of the original meaning becomes valuable to the artist in latter stages of artistic production as it helps the artist to guide the way the work may be understood, and influence the way the sculpture was intended to be interpreted by the person who created it. In the early stages of the sculptural process, the artwork also acts to reserve, or hold, the basic spatial regions for each element to prevent them from becoming co-located.

On a more physiological level, my own developing artworks also began to influence me by providing an inspiration to continue developing the work. I believe that, in the physical works, this was due to an understanding that any environmental conditions which are being experienced by the artist were also being experienced by the artwork. This factor became a 'shared experience' and created an immediate and powerful relationship between the two parties and sponsored a creative momentum to continue. By contrast, virtual works were within a contained and separate environment, distant and calculated which, while still created by me, existed outside of my own environment and may be perceived as making any ability to relate, more problematic.

Supporting the idea of these higher level influences the artwork and the artist are providing to each other, I realised these two areas also had a concurrent development completely inside themselves. Looking firstly at developments within the artists' side, there was a cycle of evolution during the activity of sculptural creation, which had a number of significant and discernable stages (refer to Figure 22 below). This study had revealed that the influence of each of the individual stages upon the artist is directly proportional to the number of times the artist passed through this cycle. The first time I completed a figurative piece, I have no doubt I had experienced the individual stages,

but they were blurred together and I certainly did not perceive them or understand them. However, as I began to complete more works, I had an increased sensitivity to the existence of separate stages and discriminating the borders between them. I propose that this sensitivity manifests itself in an increased awareness of 'where' the artist is within this cycle at any time. As a consequence, the dictations revealed that I was becoming aware of my 'position' in a cycle of experiences which supported the needs for more higher-order mental processes used during planning and prediction. In parallel with this awareness of where I was located, came a heightened level of emotional security and the confidence that went with it. The research revealed that my confidence was sponsored by my understanding that my current actions at any point, along with those preceding and succeeding actions, are all to be expected and are necessary for the completion of the work.

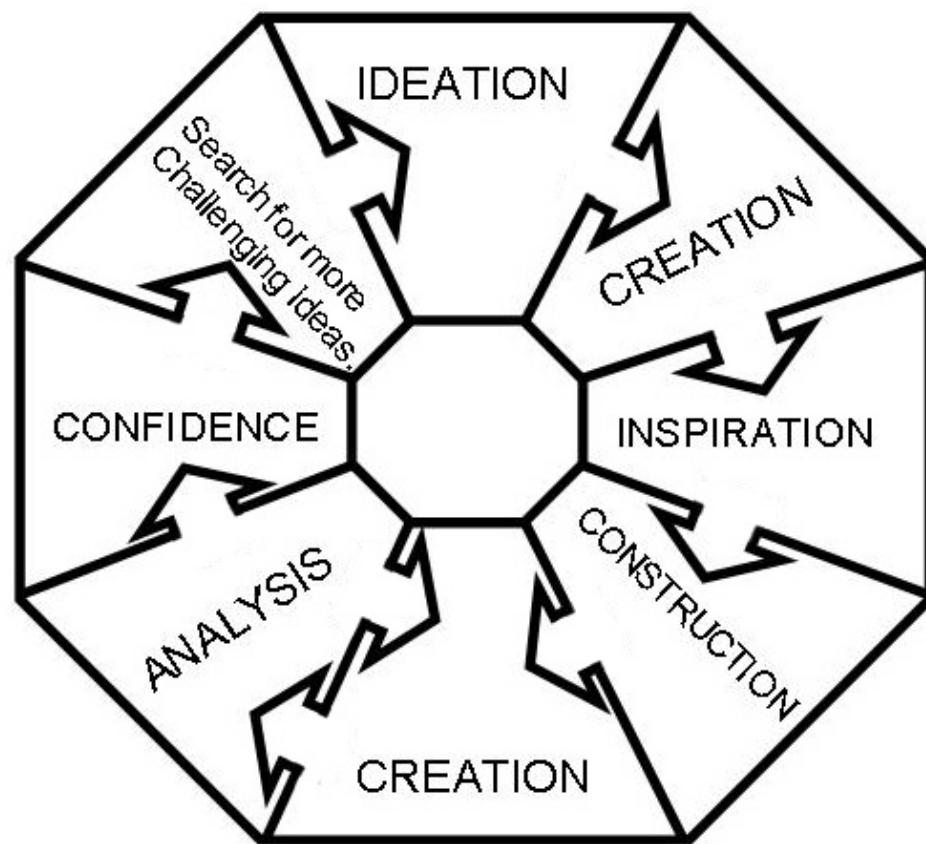


Figure 22. The cycle of constructing sculptures tends to begin at the top of the diagram with an 'idea', with each successive sculpture representing another passage through these discernable steps. Note the 'loop back' between CREATION and ANALYSIS, this was a repeated internal cycle that lasted the full length of construction. The movement from ANALYSIS into CONFIDENCE generally marks the end of the physical activity of building the sculpture.

2.3.1 The role of the reference sketch

From a point of settling on a mental image, the creation of some form of 3D matter was necessary to evolve the idea into a reality of some kind. This stage was most likely to involve the creation of reference sketches to begin getting the object outside of my own mind. It performed the role of solidifying the logics that were *internal* to the piece, contrasting with later stages when the artist is concerned with recording the *external* logics of the final composition. My own reference sketch was often small and hurried and appeared to only need to contain enough detail to capture the basic spatial allocations and feelings of an idea. From this simple sketch other iterations and experimental sketches were often made to explore if the idea could be improved upon or made more easily understood or look more appealing to my own tastes. The refinement level of the sketch and its ability to portray all of the details of the final composition were often not necessary, as the function of the sketch was to ‘freeze’ a group of ideas into a concept for a sculpture. While developing these sketches into highly detailed artworks in their own right would aid the process of creating space in some small way. I had chosen to leave the reference sketches at a simple stage and focus on the use of the sculptural tools to define the details of the compositions. Lawson (2004, p.55), in his series of books about the design process argues that with this type of drawing the “whole style of the drawing should indicate the level of precision or resolution which the designer feels at the time of making the drawing”. These sketches played an important role throughout the evolution of the sculpture by continually guiding any future ideas to stay on track with the original concept and as a consequence I used these sketches for regular visual comparison to the sculpture, to verify it was heading in the right direction and not heading down some new path (Figure 23).



Figure 23. This montage shows both the beginning and end of the construction cycle, the original reference sketch and final work 6 months later. While some elements have moved from the original idea, the intention of the finished object can clearly be seen within this tiny drawing. The figures left leg and left arm have been repositioned to promote the idea of weary contemplation.

In this way, the reference material acted as a form of goal monitor. The function of this goal monitor is two-fold as it provides both a possible endpoint and it also suggests the order in which the work needs to be assembled. It does this by raising awareness of the many interim steps and sub-goals that need to be achieved for the final composition to be realised. It also draws attention to challenging aspects such as overbalancing or suspended masses, which allows them to be accommodated into the design early and reviewed at regular points throughout the process. The understanding that the reference material has recorded the overall path to be taken, allows the artists working memory to concentrate on the task at hand, rather than reserve some capacity to constantly recall the sequence of steps. This correlates with Baddeley's (1996) account of the importance of a 'central executive' in the thought processes. By regularly comparing the developing sculpture to its references, the artist can review if the previous smaller or 'sub-goals' of forms and elements have been satisfied to an acceptable standard as determined by the image of the reference material. The reference material becomes the equivalent of the controlled data in more qualitative laboratory experiments.

Without the reference material acting as a form of map, the forward planning becomes a form of mental stress which labours the mind into holding a range of data including; a complex holographic map, the list of known tasks in sequence and also the lower order mental processes anticipated for those tasks. The reference sketch acts as a

kind of pin board of the planning and lessens the stress generated from a need for the mind to hold high resolution images. It also reveals the most probable goal of the efforts being made, not always an unblemished prediction or an exact replica, but more of a strong guide to suggest and direct the thoughts and construction towards a goal. It often represented most of what I knew about the composition at that time, leaving the subsequent stages of the construction to determine all that I did not know about the intended composition. This idea was reinforced by my own observations that the reference sketch is often still open to interpretation regarding the allocation of spatial orientations, whereas the resulting sculpture was not; the sculpture became a more unambiguous explanation of the original idea. An observer or user of the sketch would have to know what was in the artists mind in order to read the drawing accurately, it is for precisely this reason that the sketch exists, to remind the artist themselves what they were thinking before and during the drawing.

In effect, I often found myself working in reverse from the outcome back to the construction. Self talk in these periods may take the form of questions such as “how do I make something that ends up here?” or “what are the steps necessary to end up with something that looks like that?”. In effect, the reference sketch may often act as a form of ‘end point’, as it portrayed a ‘low resolution’ image of the nature of the final sculpture. This is a powerful device for the construction of sculptural compositions as it facilitates the artist using a more deductive form of reasoning. Using a combination of visual feedback from the developing sculpture and the reference sketch, the artist can form an understanding of the sculptures’ location along the evolutionary ‘timeline’ that ends with the completed work. Understanding this facilitates the artists’ ability to predict the remaining steps required for completion, and forms a profound re-assurance that the sculpture is ‘on track’. It is for this reason that the number of times an artist experiences the sequencing of these steps is proportional to their inherent fluency at estimating the current ‘progress’ for the work and the more able they are to recall, or deduce, the next logical step in the construction sequence.

Referring back to the diagram in Figure 22, from the initial stage at the top of the cycle, labeled as ‘ideation’, the mental idea begins its definition into three dimensions. The nature of the act of formulating the idea spawns the next stage in the construction cycle that I am referring to as ‘inspiration’. This is in reference to the inspiration to continue realising the idea once it has started, rather than the inspiration to begin realising it, as this stage has more to do with the build up of momentum in the artistic

expression rather than overcoming some motivational inertia to start recording the original thought. The remainder of the stages shown in Figure 22, outline a progression of successive steps that will be expanded later in this chapter as part of the detailed breakdown of the distinctions between each stage. The stage shown beyond the construction stages is labeled as ‘confidence’ and it generally marks the completion of the composition—as the analysis loop-back is an ongoing process that only stops once the artist believes that any more interaction with the work will not positively affect the finished sculpture.

2.4 Stages in the artworks development

This study had revealed that, separate to the development occurring inside the artist, there was also a system of developmental stages occurring within the artwork at the same time. Although, these developments are linear rather than cyclic as shown in Figure 24—Similar to the system within the artist, the artwork has a progression that passes through several distinct stages during its evolution. The progress of the work at a holistic level had three primary stages I refer to as ‘concept’, ‘system’ and ‘detail’ design. The margins and boundaries between the stages are summarised in table form in Appendix 4.0 of this document.



Figure 24. Reading from left to right, these images represent the Concept, System and Detail stages of a sculpture as it progresses. Concept is establishing the overall scale and orientation of forms; System sets the spatial relationship between the elements of the main subject; and Detail is the completion of refining surface finishes and small supportive forms. Over the total time recorded for each piece, Concept occupied approximately 25%, System was the highest at an additional 50% and Detail design took the balance at 25%.

The term ‘concept’ refers to an initial stage which involves determining the overall size (scale) and proportions of the composition. Once the overall proportions of the concept are defined, decisions are then made about the major masses of the sculpture and where they are positioned within the composition and relative to each other. In Figure 24 above, the concept stage on the left hand side of this simple sculpture shows the basic building blocks of what will become the base, the body and the head.

‘System’ is the second stage and is reliant on the existence of the preceding ‘concept’ stage. Even if an artist attempts to start at system design, the spatial *concepts* for elements will still be mandatory before considering their interconnection, thereby forcing the process back to ‘concept’. System design is focused on defining the ‘connection’ between elements and how the connections are determined or implied. The connection may not necessarily be spatial contact; it may be that two or more elements reflect the same visual curves or themes. During this phase, the subject matter and the context in which the subject is being portrayed are being rendered in increasing accuracy. The original narrative or meaning that inspired the creation of the sculpture is

being used to analyse the decisions being made, to ensure the original intention is being reflected by the physical shapes.

This stage of the evolution generally took the most amount of chronological time and tended to involve the highest amount of micro decisions about the shape and orientation of every component in the composition. The boundary between the stage I have referred to as ‘system design’ and the following stage of ‘detail design’ can become indistinct on some works. Generally, the cross-over of tasks inside each stage occurred when a form needed to be fully detailed in order to consolidate the relationship it has to an adjacent shape. An example of this, that was regularly repeated in my own pieces, are the eyes on figurative works where the eyeball, with its pupils and lids, are taken to a fully finished stage very early while the rest of the head is still quite rough, in order to verify that the apparent looking direction of the eyes and the features on the rest of the head agree with each other.

In Figure 24 above, the image on the right hand side shows how the witness marks from the hand tools were removed and smoothed away during ‘detail’ design and the scroll work around the base was added and finished. The ‘detail’ design phase is often an extension of the system design stage and was fundamentally the finalising of the overall surface textures and any specific refinement to areas of the composition that demanded particular or unique treatment.

2.5 Stages in the definition of space

Still looking within the structure of the artwork, the definition of space itself had a progression from the need to construct shapes that appear to be simple to the series of complex sub-tasks necessary to render them. The more highly detailed areas of the composition were not treated as one complex shape, rather the multitude of shapes were broken down into a succession of increasingly simplified forms. These simple forms were then individually shaped, in relation to each other, as a series of manageable steps.

During the course of this research the most basic level of shape became referred to as a ‘*form*’. These forms then combined into the intermediate level of spatial complexity referred to as an ‘*element*’ and finally the entire work, referred to as the ‘*composition*’. Similar to the evolution of the sculpture, the individual levels of shapes also required the existence of the previous level to exist. The confirmation of this mechanism being used to simplify complex (and daunting) tasks, armed me with knowledge whereupon I became more confident in attempting highly involved and

elaborate compositions. The de-mystifying aspect of the relatively simple combining of forms, assured me that even challenging pieces could be overcome by assembling each individual form, giving regard to keeping its proportions accurate to itself and the final composition.

The term ‘form’ in this document refers to the lowest common denominator of three dimensional space, a featureless shape that cannot be effectively simplified any further. A form marked the smallest section of the artwork that is meaningful to examine. These are the building blocks of all shapes as I understood that all ‘elements’ and ‘compositions’ consist entirely of the accumulation of these forms. They serve a dual role of providing both the lowest common denominator of spatial definition and a powerful tool for analysing the grouping of many shapes. In the case of groups of shapes, the artist or observer analyses assemblies of shapes by determining if they are conforming to a large underlying form that may not be clearly defined, but is implied by the entire group. As an example, consider the individual features of the human head which need to be correctly proportioned within themselves, while simultaneously conforming to the overall form of the head as an ovoid. These large, underlying forms at the macro level are used to define the pose of the head, limbs and torso of the human figure and are critical to the accurate portrayal of both the anatomical accuracy and also the subtlety of human poses that evoke emotions and empathy. It may be possible that one of the distinctions between sculptors possessing expertise and novices in figurative sculpture, is the method and control used to assemble these various units. I found it difficult to articulate in words, for the research data being recorded, the actual emotional meaning of forms due to their deceptively simple appearance being in conflict with their importance to convey and support the narrative of the entire composition. Perhaps the difficulty in conveying their importance is as O’Toole (1994, p.54) states in his research into the language of art, that “it is precisely this emotion, which is conveyed by sculpture alone”.

The next term ‘element’, is defined as a group of these forms combined, used either in light contact or interpenetrating to represent a recognisable object. For example, a large set of interconnected ovoids and cones may be utilised to spatially describe an element recognisable as a single finger on the human hand. Here, the individual ‘forms’ are very subtle to distinguish, however when combined, they represent a recognisable ‘element’. The small individual forms are imbedded inside each other to an extent that they are not immediately discernable and it is the ability of

an artist to understand how to create such a complex element by using a series of simpler forms that contributes to the spatial competency of individuals. It is understood that the phrase 'recognisable' is culturally specific with regard to that which constitutes a recognisable object. It is not the intention of this document to define the cultural specificity of my sculptural works; this would potentially distract the intention of the research. It is therefore stated that this research assumes the sculptures are being constructed within a contemporary Australian social culture, and as a consequence, the word 'recognisable' applies to those objects that would be reasonably considered as familiar to a contemporary Australian culture.

Finally, the term 'composition' is used here to represent the total inclusion of all of the implicit 'forms' and 'elements' within the work. It is the sculpture in its entirety, with all included elements and forms fully defined and considered as having their spatial relationships to each other determined or implied. The composition level of the artwork describes both the consolidation of its separable parts and the intended narrative and meaning for work. When working on the composition level, I observed that I was dealing with which specific elements need to be included or rejected and how they may be understood, rather than their proportional accuracy. Compositions varied in their nature, from highly complex with many recognisable elements that place a heavy demand on the visual senses, to compositions that were spatially simple, consisting of just a few forms where the visual analysis was less demanding. Both complex and simple compositions represent a challenge to a figurative sculptor. Complex works demand that all of the elements are held in proper proportion to each other and the narrative or meaning of the work is generally determined by mapping all of the shapes, and drawing intuitive conclusions about how they are positioned to each other. Simple compositions are a separate type of challenge, as the artist has less visual devices available to capture their intent. Reductions in the amount of forms may, in turn, place a greater importance on ensuring that the proportions, surface finish and orientation of the individual shapes are more highly controlled.

2.6 Subject matter as a device for spatial definition

Research by authors such as Lawson (1994, 2004) and Goel (1995) have identified the existence of separable stages within the entire process flow of design. Goel (1995) in particular, identifies four stages that he describes as 'problem structuring', 'preliminary design', 'refinement' and 'detail design'. The general

philosophy of these stages may appear to overlay with the four stages of 'reference sketch', 'concept design', 'system design' and 'detail design' being proposed here. I needed to comprehensively describe the functions of each stage of figurative sculpture and to define the borders of each activity being explained in this document. Lawson and Goels' explanations rely on the existence of a pre-existing problem of known extents, whereas I believe that sculptural design does not always presuppose an existing problem. Works done on commission to a given brief may fit into these parameters; however sculptors may create works driven from their own desire for expression, rather than the demands of an imposed design brief.

Having observed my use of these building blocks of forms, elements and compositions, I also became aware that these needed to be more than just proportionally well-defined. They were also used as devices to convey my original agenda, the meanings I needed to capture in space. Two of these devices used to direct the way a composition is understood involve enabling an observer to perceive the 'subject' of the work, and its displayed 'context'. I maintain that each of these devices work in combination with each other to support the projection of an artist's intention. The term 'subject' makes reference to recognisable groups of elements that are combined to portray specific identities. By way of example, if a figure is intended to represent a particular character or group of characters within a culture, the artist must render sufficient characteristics of that group, in enough detail, to enable them to be identified. It has been argued by Portugali (2005, p.239) that such visual landmarks act as memory cues and are essential to enable the development of the cognitive mapping of regions. A sculptor needs these landmarks to determine the orientation of separate elements, to each other, and create areas of focus at specific locations within the composition. The artist may utilise a range of tools to transfer the idea of the 'subject' to an observer, these may include: suggesting identity by the surrounding context being presented; by mimicking the visual aspects of the individual; or more directly by use of labels such as texts and signs within the composition or the title of the work.

The term 'context' makes reference to the composition built around this subject. The context of a work is critical to its social meaning as it provides the vehicle for cultural heritage, social commentary or individual opinion. Context in my own works was transferred by a large number of variables, including many that are culturally specific. These variables may include: portrayal of specific actions or events,

recognisable environmental elements, predictability of the interaction of recognisable elements, and the scaling and proportional accuracy of the subject.

I have shown earlier in this chapter that once the overall composition was captured in reference material and the artist had determined the intended appearance of the finished work, the focused effort was directed to manage the technical details of forming the idea into three dimensions. However, it was not as easy as simply tracing out the reference sketches from different viewpoints. During the act of translating from two dimensions (2D) into three dimensions (3D), decisions, additions and compromises must be made based on areas where the reference data may be vague or ambiguous. Some of these decisions were answered with regard to what was best for the subject and the composition, while others were made with regard to the properties of the material being used. In addition, the artist may be pressed to make compromises and alterations to the 3D model because the reference sketches may be insufficient in accuracy to represent space, and as a consequence, elements that were intended to align need modification to ensure their connection is complete. When these problems arise, the artist draws on a range of influences to decide on which attributes need to take precedence and why. These considerations become the artists' criteria for making decisions about their own creation of three dimensional spaces.

2.7 The criteria used to deliberately control space

As I began to record the 'internal decisions' I made while forming shapes in space, the same set of criteria began to regularly reveal themselves. Most often, decisions about which criteria were relevant and which were not, were made quickly as not every decision involves considering every possible influence. It took many repetitions of similar tasks for me to break down the criteria involved in determining why an area of the sculpture 'didn't look quite right' and estimating which measures I had to implement so that it began to 'look right'. Often, any creation or refinement involved the combination of many different criteria to varying amounts specific to each problem.

Unresolved areas were generally analysed from many different view points to determine where the external surface 'should be' compared to where it 'was'. In the case of the physical clay works, a small piece of clay was prepared that approximates the volume of any missing material.

In order to determine what ‘looks right’, and what needed to be done to the surface of the clay for the sculpture to reflect that, the research revealed that I would consider the following criteria in isolation or in combination with each other:

- Mass
- Stability
- Angle
- Complexity
- Accuracy
- Human Traces

These are expanded further in Appendix 5.0

It is not my belief that all aspects of the work are in accordance with a pre-determined plan; unintended or accidental forms and marks can sponsor a new interpretation of intended shapes. These ‘accidents’ may introduce new forms or connections that stay within the guidelines from the reference sketches, creating an unanticipated area for additional expression. This is more common in the ‘system’ and ‘detail’ design stages, as the ‘concept’ level is less strict in the treatment of the surface and is consequently based on rough shapes and approximate forms, so an accidental tool or hand mark was generally considered as being inconsequential and was to be refined in subsequent stages. Many of my works for this study were improved by the unexpected treatments, and the irregularities brought new life to a potentially bland area on a sculpture. The ability of an analytical eye to sponsor new avenues of expression from unexpected sources is often utilised in the ‘system’ phase where surface treatments are less refined and many smaller adjustments are made to the connection of elements. Something that Lawson (1994 p55) referred to as, “sometimes the hand does something that the eye re-interprets and you get an idea from it”.

Within and outside all of the influences of these listed criteria, there remains room for individual expression and ‘artistic style’ within their limits. These criteria are merely a part of the premeditated considerations involved in sculptured forms. The role of unforecast compromises and enhancements act to keep the activity challenging and motivating. If the only aspects to be managed were those that could be predicted, it may be difficult to be inspired by a regulated and methodical form of personal expression. My research revealed a shifting boundary between the artist imposing their will and the material imposing its constraints. I therefore maintain that there is a form of dynamic

equilibrium at play in clay sculptures whether virtual or physical. It is the state where the pressure applied from outside of the clay (by the artist imposing their concepts) attempts to balance with internal forces from inside the clay (in the form of its physical limits and material properties).

The logistics of realising the sculpture into three dimensions was more complex than just the mechanised processes listed above; an artist also needs to apply their own mental processes in order to complete the composition. It is these personal mental operations that enable the artist to make decisions when: presented with areas of conflicting priority, attempting some actions with unknown outcomes, and the continual challenge of keeping the sculpture aimed at the desired goal. In this next section I will discuss some of the ‘orders’ that these processes may be categorised into and why they are important for sculptors to manage.

2.8 The allocation of mental capacity to problem solving

At their most simplistic, these mental processes occurring within the practicing artist may be considered as consisting of higher and lower ‘orders’. With regard to the lower orders, Mackintosh (1998, p.299) argues that lower order mental processes may include acts of encoding, mapping, applying and producing. Whereas with regard to sculpture, higher-order mental processes were more often applied to strategic factors such as planning and were important for making assessments and corrections with respect to the entire composition. The sequence of performing higher order solutions may also include considerations such as:

- Recognizing the existence of spatial problems
- Deciding on the nature of the problem
- Selecting the appropriate lower order tasks to apply
- Combining components into a single mental image
- Evaluating the success of the problem solving once it has been done.

These higher order processes or “meta-components” as described by Sternberg (1985; 1990, p.268), are applied to coordinate the lower level operations that are more aligned with performance and controls.

Higher order processes are necessary for more complex and difficult issues and understanding their existence and application was necessary to reveal a more complete picture of all the mental processes being utilised when an artist is attempting to

construct a deliberate 3D composition. Recordings made during the construction of my final works revealed the traces of higher order processes such as: the need to analyse and plan for the sculptures sequence of assembly, issues of deliberate symmetry and consistency of overall proportions or whether the whole composition needed to be stretched, twisted or compressed.

In contrast to the higher orders, lower order processes were likely to deal with specific areas of the composition rather than overall aspects and these specifics may include:

- Visual analysis
- Proportions within small areas or specific elements
- Comparing surface finish across related elements
- The selection of specific tools and techniques to create the desired effect.

It has been argued by Sternberg (1977, 1985) and Pellegrino (1985) in their research on analogical and inductive reasoning, that these lower order components may also include tasks such as: encoding lists of attributes and inferring specific actions (Sternberg 1977, 1985; Sternberg & Gardener 1983; Pellegrino 1986; Alderton, Goldman & Pellegrino 1985). I believe that these have a direct application to the more deductive processes involved in clay sculptures as an artist uses their imagination and mental images to create the solution. Once they have determined the final surface, the next step is analysing the nature of the intended shape and determining the specific actions required to generate it. These two layers, simplified into higher and lower order mental applications, do not act independently of each other, but work together to provide a set of tools for an artist to make decisions and directions. Either at the macro level regarding the entire composition, or the micro level regarding how to technically implement those ‘macro’ decisions.

As a result of the history of decisions being made about the artwork by the artist, the composition establishes itself as a repository of 3D landmarks in space. These landmarks are essential for any observers’ ability to spatially map and navigate around the composition. The artwork successively establishes itself as the embodiment of all the created ‘facts’ used by the artist to build the truth about the composition and the interpretation of its meaning, from the artists perspective. In the case of my own works, I accept that these ‘facts’ may represent my own ‘facts’ about fictional characters. The created object extends its influence over the artist during periods where the work is

being reviewed, by facilitating the transfer of roles held by the artist, between creator and observer. When analysing the sculpture, the artist may not merely be utilising the higher and lower order mental processes of creation, they may also be interrogating the work to look for evidence of how any independent observer may read the resulting composition. During this activity, the work influences the artist by its ability to reflect, within the composition, the subtle combinations of subject, context and the essence of any original reference material.

My research revealed that the number of cycles of interactions between the artist and the artwork are much higher than my original expectations. Sculpted works such as Figure 25 below, have thousands of interactions evident from the hundreds of separate decisions about shaping of forms and subsequent large numbers of interactions from my fingers or hand tools. To record the total number specific to each piece would be extremely difficult as many of the cycles occur below a level of conscious intention. I became aware of some higher level thoughts about the composition, and how it needs to be rendered, occur outside the periods of actually working on the sculpture. These thoughts were often prompted by unrelated tasks or encountering images and forms that direct me to recall the artwork, its stage of construction and how I want it to appear when it is finished.



Figure 25. This image shows an early work titled “Rest in peace”, the simple folds in the drapery and tracing of the anatomy require the accumulation of hundreds of individual interactions between the artist shaping the clay and the clay reflecting only what has been done, not what was intended.

The phenomenon of making conscious decisions about the artwork when I was performing other tasks prompted my understanding that some significant higher level mental processes are subconscious, and may require periods of contemplation before becoming a conscious and recalled consideration. It may be argued that these introspections require a period where they are free from being directed or driven by an artists desire, in order to manifest themselves in a way that is relevant to the artwork.

It had become my understanding that, while the development of the artwork was within its early stages of 'concept' and 'system' design, there was a greater demand upon the artist for higher-order mental processes associated with analysis, planning and strategy. And in addition, these mental processes were more demanding on short and mid-term memory than they were on long term memory. This understanding had developed from my observations that my conscious thoughts were being concentrated upon the task at hand, in the early stages of evolution. This was due to the need for constant comparison between the visual feedback from the sculpture, to both its reference sketches and the mental images of the final work which were still being recalled from memory. As the artwork evolved away from the 'concept' stage through 'system' design and into 'detail' design, the dependence on higher-order mental processes decreased and there was a greater reliance on lower-order processes.

I believe that this was essentially caused by the artwork now replacing the mental images that were stored in long term memory and being used to support the reference data. Further, the artist may then begin releasing their mental images of the original thoughts and ideas, in favour of the artwork in front of them and rely on a combination of their visual feedback from the sculpture and the available references to complete the work. These lower-order mental processes were not as demanding on my thoughts from moment to moment and seemed more reliant on longer term memory for recall of techniques, tools selections, and interactive analysis of the work being done.

The transition from the immediate demands on short term memory and higher-order mental processes through to long term memory and lower-order mental processes, offers some explanation of the recorded psychological changes within me during the creation of art objects. More of my available mental processes would then be assigned to ancillary or even unrelated tasks, as the demand for constant creative solutions wanes and the remaining tasks become more mechanically repetitive. There is an observable level of distraction or even mental boredom during this stage, however the trend does

not continue through to completion, as the final stages of the construction often mark a return to an increased level of visual and mental interest.

I am not prescribing that the chasing out of the surface details is not a creative process in itself, for this stage is not merely recording a creative process that has already stopped. Instead, I believe it is the concentration of the creative process, focused within the restrained boundary of subject and its context, a living process of imaginative input being deliberately limited to expression within the body of a defined idea. My own motivation would often positively respond to coming to the end of a long series of tasks and the realisation that I had recorded something that I may not have imagined plausible when I started. Diary and journal entries, digital sound recordings and periods of introspection have all identified a steep rise in satisfaction generated from the conversion of that original mental image into a finished object. This often positively contributed to a better mood and motivation, as the presence of the finished piece seemed to bolster my understanding of myself as becoming more able to convert my thoughts into objects.

2.9 Schematics of spatial decisions

In order to capture the internal systems discussed so far, a simplified schematic was drafted to reflect my understanding. Due to the complex nature of such a diagram, I will start with some basic premises and explain each addition in turn.

To reflect the basic understanding that the artist and the artwork need to be separated in order to stimulate spatial decision making, the base level diagram appears as a simple two part diagram (Figure 26). The diagram is split horizontally into two halves, the upper half representing the artwork and the lower half representing the artist. The two areas are represented as having equal square areas and sharing a common boundary, yet importantly they need to be shown as separate entities (distinct colours).

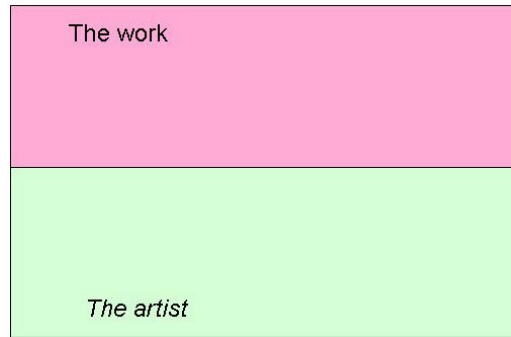


Figure 26. The artwork and artist as separate entities sharing an interface on one of their sides.

The diagram takes on more complexity with the addition of symbols representing the complex relationship between these two parties. At its most simple (Figure 27), the artwork and artist may be considered as having basic cyclic interaction, where the completion of one action marks the start of the complementary action within the other. This cycle, if repeated, may result in the creation of a body of artworks.

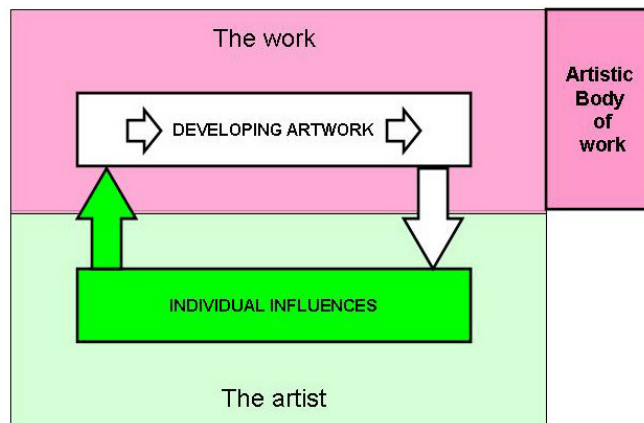


Figure 27. The artwork and artist interaction represented in simple diagrammatic form. Note the existence of an independently observable phenomena represented by the 'Artistic body of work', this is the completion of externalising the artwork from the artist.

Directing focus to just the top half of the diagram, the artwork is shown as having some degree of development within itself. This development is a tangible and observable phenomenon as witnessed by the sequential nature of the completion of each artwork from start to finish. Within just the upper half, there is a recordable evolution of the sculpture from its simple (Concept) beginnings, through its mechanical connections (System design), to more complex surface treatments (Detail). In Figure 28 below, the path of the developing artwork is shown in parallel with the artistic strategy of achieving spatial complexity by building basic forms into recognisable elements,

which are in turn combined to result in the final composition. This strategy occurs many times during the creation of the work; however it is shown diagrammatically here as a single iteration. The sculptural development moves from left to right as the artists intended meaning within the composition is encoded and distilled, this intention then becomes available for decoding by either the artist or an independent observer.

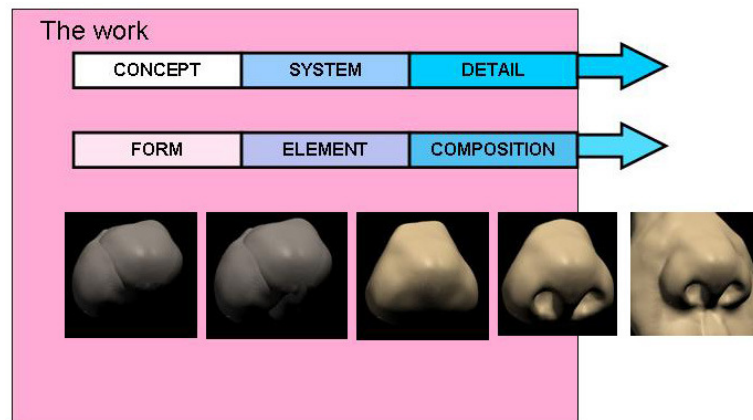


Figure 28. The artwork is shown evolving from left to right. As well as the forming of the idea into three dimensions, this evolution also marks the stage where the object is imbued with its subject and the context in which the subject is represented. The sequence of images shown here reveal an example of combining the single forms into recognizable elements as the work progresses from concept to detail design phases (in this case the nose of an infant).

By adding more connectivity between the sub-systems of this diagram, the numerous smaller interactions between the artwork and the artist are revealed between the start and the completion of the sculpture (Figure 29). These interactions allow the opportunity for the artist and the artwork to use the influences of both sides to record the shape of forms in space within the sculpture. This diagram shows only a few brief communication cycles; in practice it has been my experience that these communications are almost continuous. For the sake of clarity, these abundant cycles are represented by simple boxes and directional arrows where: short and long term memory usage, the constant need to compare the work to the reference data and the demands of the material and its environment (digital or physical) are exercised. Note the blue arrow in the upper right hand corner, this will point off to the body of work that exists outside the current work and the artist, and are the direct result of previous cycles of this process.

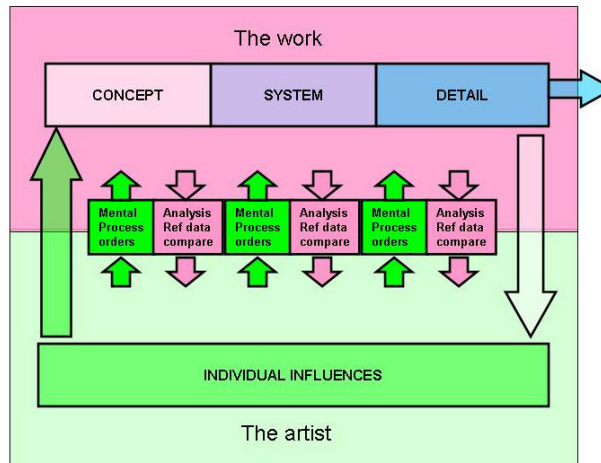


Figure 29. The overall cycle of creation is now shown as consisting of many smaller interactions and examinations. The blue arrow in the top right hand corner indicates the final stage of artistic creation, resulting in the body of work. The existence of this artwork then affects the nature of the individual influences available to the artist to communicate with the next construction cycle.

Subjective factors such as experience, expertise, mood and intention may be mapped within the diagram as “INDIVIDUAL INFLUENCES” that push, from the artists’ side, into the artwork via the artists’ responses to the many small interactions during the construction (Figure 30). Any apparent successes of the artist’s prior sculptural experiences begin to add pressure to the start point of each cycle via factors such as: inspirations, the need to express ideas in three dimensions and the desire to attempt more challenging works.

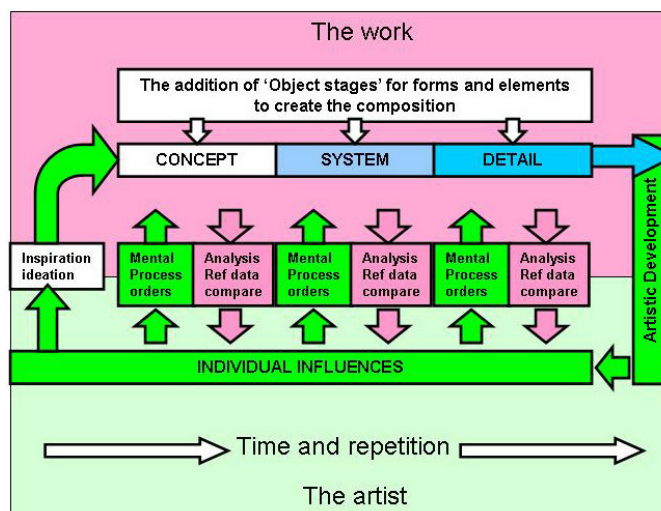


Figure 30. The bridging phenomena of inspirations and ideas are added to the start of the diagram, while the end of the process is joined back to the artist via the artistic development resulting from creating artworks that the artist themselves determine as being successful in translating an idea into a matching object.

The last process flow to be recorded in this schematic was the potential for influences from outside of both the resulting artworks and the artist. Shown on the right hand side in Figure 31 below, the body of works may be exposed to independent observers via an artistic exhibition. I am aware that the proportions of the arrow recording the feedback from the underside of the “Exhibition- Observers Reaction” to the “Artistic development” may not be indicative of the ‘size’ of the influence and is also highly subjective by its nature.

The amount to which individual artists may allow the opinions of observers (which may include members of the relevant fields), to influence their self opinion, and hence future works, will vary from person to person. Some artists are more sensitive to the perceptions and trends within the field while others are more independent and may not be compelled to exhibit their works at all. The diagram now includes two simple blocks at the bottom to indicate those processes that are within the possible control of the artist and those that are influenced by individuals outside of the creative process for each sculpture. Note that the artist’s influence is bound by the artistic development and their forms of expression (shown here as the Artistic Body of Work). The applicable domains’ influence is bound by reactions to the body of work and projecting its reactions and understandings onto observers of the artworks and potentially, the artistic development of the individual creator.

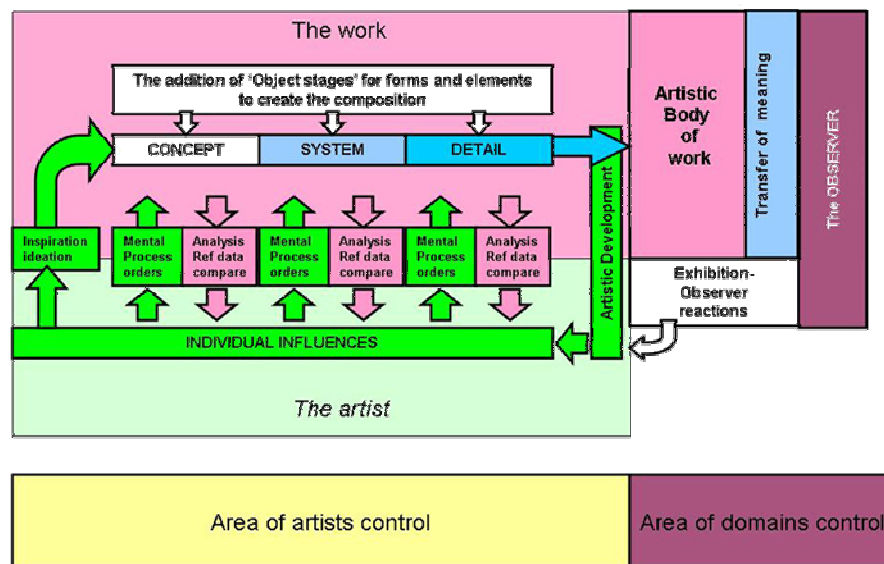


Figure 31. The diagram now showing the influences outside of the artists own control and the channels of influence relevant to the body of work being created.

When reviewing the diagram holistically, it became apparent that this schematic was occupied by internal cycles, however in itself it is essentially linear, it goes from 'somewhere' (left hand side) to 'somewhere' (right hand side). At the far left are the phases of ideation and inspiration, shown as leading entirely from the artist into the developing sculpture, this step signifies the start of the sculpting process. Activities occurring before the steps shown here are outside of this research and may be subject to still more cyclic schemas such as the systems model of creativity (Csikszentmihalyi 1996). Similarly, those activities whose influences are commencing at the far right end of this diagram are the socio-cultural aspects to the body of work and their interaction with the relevant fields. These too may be subject to more cyclic models of 'actors' 'actions' and 'locations' (Spradley 1980, p.40) and again, are beyond the scope of this document.

APPENDIX 3.0 – Reference Systems

The sculptures created for this study are all separate objects, specifically constructed to capture a purpose or intention. It was during the building of the research pieces that it became more apparent to me that systems were being used to keep track of how any separable elements are positioned within each composition and how the individual forms are positioned relative to each other. These systems are important to this document because they represent one of the fundamental tools in use by the researcher to define 3D space. Not always consciously or as a deliberate tool, but often as a way of separating or joining elements. These systems presented a way of considering something as belonging only to itself while it was being shaped, or alternatively as belonging to a complex assembly of parts, even though it may not be connected to it, yet.

These systems are relevant to the research when I became aware that I was innately using a number of different reference systems and that most objects changed from one system to another, during construction. For example, the head of the figure in “Falling” (Figure 32) was built as a separate part before being joined to the final composition.

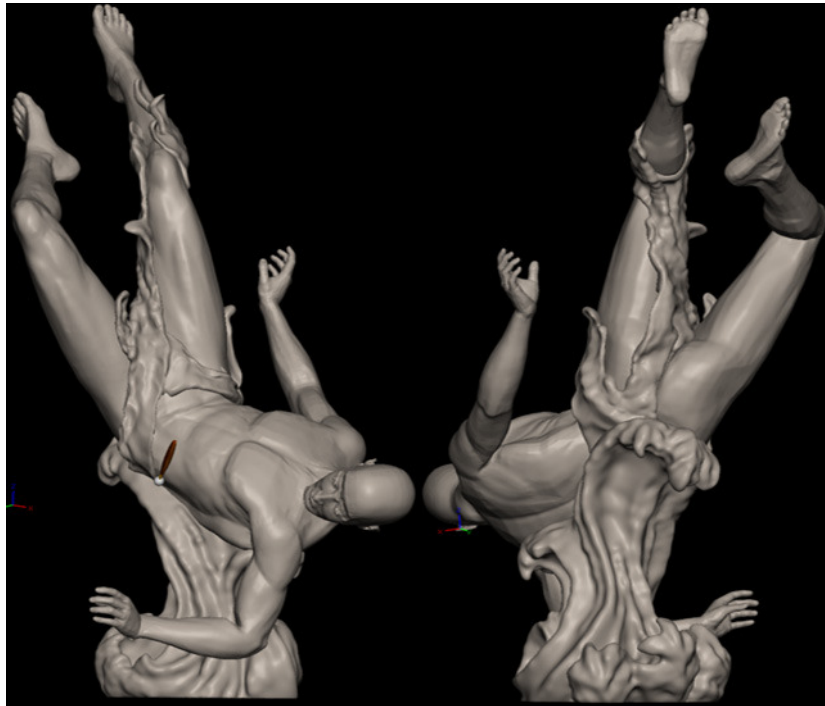


Figure 32. The ‘virtual’ sculpture of a physical piece titled “Falling”. This image represents the ‘front’ and ‘back’ of the work in the one image.

While it was separated, the head was built in a regular orientation with its face towards me as I formed it and the top of its head was pointing up (away from the direction of gravity). In this condition, I saw it as having its own individual centre point, an origin that exists within it and completely separate to me and my own origin (Figure 33). When the face was towards me, I am recorded as describing the figures own left as my right, its right as my left, it also had a 'back', a 'front', a 'top' and a 'bottom'. I also describe the features of the face in terms of its own origin, for example I used phrases such as "on his right cheek", "his left eye" and "the back of his head".

When the head was finally attached to the rest of the composition, the imagined origin, inside the separated head, disappeared and it took on the origin of the entire sculpture. The reference system in use to build the correct location and orientation of features on the head became permanently altered. For this example, the head in the final composition is positioned upside down to me and as a consequence, I referred to the head using a range of different phrases. These included phrases that made reference to the work as a whole, when I spoke about the artwork, or phrases that made reference to the figure as if it were the right way up when I spoke about its individual features. For example, an overhead light would shine down onto the 'top' of the different features on the sculpture, however I may also describe these same areas as being 'underneath' such as the 'underside of his feet' or 'under his chin'.

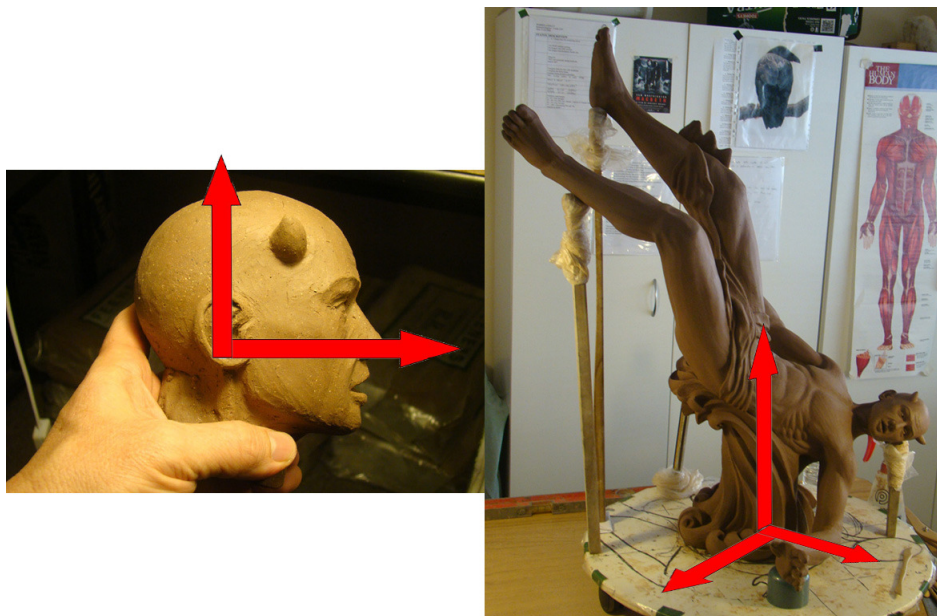


Figure 33. On the left hand side the separated head has its own 'origin' and reference system. On the right hand side, once the head is attached to the composition, it takes on the reference system of the entire sculpture (shown as directional arrows).

Without using these tools I found it very difficult to keep track of features and where they should go, because my own self talk (either mental or vocalised) used terms referring to these origins (or reference systems) as I was planning and building the work. As a consequence, I therefore understand that I must also be thinking about the origin points of parts and assemblies in order for me to implicitly and unerringly know where they are, their orientation to themselves and other parts. I was aware that I would define the origin points of elements even though they may still be just thoughts and not yet physical. If this is true, it is probable that these systems were important for me to include in the way I think about how the composition needs to be configured and must, therefore, be important to my ability to conceive and design their orientation in the first place. As the sculpture continues to develop, the various reference systems are translated from one to the other and I was able to think and verbalise about different parts of the composition with respect to either their combined and unified origin or the individual origin relevant for each element. These descriptions for locations in three dimensional space were necessary for me to verbalise the spatial relationship of features to other people and to confirm to myself that they were in the correct position to each other, regardless of the relative position of the figure and how the figure is represented.

Compositions with a single human figure tended to be referred to with respect to the figure itself. This type of system is referred to by Levinson (2003) as an ‘intrinsic’ spatial reference system where the relationship of elements are referred to using terms such as: “on the figures left”, “on the figures right hand side” etc. My own recordings revealed that compositions that have multiple figures, tended to be referred to with respect to the artist regardless of where they were in relation to the sculpture. This was comparable to a deictic system (Levinson 2003, p.58) where the relationship between elements may be referred to as; “on my right”, “to my left hand side” etc. I was aware of a third referencing system, also referred to by Levinson (2003), as a ‘global’ system which makes reference to the orientation of elements with respect to landmarks within the world such as ‘north’, ‘south’, ‘the rivers side’, ‘the mountains side’ etc. This sort of system was not recorded in use by me during this research and may be a culturally specific term.

APPENDIX 4.0 – Concept, Systems and Detailed Design Phases

CONCEPT		
Starting points	Functions	Finishing points
<p>Focuses attention on a specific emotion or desire to express.</p> <p>Unprompted, sudden inspirations.</p> <p>The need to express an idea creatively.</p>	<p>Starts the construction process.</p> <p>Captures the reference data or defines the referenced data.</p> <p>Solidifies the basic spatial attributes such as scale, composition, subject / context / relationship.</p> <p>Captures the original intention (at least) may also capture the developing intention.</p>	<p>When the next intuitive step is considering the connectivity of elements, the construction of elements or the supporting of elements.</p>

SYSTEM		
Starting points	Functions	Finishing points
<p>When there is a need to define spatial relationships between major elements</p> <p>When the overall composition and scale are finalised and the elements need clarifying.</p>	<p>Advances the concepts without introducing new subject or context from the concept stage.</p> <p>Captures the spatial relationships (3D) in unambiguous space.</p> <p>Captures the proportions without altering the scale. Proportions are prevented from creeping by the composition and the overall scale (finalizing the volume).</p> <p>Captures the connecting material (Physical World only)</p> <p>Captures the support struts, braces, thicknesses (Physical World only).</p> <p>Captures any ‘acceptable’ deviations from the original intention (the developing intention).</p>	<p>When the final volume is defined.</p> <p>When the surface finish and texturing becomes important to the development of the composition.</p>

DETAIL		
Starting points	Functions	Finishing points
<p>When the specific surface texture is required (locally or entirely).</p> <p>When small details are required to achieve the resolution of the original idea. (which is represents the resolution necessary to convey the concept)</p>	<p>Prepares the composition for completion.</p> <p>Defines the texture, surface finish, rendering and visual responses programmed by the creator.</p> <p>Prepares the composition for the next 'downstream' process. (eg Additive Fabrication or Firing)</p>	<p>When the entire composition texture is applied to the satisfaction of the creator.</p>

Table 2: The distinctions between the evolutionary stages of three dimensional construction.

APPENDIX 5.0 – Descriptions of spatial considerations

- Mass - The weight, or specific density, of materials have a strong influence on physical world pieces. Issues of supporting the mass against gravity, the materials strength and its penetrability, centre of gravity or balance points for each element or the entire composition, as well as transportability were all involved in the decisions being made.
- Stability - This term makes reference to a shape holding its proportions without the material deforming from its own weight, the weight of elements that impact it or the viscosity of the material. Depending on which material was being used, the dimensions and proportions of forms and elements may be affected by time, moisture content, exposure to light or heat and environmental conditions such as wind, movement and gravity.
- Angle – the angle created between a ‘form’ or ‘element’ and the compositions own vertical lines have a direct bearing on its contribution to the spatial meaning of the element. More vertical elements are read easily and predictably and I believe that this was due to their implied ‘balance’ and they gave the appearance of being settled and stable and did not evoke a sense of movement or tension whenever I examined them. As a consequence, I propose that elements that form an angle to the *compositional vertical* direct an observer’s eye along the suggested angle and away from the compositions implied centre. It is this very movement of focus, by tracing of curves and angles, which may sustain an observer’s attention and promote a sense of visual interest. These angular elements had been more difficult for me to create in physical works due to the engineering of their connections and supports. I believe the presence and usage of angular forms may be linked to an observer’s perception of artistic competency, based on the apparent understanding and mastery of the artist’s control over the material to hold it in suspension.
- Complexity – Complexity often projects a sense of competency, although the direct relationship between these two factors was lessened by how repetitious or predictable the complex forms were occurring. Regular patterns and repeated cycles of elements at expected locations may add complexity to a work, however the observer is able to read and anticipate their extents quickly and the time to construct them may not be directly proportional to their visual value. An example

may be the portrayal of the individual scales, hairs or feathers on a body where the number of edges and features are increased in a concentrated area to add complexity to the composition. However, if the rendering of these patterns are done consistently and competently, I believe that it is not that each individual feature will add visual interest, it is the presence of the combination of all of them that becomes important to our perceptions. Complexity may also be added to a composition by changing the nature of the spatial orientation of its elements. In this condition, forms or elements may twist through multiple planes of space, resulting in the form effectively hiding its extents from a static observer. When the spatial limits of forms or elements cannot be fully visually mapped from one viewpoint, the observer is forced to move their viewpoint by either moving the work relative to themselves or move themselves relative to the work. This movement may act to create visual interest by increasing the time required for the observer to fully map the composition.

- Accuracy - the portrayal of 'recognisable' elements introduces a consideration of how easily the element may be recognised. If an artist's rendering of the element is vague or ill-defined, the social meaning may become ambiguous or confused. Varying the level of accuracy for the portrayal of elements may be used as a deliberate device by artists to direct the attention of the observer to specific areas within the composition. Simplified representations and forms that are only suggested are read quickly and allow the observer to read them as contributing to the meaning of the work and yet do not act as a distraction for other areas within the composition that may be the primary focus. Alternatively, the artist may choose to increase the level of accuracy for elements with a higher visual priority in an attempt to either attract or direct the focus of the observer.
- Human Traces - the inclusion of elements that bear the hallmarks of the creator are also given consideration for inclusion within the composition. It is within the judgement of each artist to determine if the inclusion of artists 'witness marks' will act to enhance or detract from the intended reading of the social relevance for the object. Sculptures that include deliberate tool and hand marks reflect that there has been some form of external force used to shape its proportions and that it is not the result of natural forces.