Monash University

THE OPTICS OF ANATOMY AND LIGHT:
A STUDIO-BASED INVESTIGATION OF THE CONSTRUCTION OF ANATOMICAL IMAGES

A Studio-based PhD Accompanied by an Exegesis

Submitted to the

Faculty of Art, Design & Architecture

in Candidacy of the Degree of

Doctor of Philosophy

Department of Fine Arts

by

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ABSTRACT

The Optics of Anatomy and Light:
A Studio-based Investigation of the Construction of Anatomical Images

As anatomical images of the human body increasingly circulate in the current visual and media culture, they belong not only within the domain of scientific enquiry but also exist in a creative field that helps to further define our human identity. Images that expose the inner materiality of the body are becoming naturalized in our everyday lives, as a result of the increased proliferation of medical imagery in various media. The context for this research project is provided by a contemporary investment in what we may term 'the anatomical gaze'; one that reaches beyond the strictly defined discipline of anatomy. However, this work considers anatomical images at their inception to explore the role light plays in defining the anatomical gaze. Here, light is presented as an instigator rather than a passive illuminator of anatomical knowledge. The studio-based investigation poetically engages with some of the ways in which light impacts upon our negotiations and clarifies our imaginings of the human anatomical body. It also discusses how these experiences are articulated through images. The visual part of the research is comprised of a series of installations that hybridize old and new optical technologies, in ways that expose slippages and meeting points between different ways of visualizing anatomy. The magnification of sight and intensification of light enabled by various technological advancements have allowed us to see what previously remained invisible in the anatomical body. But, more importantly, these technical developments have also provided us with some new ways of conceptualizing these recently discovered bodily structures and their representations. For this reason anatomy is positioned in this research project as a topic that should not be, and in reality cannot be, insulated from cultural concerns. Indeed, anatomy underpins Western ideas of the body, identity and subjectivity, and it is important that it should remain open to critical investigation.

KEYWORDS: anatomy; art; light; technology; bioart; visual culture; images; media theory.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other institution and affirms that to the best of the candidates knowledge the thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signed by PhD candidate – Nina Sellars

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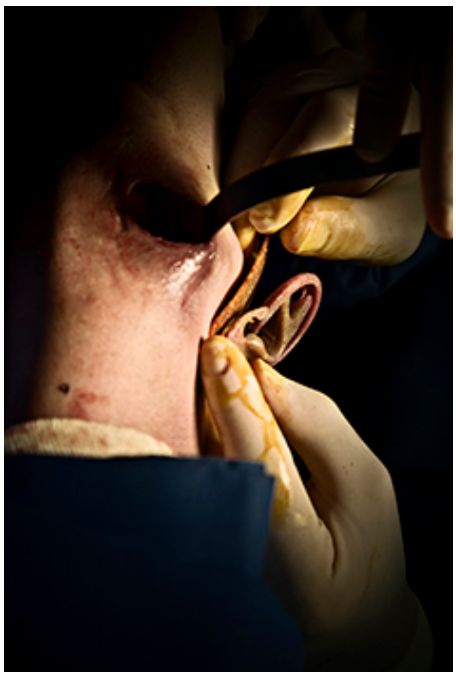
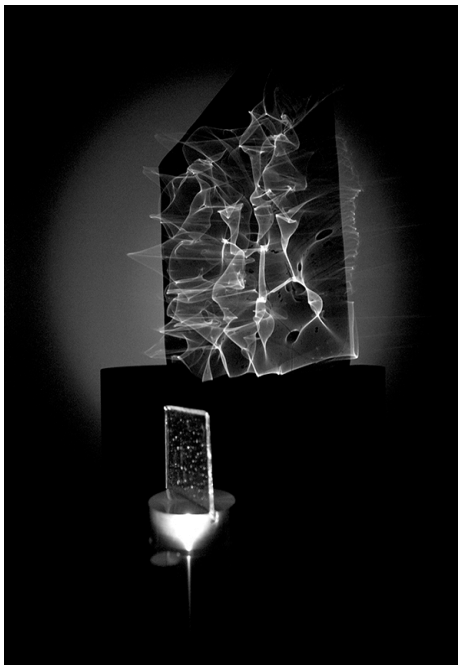
In addition, I was granted an 'Artist In Residency' by Pilchuck Glass School, Seattle, USA. The Solid-State Spectroscopy Laboratory, Research School of Physical Sciences and Engineering, Australian National University, generously assisted my research, also.

The Optics of Anatomy and Light:
A Studio-based Investigation of the Construction of Anatomical Images



Oblique

Anatomy of Optics and Light



Lucida

Scan

Figure 1. Examples of each of the four bodies of work that constitute my PhD.

INTRODUCTION

This exegesis accompanies the visual research project – *Optics of Anatomy and Light: A Studio-based Investigation into the Construction of Anatomical Images.* The visual research is presented as four separate installation artworks: *Oblique; Anatomy of Optics and Light; Lucida* and *Scan.*[1] The exegesis positions the research in relation to contemporary and historical contexts and provides a discussion of each of the installations.

This research project analyzes the construction of anatomical images, focusing on the role that light plays in the translation of flesh into image. Conceptualizing light as an instigator rather than a passive illuminator of knowledge I investigate the idea that, with the advent of new technologies which are able to emanate, record and capture light, our perception of the anatomical body alters and a new body is imagined. How does light then affect what we see and experience in relation to the anatomical body, and how are these experiences articulated through imaging? In what ways are these images engaged with outside a medical context? These questions are asked from my perspective as an artist who also has experience of working in a medical context. It is from this particular vantage point that I investigate the production of anatomical imagery in the realm of science and its related representation in popular culture. Significantly, the body, even in its scientific representation, remains embedded in culture and anatomizing the body has always been a public – and not just scientific – concern.

[1] The examination exhibition *Optics of Anatomy and Light* was held at Fehily Contemporary, Melbourne, 6th – 22nd December, 2012.

As part of this project I have undertaken on-site research at locations historically significant to the visual study of anatomy and its graphic representation. I select sites in which visualization, considered as a process, is reliant on a particular spatial positioning of the observer. The sites allow me to conceptualize the viewer's body, in this instance my own body, as forming part of an operational (optical) space. My research has included experiencing the intensely focused observational space of the Renaissance anatomy theatre at the University of Padua, as well as the immersive spectacle of Masacchio's *Trinity* fresco (c.1425) at the Dominican church of Santa Maria Novella in Florence. The *Trinity* is not only the first painting to depict a naturalistic skeleton, but also the first painting that uses linear perspective to create a life-size virtual realm which appears contemporaneous with the viewer's own reality. Masacchio intended for the fresco to be directly experienced in-situ, where it could be approached by a viewer, within the architectural space of the Santa Maria Novella.[2] These sites prove important to my research as essentially I consider the study of anatomy as being the art of visually locating organs in space, this relates both to the physical exploration of the corporeal body and its pictorial representation, respectively. Such aspects of the Renaissance are particularly relevant to my research, as artists from this era in Western Art were the first to naturalistically depict light and anatomy as physical entities existing together in continuous relative space.

An extensive amount of my supporting research was undertaken in libraries and museum collections in Italy and the United Kingdom, in particular at the Wellcome Trust Library in London, where I examined antiquarian anatomical atlases and

[2] Martin Kemp, *Seen/Unseen: Art, Science, and Intuition from Leonardo to the Hubble Telescope* (Oxford: Oxford University Press, 2006), 21; Bernard Schultz, *Art and Anatomy in Renaissance Italy* (1982; repr., Ann Arbor, MI: UMI Research Press, 2011), 47.

illustrated scientific texts. The specific intention of this contextual research is to locate evidence that elucidates, and highlights, the role that light plays in the translation of flesh into image. I take a twofold approach to this task. Firstly to uncover signifiers, which illustrate the influence of light on the perception of the artist and/or technician, and secondly to identify the mediation of light in the technological production of the image.

In considering the contemporary relationship between art and anatomy, I focus my investigation on the changing status of the image in the current visual and media culture. I examine how the meaning of the word *image* is being seemingly redefined and can be witnessed in our altered engagement with images. In addition, I discuss the work of artists who clearly exemplify the important changes that are currently taking place in the way we think about anatomy.

In regard to the production of my studio work, the method that I use involves the purposeful combination of *new* and *old* optical technologies. As such, working with glass forms an important part of my research into the field of optics. Importantly, glass intimately connects with the discipline of anatomy, also. Indeed, modern anatomy can be thought of as being witnessed 'in-vitro' i.e. through vessels, lenses and computer screens. During the period of this research project I was an artist in residence at the Pilchuck Glass School. At PGS I was able to experiment with ideas of optics and light in ways that lay outside normal glass practice. These ideas were further developed working with the Laser Physics Centre at the Research School of Physical Sciences and

Engineering, Australian National University.[3] Here I explored various ways of directing light. However, these opportunities formed only part of my studio-practice, as I also worked with photography, drawing and new media installation. I consider media as 'ways of seeing' and modes of engaging with the visual world. In addition I regard each medium as having a unique conceptual, and practical, connection to light. In this way the practice of using varied media provided me with different perspectives from where I could approach my research aims anew.

The artwork that I produced during this research period has been displayed in various exhibitions. Including, *Brain: The Mind as Matter*, Wellcome Trust, London (2012); *A Body of Knowledge – The Anatomy Lesson,* Ian Potter Museum, Melbourne University (2012); *Art and Science: Merging Art and Science to Make a Revolutionary New Art Form,* GV Art, London (2011); *Human +: The Future Of Our Species,* Science Gallery, Trinity College, Dublin (2011). These exhibitions have assisted in contextualizing my research within contemporary arts culture and made it possible for the work to be critiqued, both nationally and internationally, in a public arena. Feedback was provided through reviews, articles and book chapters, and also from responses to floor talks and radio interviews (see appendix A). During this time I was also an invited guest speaker in panel debates and symposia, including *Performing Medicine: Screening The Body,* Whitechapel Gallery, London (2011); *Lightwave Festival*, Science Gallery, Trinity College, Dublin (2008); *Art and Science*, GV Art gallery, London (2011). In addition I organized the symposium, *Solid States/Liquid Objects: Discourses of Mediation,* Monash University (2009), which brought together artists, scientists and media theorists to discuss processes of mediation (see Appendix B). The public

[3] I worked with Dr. Matthew Sellars who is a senior research fellow in the Laser Physics Centre, Research School of Physical Sciences and Engineering, Australian National University.

speaking engagements provided the opportunity to have my ideas challenged by leading figures in the arts and sciences, as well as by the general community. This in turn enabled me to further refine, defend and position my argument and, importantly, it allowed me to gain insight into the significance of these debates in relation to broader social concerns.

Artist's Background

Even though such a thorough engagement with both art and science is not an easy undertaking, I believe I am well predisposed to undertake this kind of interdisciplinary study. As well as being a visual artist working across the disciplines of drawing, photography and new media installation, I have been employed as an anatomical illustrator and prosector i.e. a dissector of cadavers for medical display.[4] Also during the period of my PhD I have taught the Anatomical Drawing unit at Monash University, both in Melbourne and at the Monash University Prato Centre in Italy. Indeed, throughout my arts practice I have focused on anatomy and its symbiotic history with arts and technology. My more particular interest lies in exploring the internal architecture and perceptual awareness and abilities of the acculturated body as embedded in the world and mediated by technology. This research project is an extension of this practice. One of its focal points is to investigate how light illuminates, irradiates and exposes structures of an anatomical body as seen through the eyes of a receptive mind.

[4] The Department of Anatomy and Human Biology at the University of Western Australia employed me to be a prosector (2002 – 2004). During this period I also lectured part-time at the Western Australian Academy of Performing Arts, where I taught drawing to the Lighting, Costume and Design students. Working at WAAPA and within the anatomy department provided two experiences of *theatre,* both designed for the attentive beholding of *spectacle*.

The question of *seeing*, and the associated states and processes of *almost seeing*, *not seeing*, and *being blind*, are important to my research. I have both intellectual and personal reasons for this particular focus on concepts of sight and the visual. As a teenager I lost my eyesight after the surgical removal of a brain tumour. Though my eyes still functioned my brain could not decipher the visual information. Seemingly, during the period of blindness, my world extended only as far as my reach, to that which I could touch with my hand, with detail being a tactile quality. In this way vision became a mix of memory and fingertip. I felt embedded in a vision that was all *here,* so to speak, there was no over *there* as experienced with sight. This period of *being blind* was followed by one and a half years of *almost seeing*. However what I was seeing at this time did not necessarily correlate with reality. I lived in a distorted visual field, with flashes of light and moving dark shadows, which seemed to exist without any external source of reference, and occurred whether my eyes were open or shut. I became very aware of the act of seeing. This brought up questions for me of where 'sight' is located; what constitutes sight and thus reality and, after my sight returned, why was nothing quite as I had remembered it? The visual world seemed to lack depth, not appearing how I had left it, or rather as I had come to imagine it to be while blind. My perception of visual space was different and nothing within that space appeared real, including my *being* in the world. In part this is why drawing and photography have been important to me. In effect, when I began drawing I was using the medium to collapse a far sense into a near sense, imagining the pencil touching the surface of the object that I was drawing. To some extent regaining for sight a sense of tactility. Photography however allowed me to explore a *still* image of a *real* scene, somewhat objectifying my vision. Importantly, both mediums provided a way for me to negotiate the visible world – and a means to construct fictional spaces in which to explore contestable realities.

The phenomenological experience of living through the changing state of *almost seeing* is only one of the driving forces behind my research. I want to suggest that we are always in the process of *almost seeing* and that the visual world is never fully open to us. This provokes the following questions: 'What exists or takes place in the perceptual gap?' and, in the context of my research, 'How does this gap influence our perception of the anatomical body and its relation to light?' These gaps and omissions of perception, which could be thought of as breaches of objectivity, occlude very human concerns.

Methodology

Central to my research is Marshall McLuhan's concept that the way in which a medium communicates information, how it relates to us physically and in a broader sense socially, has far greater impact on us than any content it may contain. McLuhan visualizes mediums and technologies as 'extensions' of ourselves, a sense accelerated or augmented, which the body then compensates and adjusts.[5] As mediums and technologies are already a part of us, existing as extensions of our senses, they go unnoticed permeating our perceptions without our awareness. When consciousness is distracted by content, the unconscious is affected by medium. 'For any medium has the power of imposing its own assumption on the unwary'.[6] McLuhan treats the terms medium and technology as interchangeable and I continue to regard the terms as similar, though in the context of my research I offer a distinction.[7] I place emphasis on the word technology when referring to the use of an instrument, either by an artist

[5] Marshall McLuhan, *Understanding Media: the Extension of Man* (New York: New American Library, 1964), 45-52.
[6] McLuhan, *Understanding Media,* 16.
[7] Marshall McLuhan, "The Playboy Interview," *Playboy Magazine*, March 1969. The Marshall McLuhan Center on Global Communications: http://www.mcluhanmedia.com/m_mcl_inter_pb_02.html (accessed 18/04/12)

or scientist, employed in the act of observation, and I use the word medium most often when referring to a visual record made during the initial act of examination. Considered in this way a technology facilitates the exploration of a subject, which considered in McLuhan's terms involves an extension of the capabilities of the body, whereas a medium is used to convey information.

Using McLuhan's theories as a guide, I can revisit the idea that we are always in the act of *almost seeing* and that the visual world is never fully there for us. Here, I put forward an approach to exploring the perceptual gap created by *'almost seeing,'* Effectively, to externalize the perceptual gap into a phenomenological space, a space which is defined by technology. If we think of it in these terms it becomes a living, dynamic space, open for exploration. In the context of my research I consider this dynamic space as being defined by the *task envelope* of light.

A key concept that I put forward in this research is that light-directing technologies create, and delineate, a task envelope. The term *task envelope* is usually associated with the instructional specifications of robotic machinery; it delineates the area covered by a piece of equipment when it is in use and determines an envelope of operational space. The specifications of a task envelope are usually provided for safety reasons, indicating where the body should *not* be in relation to working equipment. However in the context of this research my use of the term is inclusive of the body, as I conceptualize the viewer's body as forming part of an operational (optical) space. I argue that the task envelope of a light-based technology defines a perceptible limit to both the observer's action and understanding by determining *what* they see and by instigating *how* they see it. The term also implies that the impact of light extends far beyond just that of sight.

Essentially, in this research project I contrast two methodologies. I juxtapose the concepts of media theorist Marshall McLuhan and Martin Heidegger's philosophies of phenomenology. McLuhan offers theories on technology's capacity to structure and extend our senses whereas Heidegger provides a philosophy that addresses the experience of the individual and presents perception as a correlate of the body's sensory functions and the environment that surrounds it. Taking a phenomenological stance allows us to think of ourselves as being both embodied and embedded in the world however for Heidegger *being-in-the-world* is to be literally thrown into a process of making sense of the world that begins with being perplexed by one's own existence.[8] Heidegger's philosophy is relational in that it directs attention away from how things simply appear to us, that is to say where perception is regarded in and of itself, focusing instead on the idea that awareness is discursive and unfolds through a questioning of how the world comes into view for us as being meaningfully present. Heidegger considers, in part, that meaning resides in how things appear as significant through a process of being useful. That is to say that meaning resides not in things or in perception but in our actions.

In comparison to Heidegger, and the first person philosophy of phenomenology, McLuhan not only offers an approach to understanding technology but also an approach to comprehending the broader social implications of the emergence of new mediums. McLuhan asserts that what is important is the way in which a medium conveys information, as ultimately the 'medium is the message.'[9] I argue in addition that each medium, and technology, has a unique relationship to light and in part it is light that reveals, configures and reconfigures the message.

[8] Martin Heidegger, *Being and Time* (New York: Harper Perennial, 1962), 78-90.
[9] McLuhan, *Understanding Media*, 7-23.

Method

The method that I use in the production of my studio work involves the purposeful combination of *new* and *old* technologies. Essentially, this is a practical adaptation of a McLuhanian concept. In Marshall McLuhan's text *Understanding Media* he explores the idea of 'hybrid energy' and asserts that the hybridization of media creates 'new force and energy by fission or fusion.'[10] McLuhan contends that the compounding of media offers the 'opportunity to notice their structural components and properties.'[11] His assertion is that in the initial moment that two media meet, the traits of one expose the qualities of the other. In my appropriation of this idea my objective is to produce images and installations that contain elements which are seen to alternate between states of juxtaposition and union, with the traits of one medium exposing the qualities of the other. In relation to my research I argue that each optical technology has a distinct mode of visualization, which is defined by its relationship to light. Therefore I conceptualize the hybridization of media as uncovering the individual technological configuration of light that is distinct to each optical instrument.

Anatomy: A Working Definition

Here I want to clarify what anatomy *is.* The etymology of the term *anatomy* can be traced back to the Greek *ana-,* meaning *up*, and *temnein,* meaning *to cut*. In the medical sciences the term anatomy refers to the structures of the body, its organs and the systems. It is different from physiology, which describes the body's functions, and encompasses the movement and animation of those structures. Conceptualized in this

[10] McLuhan, *Understanding Media,* 53.
[11] McLuhan, *Understanding Media,* 54.

way, the anatomical body can be understood as a still body, a non-moving body, and this remains equally true regardless of whether the body being considered is living or deceased. The anatomical body's condition of stillness relates directly to its intended use. It is a body to be investigated and recorded, whether by using modern medical imaging to capture images of the internal structures of the living body, or through the manual dissection and documentation of the deceased body. Anatomy can then be thought of not only as structures of the body but also as a method of questioning, an approach to the body that denotes, and was created by, scientific enquiry. However, by placing focus on the translation that happens when the *manual cut* of dissection – one which is guided by a corporeal eye – is replaced by the *virtual cut* of technology that is produced through the invisible penetration of light used in modern medical imaging, it becomes clear that this very method of questioning, that is to say *anatomy as a methodology,* has changed. With the cut, the spectacle and its visual realization are now being performed as one instantaneous act. There is a sense of speed and immediacy that enters the discourse surrounding anatomy, but there is also an entirely different set of phenomenological engagements that are brought into play when light, from the extremes of the electromagnetic spectrum, is used as a medium to view and image the interior of a living body. In this discussion, I want to engage with the traditional meanings behind anatomy, with a view to redirecting them towards a more animated definition, one that will allow for a *quickening* of the anatomical body through its active relationship with light.[12]

[12] quicken, *v.1* – To give or restore life to; to make alive; to vivify or revive; to animate. *The Oxford English Dictionary*. 2nd ed. 1989. OED Online. Oxford University Press. http://dictionary.oed.com/cgi/entry/50194991 (accessed September, 2009).

Light: A Working Definition

When compared with the apparent stillness of the anatomical body, light can be described as an active, dynamic force – not only in a physical but also in an epistemological sense. Light itself is an unstable concept. It is difficult to define as it traverses various areas of knowledge in which it functions as both metaphor and physical agent. The philosopher Jacques Derrida refers to metaphors of light as forming the basis of all philosophy when he states that 'the entire history of our philosophy is a photology.'[13] Media theorist Marshall McLuhan conceptualizes [electric] light as a pervasive medium that alters our sensory engagement with the world: for him light exists as 'pure information.'[14] Identifying what light means in the context of my art practice has been an ongoing and context-dependent process. My study of light originally began in the realm of physics. As the area of knowledge that had constructed the anatomical body, science appeared a logical departure point for me, providing a methodology that placed light as part of a measurable, physical world. This is where I thought light would appear the clearest, the most stable and easiest to grasp. That departure point soon became a point of disappearance: the place of the last sighting of an elusive force. As 'light both reveals matter and ultimately retreats to a realm where it remains inaccessible to sight and to reason.'[15] Light in itself cannot be seen and is accessible only through a combination of discourse, representation and affect.

[13] Jacques Derrida, *Writing and Difference.* Trans. A. Bass (London: Routledge, 1978), 27.
[14] McLuhan, *Understanding Media*, 57.
[15] Melissa Miles, *The Burning Mirror: Photography in an Ambivalent Light* (Melbourne: Australian Scholarly Publishing, 2008), 37.

In common usage, light is normally classed as a visible sub-section of the electromagnetic spectrum, but in the context of this research, and my wider art practice, I refer to light as comprising the entire spectrum, including its invisible parts.[16] Importantly, the electromagnetic spectrum is continuous. (This definition was not arrived at arbitrarily: it was made in consultation with a quantum physicist.)[17] My intention is to remain faithful to real world physics while suspending the discipline's historical classifications that divide the spectrum into separate sections. As different technologies were invented, their capabilities for measuring separate areas of the spectrum were recorded as new sections of the spectrum. The artificial boundaries document not so much the qualities of light, but rather the qualities and history of our measuring devices. This view is reflected in a statement by the quantum physicist Werner Heisenberg: 'since the measuring device has been constructed by the observer... we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning.'[18] This revised approach to understanding what counts as light allows me to traverse the entire spectrum in my discussion of light and associated technologies used in the exploration and imaging of the body, i.e. X-rays, computed tomography scans (CT), positron emission tomography scans (PET) and magnetic resonance imaging (MRI).[19] However, the aim of this research project focuses not so much on the technical specifications of bodily imaging, but

[16] Jerry D. Wilson and Anthony J. Buffa and Bo Lou, *College Physics.* 8th ed. (Upper Saddle River, NJ: Pearson Prentice Hall, 2009), 679. 'An electromagnetic wave (light) consists of time-varying electric and magnetic fields that propagate at a speed of *c* (3.00 x 108 m/s) in a vacuum. The different types of electromagnetic radiation (such as UV, radio waves, and visible light) differ in frequency and wavelength.'

[17] This was discussed with Dr. Matthew Sellars, a senior research fellow in the Laser Physics Centre, Research School of Physical Sciences and Engineering, Australian National University.

[18] Werner Heisenberg, *Physics and Philosophy* (New York: Harper & Bros:1958), 25.

[19] In my research I do not reference X-ray; for the most part this is because there are already extensive, detailed discussions about the importance of its invention. In addition, I include MRI as being a 'light' emiting technology, which is not how it is generally accepted, however the MRI wavelength forms part of the electromagnetic spectrum, and by suspending classifications I see MRI as being a light with a very long wavelength.

rather the network of relations and discourses around the anatomical body, both in culture and science, that have been initiated by these technologies.

Anatomy Mediated by Light

Arguably, light that penetrates the body also animates the body. I stated earlier on in my definition of anatomy that, as our ability to visually access the living body developed with the introduction of modern medical imaging, *anatomy as a methodology* itself changed. A sense of speed and an 'ocular' immediacy entered the discourse surrounding anatomy. When light from the extremes of the electromagnetic spectrum is used to image the interior of the living body, it culminates in the *virtual* cut, the spectacle and the visual realization being performed in one instantaneous act. In the radiography room, which is an anatomy theatre of sorts, the relations and positions of the traditional protagonists are altered. The observed body is no longer necessarily a dead body, i.e. the ultimate still body, but it has become a *patient* body, still, ill and waiting. Witness the transformation of the role of anatomical images that has taken place in the process - from those of the Renaissance period, professing the illumination of God's perfect design to those of the contemporary medical scan, exposing the pathologies of the individual. The *patient* body of modern radiography is sensorially unaware of the light that is unveiling its interior, as its effect cannot be directly seen or felt. Yet, because of the light's intensity and potential harmfulness, the spectators have now become removed from direct viewing. With the audience dispersed and the anatomist displaced, the *patient* body must remain alone. This alienation of observation is nothing new, as the anatomical body has always been positioned as a liminal, but unlike the Renaissance cadaver, the radiographer's *patient* is alive and conscious.

With the magnification of sight and the intensification of light, both enabled through various technological advancements, the viewer has been allowed to see what had previously lain invisible in the anatomical body. The abstraction of the body in medical imaging is accelerated through its magnification, as minute forms become intangible and lie outside our reach. The sense of sight can no longer be verified by the touch of the hand, as a result of which the bodily microcosms being produced are accessible only by way of analogy. Magnification also dissolves discernable boundaries, or it multiplies them exponentially, depending on one's focus. Viewing an organ such as a heart at a cellular level negates, in that particular moment, the ability of being able to see it as a whole, let alone being able to perceive it as part of a system. On the other hand, such micro-perception can add millions of newly constructed boundaries such as divisions between individual cells. The limits of individual structures where an organ begins and ends become less clear and less relevant if questions about function, relations and communication are raised. How our body interacts in the world, where it begins and ends and even where *thinking* takes place becomes less discernible as the boundaries of the body contract and expand depending on social, cultural and technological influences and perceptions. In this sense, the study of anatomy and its relationship to light is also, inevitably, a study of our ontology and epistemology – it is a study of who we are and how we construct knowledge. Importantly, the main focus of this research project is to explore how light influences our phenomenological engagement with the anatomical body and how we see ourselves after being exposed to the anatomical interior.

PART I

CONTEMPORARY CONTEXT

'Friending' Anatomy: The Online Presence of Virtual Anatomies

As images of anatomical figures circulate on the Internet, they can appear increasingly disconnected from their origins. By this I mean that anatomical images can appear separated not only from the biological bodies which they represent, but also from the URL of their initial digital host. Sociologist Catherine Waldby describes the online virtual anatomies that originate from the National Library of Medicine's Visible Human Project as being 'digital revenants' which now 'haunt the public spaces of the web.'[1] However, Waldby's perception of the VHP is only one such (scholarly) response to the appearance of virtual anatomies in the public domain. Yet, as these supposedly objective bodies permeate social networks, they are open to multiple acts of subjective interpretation by viewers who are at once disparate and anonymous. In what follows I examine the social life of these previously institutionalized bodies, by investigating some of the ways in which they appear in popular culture. In addition I discuss the artwork of selected visual artists who are currently engaging with contemporary concepts of anatomy – Orlan, Marilene Oliver, Revital Cohen, Tissue Culture & Art and Stelarc. All of these artists clearly exemplify the important changes that are currently taking place in the way we think about anatomy. My principal aim with this enquiry is to examine the contemporary relationship between art and anatomy by investigating what appears to be the changing status of the image.

This chapter provides a general overview of contemporary concepts of the anatomical body as they manifest themselves in the arts and biomedical sciences. Importantly, it is intended as a poetic exploration, not a scientific examination, of the

[1] Catherine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine.* (London: Routledge, 2000), 23.

ways in which the anatomical body is visualized. Here, the *poetic* is to be understood as a process of 'active making.'[2] Emergent through an inextricable entwining of representation and discourse, the poetic can be said to emulate life and construct possible ways of being-in-the-world, meaningfully. In the context of my research, the term *poetic* signals my desire to explore the 'still' anatomical body of medical science, through 'the transformative and interventionist energy of the creative arts.'[3] With this idea in mind, the following discussion incorporates concepts of the cyborg, the posthuman as well as the semi-living; each of these examples relate to, yet extend beyond, the quantitative discourse of anatomy.

I also include the Renaissance era as an essential part of this chapter. I argue that Renaissance thought is still extremely relevant for our contemporary concerns, as it is often used as the elemental foundation for emergent debates regarding the relationship between art and anatomy. In this way the Renaissance, as a way of thinking, remains operative and continues to influence present-day visualizations of anatomy. Therefore I highlight it here as being an important strategy in contemporary discourses regarding art and anatomy. In general, the Renaissance period is considered as the origin of both the scientific study of anatomy as well as of the processes used in its naturalistic depiction. Arguably, the Renaissance thus provides a stable and unified history for contemporary concepts of the anatomical body, which otherwise can appear dynamic and unstable, and at times difficult to grasp. But why describe a body, which is intended to be transparently accessible, as somehow evasive?

[2] I relate the idea of 'active making' to Aristotle's use of the term *poetic* in which he states that the object of poetry is to depict 'men in action.' Aristotle *Poetics* 1448[a] 1-5.
[3] Sarah Kember and Joanna Zylinska. *Life After New Media: Mediation as a Vital Process.* (Cambridge, MA: MIT Press, 2012), 201.

Importantly, the anatomical body is as much defined by the methods used to behold it as it is defined by the structures that it claims to reveal. Anatomy is a science predominantly based on visual observation. Therefore the anatomical body's existence is seemingly reliant on modes of visual communication — which are constantly, and rapidly, evolving. However, with each new technology used in our seemingly relentless visual interrogation of the body we are not only seeing more of the body, but we are also seeing it differently. With the perceptible limit of the anatomical body no longer linked to anything tangible, our corporeality seems to be expanding exponentially. And, through a proliferation of imaging possibilities, we are being offered a multiplicity of disorientating views. Here the body can seem evasive, simply because it can appear unrecognizable.

Waldby compares the VHP to the illustrated anatomical atlases of the Renaissance, with both serving as examples of 'the ways in which the media of anatomical demonstration condition anatomical knowledge and practice, and in turn lay out the material conditions for the use formation and circulation of normative archives.'[4] Adopting Waldby's stance the anatomical body can be thought of as being reworked, so to speak, by the process of its mediation – in this instance resulting in the virtual screen-based image and the illustrated book respectively. But our perception is also being conditioned to accept these 'normative [visual] archives' as being true reflections of the physical body. In this way each new process of visual mediation can be thought of as presenting a new anatomical body, an idea that I will return to in relation to the posthuman. However here I want to raise a broader question: what is happening to our understanding of images in the twenty-first century?

[4] Waldby, *The Visible Human Project*, 54.

Seemingly, the meaning of the word *image* is being redefined and can be witnessed in our altered engagement with images. It could be said that, to a large extent, we no longer look at images, but rather we interact with visual entities. Importantly, the methods that we now use to create and view images are appearing to complicate prior notions of reality, e.g. virtual reality, augmented reality and mixed reality. It would seem that any contemporary definition of the word image will need to question where the image appears, how it appears, and how it relates to reality. In other words, it will need to interrogate whether the viewer is assimilated into the view of the image, or more interestingly, whether the image is behaving like an object. However, Elizabeth Grosz argues that 'we did not have to wait for the computer screen … in order to enter virtual space; we have been living in its shadow more or less continually.'[5] In her book, *Architecture from the Outside: Essays on Virtual and Real Space*, she suggests that,

> The virtual reality of computer space is fundamentally no different from the virtual reality of writing, reading, drawing, or even thinking: the virtual is the space of emergence of the new, the unthought, the unrealized, which at every moment loads the presence of the present with supplementarity, redoubling a world through parallel universes, universes that might have been.[6]

Grosz is referring to a notion of the virtual, which is the immateriality of imagination. But she is also implying that this immaterial space of imagination is no different to the virtual space of visual representation. In contrast I consider there is a significant difference about the virtual when anchored in a pictorial space. Not only for

[5] Elizabeth Grosz, *Architecture from the Outside: Essays on Virtual and Real Space* (Cambridge MA: MIT Press, 2001), 78.
[6] Grosz, *Architecture from the Outside*, 77.

the reasons that I have outlined, i.e. due to the viewer's interactivity with the image and immersion in a constructed perspectival space, but also that images allow an individual vision to be recorded and disseminated. This is an important issue for anatomy. Anatomical images can be thought of as visual manifestos for emergent concepts of the body, which in turn allow contestable anatomies to circulate and to enter the public domain. This leads to a second important difference about the virtual space and objects when contained in images. Here I align my thinking with Anne Friedberg's assertions on virtuality. 'The semantic slippage between the virtual that has no material existence (appears in the brain, on the retina) and the virtual image that is formed in representations signifies a subtle shift in its materiality.'[7] It is this shift in materiality that I find of most interest in relation to anatomical images. Seemingly, images are becoming more substantial. However, at the same time, there is a sense of transparency about the physical body — which, as a result of its multiple imagings, can feel open, isolated and lacking a boundary.

The art historian Ernst Gombrich considered that the viewer plays a significant role in bringing an image into existence. It is how the image appears to them as being *meaningful*. However, this would seem a somewhat complex action when the image being viewed is virtual, interactive and reflecting the internal organs of the human body. For in this moment the viewer is not looking at an image as such but rather engaging with a reflection that exposes the inner materiality of the body. I want to suggest here that the image, both as a concept and as an actuality, should be revisited especially in relation to anatomy. The way in which an anatomical image appears *meaningful* seemingly challenges ideas of identity and subjectivity, as well as our

[7] Friedberg, Anne. *The Virtual Window: From Alberti to Microsoft.* (2006; repr., Cambridge, MA: First MIT Press paperback edition, 2009), 10.

understanding of physically *being* in the world. This can only be further complicated when the generally accepted qualities that identify an image from an object, i.e. a virtual entity from a fleshy reality, are becoming increasingly harder to discern.

Is a way of 'seeing' becoming a way of 'being', where images no longer depict reality but can be thought of as actively redefining it? Following this idea further, are images, and the various new modes in which we engage with images, effectively redefining what it means to be human? In this instance I use the term 'redefining' in a very literal sense, as I want to suggest that images are shaping our corporeality. However, it could be argued that images have always, to some extent, been used to modify, and not just reflect, our existence.

Cut/Collate/Construct: Contemporary Artists Working With Concepts of Anatomy

ORLAN

In her plastic surgery project *Reincarnation of St Orlan* (1990-1993), the French performance artist Orlan explores the influence of images on Western society's perception of beauty. Appropriating sections of classically defined beauty, cited for the most part from popular Italian Renaissance paintings, Orlan undertakes 'self-portraiture in the classical sense, [yet] realized through the possibility of technology'.[8] The performative surgeries present Orlan centre stage and awake. Complete with costumes, props and sets she is an impresario directing her own facial reconstruction, the plastic surgeon taking on a somewhat ancillary role to Orlan's self-directed

[8] Orlan, *Carnal Art Manifesto,* http://www.orlan.net/adriensina/manifeste/carnal.html (accessed June 30, 2012)

transformation. For Orlan, the aesthetic outcome is not as important as the surgical act, as her intention is to make her face a 'site of public debate'; to this end the surgeries are filmed and televised.[9] Effectively, in these surgery spectacles, fragments of imagery are remediated in flesh, thus forming a [living] composite of perceived feminine beauty. In this way, the *Reincarnation of St Orlan* alludes to the classical beauty of art history, which in fact has always been a chimeric construction. The theorist Leon Battista Alberti provides instruction on how to perfect a 'Renaissance' beauty in his treatise *De Pictura* (1425):

> It is useful to take from every beautiful body each one of the praised parts and always strive by your diligence and study to understand and express much loveliness. This is very difficult, because complete beauties are never found in a single body, but are rare and dispersed in many bodies.[10]

Of course what Alberti is prescribing relates to the art of painting, not to manifesting the act as living flesh. However, in the surgeries, Orlan seems to be questioning whether we can regard an image as any less violent when it reflects such grossly unrealistic expectations. For Orlan's aim is to challenge notions of idealized feminine beauty that are defined by the male gaze, the face being placed under particular scrutiny as a site uniquely susceptible to the destruction/reconstruction of identity. In her online manifesto *Carnal Art,* Orlan states, '*Carnal Art* is not against aesthetic surgery, but against the standards that pervade it':[11]

[9] Simon Donger and Simon Shepherd, *Orlan: A Hybrid Body of Artworks* (Abingdon, Oxon: Routledge, 2010), 28.
[10] Leon Battista Alberti, *De Pictura*, 1425. Trans. by John Spencer (New Haven, CT: Yale University Press, 1956), 92.
[11] Orlan, *Carnal Art Manifesto,* (accessed June 30, 2012)

> I have worked a lot with the social representations of bodies through mine. I have modified to absorb and subvert those representations: to discover what they hide and what else they can offer. I have made myself both an object and a subject: I have searched for a certain flexibility in identity in order to reinvent myself. I inhabited the trenches separating flesh and imagery, the body and identity. I created ORLAN.[12]

The *Reincarnation of St Orlan* is not a recent work, as it is now twenty years old. However, the work appears prophetic of the contemporary cosmetic 'makeover' culture that is propagated by reality television shows such as Fox's *The Swan,* ABC's *Extreme Makeover* and MTV's *I Want a Famous Face.*[13]

MARILENE OLIVER

There are also artists who perceive the body as requiring reassembly, the social body somehow fractured, after its exposure to diagnostic imaging. Marilene Oliver is one such artist who seeks 'to repair the fragmentation' of the medically imaged body.[14]

> My relationship with the body is nostalgic and romantic, based on an anxiety that the body is becoming redundant. New technologies, especially communications and medical imaging alienate us from the bodies that we have. They promote a decentralisation of the self - they allow us to project ourselves into different spaces and offer us new views of our bodies that belittle being contained in a physical body.[15]

Oliver describes her artwork as 'allowing data to become relic,' as she carefully constructs tangible sculptures out of virtual anatomical imagery.[16] Indeed, the works

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[12] Simon Donger and Simon Shepherd, *Orlan,* 118.
[13] Kember and Zylinska, *Life After New Media,* 133-142.
[14] Marilene Oliver, *Artist's Statement (Royal College of Art 2007),* http://www.marileneoliver.com/writings/writsartiststat.html (accessed June 30, 2012)
[15] Marilene Oliver, *Artist's Statement* (accessed June 30, 2012)
[16] Marilene Oliver, *Research Statement (Royal College of Art 2007),* http://www.marileneoliver.com/writings/writresstat.html (accessed June 30, 2012)

seemingly evoke the paradoxical status of a holy relic, being both material and unearthly.[17] The fate that besets all real world organic matter is seemingly negated in the virtual world, as 'the irreversibility of time, the inescapability of decomposition, [and] the finality of death are suspended.'[18] Seemingly, the virtual realm offers eternal life, or at least the possibility of eluding decay. This quality transfers to Oliver's sculptural works, the anatomical bodies being resurrected and liminally positioned between the 'material and unearthly.'

The ethereal quality of Oliver's work is, to some extent, innate to all virtual anatomies and appears as an artifact of their production. Generally, for documentation, the physical body is laid out on a dissecting table or scanner bed, however the resulting images are typically shown vertically. In this way, a virtual body can appear animated through reorientation; giving the body an otherworldly character, as its mass seemingly defies gravity and thus appears no longer of the real world. The virtual body floats in space, with its feet drifting unable to be grounded. In appearance, the virtual figure is not dissimilar to the pointed-toed figures of medieval illustration, which appear unaffected by real-world time and space, as they float against depthless backgrounds of black or gold.

In the making of her sculptural piece, *I Know You Inside Out* (2001), Oliver downloaded anatomical images from the *Visible Human Project* to reconstruct the male figure, Joseph Paul Jernigan, 'to put him back together again', to make him 'whole.'[19]

[17] Andrea Nightingale, *Once Out of Nature: Augustine on Time and The Body* (Chicago: The University of Chicago, 2011), 169.
[18] Waldby, *The Visible Human Project,* 18.
[19] Oliver, *Research Statement* (accessed June 30, 2012)

> In making *I Know You Inside Out* Jernigan was relocated in time and space: returned from a digital to analogue state, no longer decentralised, fragmented and prone, but centred, whole and upright.[20]

Oliver is not piecing together beautiful 'bits' of bodies for the creation of an idealized beauty (the same classical beauty that Orlan subverts in her plastic surgery project). Rather, she pieces together a formerly whole body, that of Joseph Paul Jernigan, a 39-year-old male who has been convicted of murder. Before his execution he donated his body to the *Visible Human Project*.[21] The act of re-piecing the fragmented Jernigan into a 'whole' figure seemingly reflects St Augustine's dictum that the body is an aesthetic unity. Even Oliver's anxiety about the scientific fragmentation of the body seems to resonate with St Augustine, as he believed that anatomists, 'have ruthlessly applied themselves to the carving up of dead bodies, having probed into all the secrets of the human body, with little regard to humanity.'[22]

In contrast to *I Know You Inside Out,* Oliver's latest work, *Melanix* (2012)*,* is not a sculptural still 'relic' but a screen-based image. Yet the viewer is not looking at an image as such, rather engaging with a reflection that exposes the inner materiality of the body. Oliver's work *Melanix,* made in collaboration with Brendan Oliver, is an interactive video installation that combines video output from radiology software with a Microsoft Kinect sensor:

> The Kinect sensor (a motion and skeleton tracker) has allowed Marilene Oliver and creative coder Brendan Oliver, to develop the idea of a dance

[20] Oliver, *Research Statement* (accessed June 30, 2012)
[21] Waldby, *The Visible Human Project*, 1-23. Waldby provides a detailed discussion about the moral economy surrounding the seemingly redemptive, sacrificial act of Jernigan (a criminal awaiting execution) donating his body to science.
[22] Augustine *De civitate Dei* 22.24; Bernard Schultz, *Art and Anatomy in Renaissance Italy* (1982; repr., Michigan: UMI Research Press, 2011), 13.

> between scanned body and computer user into a life size, full body experience. Mouse clicks, keyboard taps have now been replaced by whole limb movement and the 15 inch screen is now full high definition projection.[23]

Here, a previously 'institutionalized' body is socializing through a choreography of viewing, which Oliver has initiated. In part, I consider *Melanix* as exposing the contemporary relationship between art and anatomy, which appears to be founded on the changing status of the image. As it could be said that, to a large extent, we no longer look at images, but rather we interact with visuals.

REVITAL COHEN

The London based designer Revital Cohen states that her work 'develops critical objects and provocative scenarios exploring the juxtaposition of the natural with the artificial'.[24] A number of her projects provide a poetic critique of bioengineering that places the 'natural' body in dialogue with biotechnology. In relation to my research, Cohen's work titled *The Immortal* (2012) is of particular interest, as the installation relates to the subject of anatomy, but deftly avoids direct representation of the corporeal. In Cohen's description of the work she states,

> The Immortal investigates human dependence on electronics, the desire to make machines replicate organisms and our perception of anatomy as reflected by biomedical engineering.[25]

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[23] Marilene Oliver, *Melanix.Execute,* http://www.marileneoliver.com/portfolio/portfolio2012/Melanixexecute001.html (accessed June 30, 2012)

[24] Revital Cohen website http://www.revitalcohen.com/ (accessed June 1, 2012) It should be noted that Cohen has recently married and formed a joint arts practice with her husband Tuur van Balen, who is also a designer. Therefore the website information has changed slightly from when I began my research. Search for 'Cohen van Bahlen.'

[25] Revital Cohen website, *The Immortal,* http://www.cohenvanbalen.com/work/the-immortal# (accessed October 30, 2012)

In *The Immortal* installation the materiality of the anatomical body is made present through its absence; the body replaced by a network of life-support machines which is intended to 'mimic a biological structure.'[26] *The Immortal* does not represent the sleek toys of a technologically accessorized body, (e.g. smart phones, tablets, GPS's) – the twenty-first century utopian technologies that we seemingly 'cannot live without'. Instead, *The Immortal* comprises the lumbering, restrictive technologies that are used to maintain a patient body; a body that is still, ill and awaiting recovery.

Cohen appears indicative of a current trend. Designers are making significant and meaningful contributions in relation to challenging contemporary concepts of anatomy. In part, this has been made possible through a shared use of technology. That is to say, bioengineering positions the body in a dynamic network of disciplines, discourses and technologies; complementing this, 'design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange.'[27]

In the example provided by Carnegie Mellon's School of Design mission statement, the aim is for design students to be 'agents of change who can respond to the problems and opportunities of life in the 21st century:'[28]

> At Carnegie Mellon's School of Design, we believe design to be a humanistic discipline: the art of conceiving, planning and shaping products that are made to serve people in answer to their individual and collective

[26] 'Anatomical knowledge is a precondition for all internal surgical practice, which allows interior organs to be exteriorized and treated in linkage with life-support systems.' Waldby, *The Visible Human Project,* 51.
[27] International Council of Societies of Industrial Design, *Definition of design,* http://www.icsid.org/about/about/articles31.htm (accessed May, 2012)
[28] Carnegie Mellon University, *Carnegie Mellon Design*, http://design.cmu.edu/show_program.php?s=1&t=1 (accessed June 30, 2012)

> needs and desires. Our aim is to prepare designers for a world that places high value on the quality of human interactions. We develop and design products, artifacts, environments, systems, and services that support and enhance these exchanges.[29]

Working with this methodology, all it takes is the critical and playful eye of an eloquent young designer, such as Cohen, to subvert the science of anatomy. More than ever the body is being 'designed,' which presents opportunities to discuss how this process is being pursued and to explore the issues that are being revealed, including those of ethical concern.

TISSUE CULTURE & ART PROJECT

Tissue Culture & Art Project (TC&A) consists of the designer Oron Catts and the artist Ionat Zurr; together they explore the use of tissue engineering as a medium for artistic expression. Their interest lies with the ethical concerns that are raised by bioengineering. As part of their practice TC&A grow, what they refer to as, 'Semi-Living' entities. In the example provided by their artwork *Pigs Wings* (2003), made in collaboration with the artist Guy Ben-Ary, TC&A created three sets of wings cultured from living pig bone tissue. Each set is designed to represent different cultural perceptions of wings, i.e. the angelic, the evil and, what TC&A select as being neutral, the extinct flying reptile pterosarus from the Jurassic period. TC&A recognize the absurdity of the work, which is implied by the title, and are aware that aesthetically the wings fall short of what they promise, as in reality they are small blobby masses. However, this 'lack' is intentional and forms part of the work, highlighting that 'the

[29] Carnegie Mellon University, *Carnegie Mellon Design* (accessed June 30, 2012)

rhetoric used by private and public developers as well as the media have created public anticipation for less than realistic outcomes' in regard to bioengineering.[30]

Yet, underlying all of TC&A's works are significant ethical questions regarding 'Semi-Living' entities, as inevitably we are responsible for their *being* in the world.

> We are investigating our relationships with the different gradients of life through the construction/growth of a new class of object/being – that of the Semi-Living. These are parts of complex organisms which are sustained alive outside of the body and coerced to grow in predetermined shapes.[31]

Can we easily discard these 'Semi-Livings?' At what point do we empathize with these *others* who are often no more than a cluster of living cells. The term 'Semi-Living' evokes thoughts of *constructed* sentients, palpable *beings,* which in turn raises questions about our own *being* in the world, whereby our *being* is understood as our *being-with-others,* meaningfully. Essentially, Catts and Zurr 'are interested in the new discourses and new ethics/epistemologies that surround issues of partial life and the contestable future scenarios they are offering us.'[32]

STELARC

Stelarc experiments with 'alternate anatomical architecture.'[33] He perceives the human body, with its particular forms and functions, as being 'obsolete.' However, importantly, he considers that to exist as an intelligent agent means to be both

[30] Tissue Culture and Art, *Pigs Wings Project,* http://www.tca.uwa.edu.au/pig/pig.html (accessed June 18, 2012)
[31] Tissue Culture and Art Project, *The Manifesto*, http://tcaproject.org/ (accessed June 30, 2012)
[32] Tissue Culture and Art Project, *The Manifesto*, (accessed June 30, 2012)
[33] Stelarc, *Ear on Arm: Engineering Internet Organ,* http://stelarc.org/?catID=20242 (accessed June 30, 2012)

embodied and embedded in the world. Therefore, Stelarc's aim is not to replace the body, but to extend it, creating 'alternate' interfaces between body and world. From robotic enhancements to visceral extensions, his skin has been stretched (*Suspensions* – 1976-2012) and his organs 'replicated, relocated and rewired for additional capabilities,' as witnessed in his ongoing *Extra Ear* project, which he initiated in 1997. [34,35] The aim of the *Extra Ear* project is to create an 'Internet organ for the body,' that is to say, 'an ear that not only hears but also transmits' wirelessly through the Internet. In 2006, I was fortunate to have the opportunity to photograph the surgical construction of the *Ear on Arm,* which took place in a private practice in Los Angeles. I selected images from this shoot to create the photographic installation *Oblique* (2008), which forms part of my PhD.

Initially, Stelarc planned for the *Extra Ear* to be constructed next to his real ear on the right side of his head. The decision to construct the ear on the left forearm was due to health concerns, as there was a risk of possible nerve damage at the original site. In relation to my research, the final placement of the *Extra Ear* on the forearm is what I find of most interest, historically the site features in Renaissance illustrations of anatomists 'at work' i.e. in the act of dissection.[36] In contemporary contexts the forearm may seem an innocuous location, but in the Renaissance it represented the

[34] Discussion with Stelarc, Melbourne, May 30, 2012.
[35] In addition, I attended the *Ear on Arm Performance* (2011) Lorne, Australia, and the *Ear on Arm Suspension* (2012), held at Scott Livesey gallery in Melbourne, Australia.
[36] The most famous example is the portrait of the anatomist Andreas Vesalius, in *De Humani Corporis Fabrica* (1543), in which he is seen holding a dissected cadaveric arm to display the flexor muscles of the forearm. In this portrait, as well as the frontispiece of *Fabrica*, Vesalius looks out from the image, seemingly to emphasise his dictum that the study of anatomy should combine visual observation and 'hands on' dissection. The frontispiece of *Fabrica,* though not displaying the flexor muscles, again shows Vesalius with his hand placed on the cadaver. It was an important visual statement that conveyed the epistemology behind Vesalius' anatomical method. Prior to Vesalius the common practice of teaching anatomy separated the anatomist from the cadaver, as the anatomist would stand at a raised lectern, reciting from the texts of Galen, while menial dissectionists cut up the body. Rembrandt's 'The Anatomy Lesson of Dr. Tulp.' provides another example of a Renaissance image that focuses on the forearm and the action of the flexor muscles.

site of human identity and intelligence. This understanding of the forearm is based on earlier Galenic and Aristotelian concepts of the flexor muscles as being the actuators of the *grasping* hand. The art historian Martin Kemp explains that,

> the mechanism of the hand was seen as perfectly designed for *apprehensio*, that is to say "grasping," and it is fitting that "apprehension" in Latin as in English came to assume the dual meaning of taking hold and becoming cognizant of new ideas.[37]

Inadvertently, Stelarc constructed the *Extra Ear* on an anatomical site historically associated with the grasping of 'new ideas' and with the defining of human identity. In addition, the site allows Stelarc to interact with his creation, thereby forming, to a certain extent, a McLuhanian *closed system* between body and technology, i.e. the *Ear on Arm* is a technological *other* that is an extension of the self, which ultimately fascinates the user.

[37] Martin Kemp, "The Handy Worke of the Incomprehensible Creator," Sherman, Claire Richter and Peter M Lukehart, ed. *Writing on Hands: Memory and Knowledge in Early Modern Europe* (Carlisle, PA: The Trout Gallery, 2000), 22.

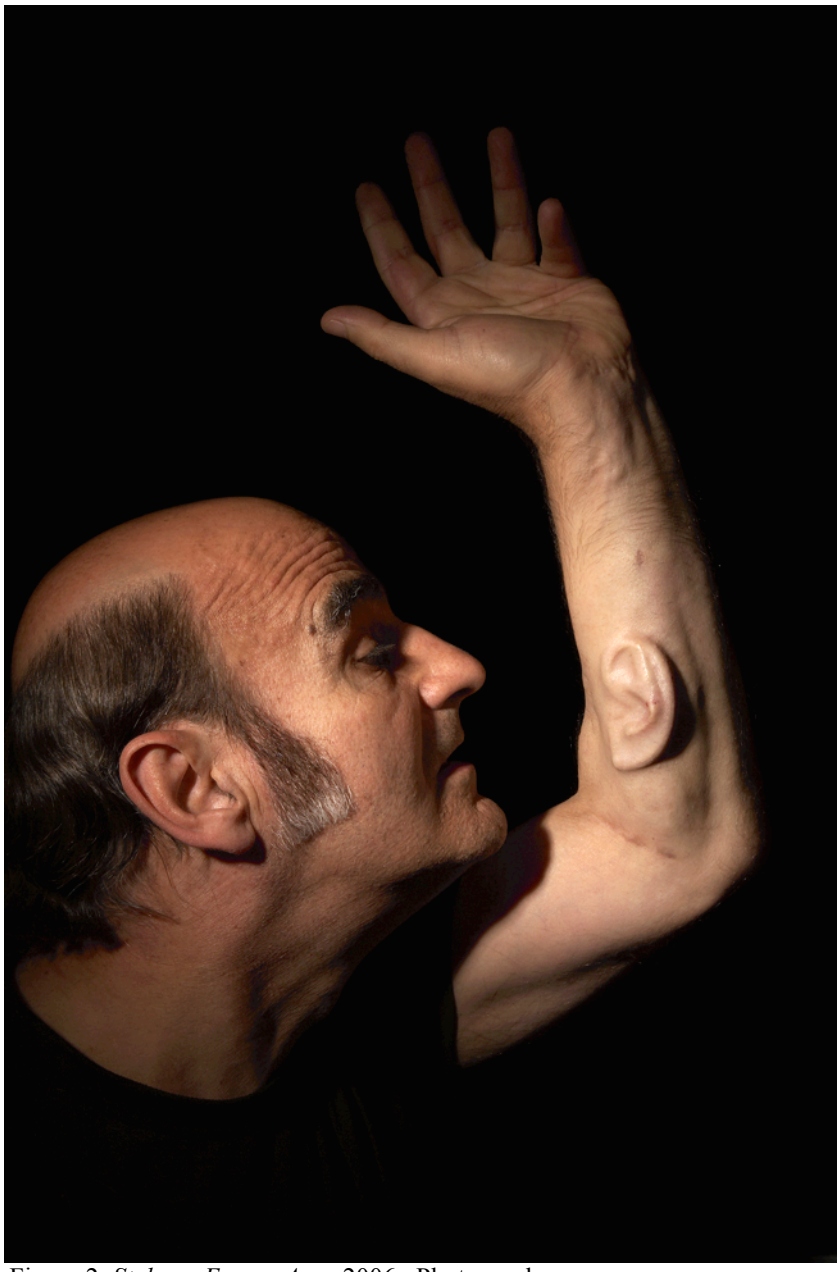

Figure 2. *Stelarc: Ear on Arm,* 2006. Photograph.

As witnessed in this discussion, the poetic visions of anatomy created by contemporary artists and designers are more likely to offer up (challenging) contestable anatomies rather than idealized images of immutable forms. However artists are not alone in their seeming departure from the perceived stability of the Renaissance ideal. There are also radical changes taking place in the sciences, which I argue originate from the changing status of the image.

Virtual Entities as Fleshy Realities: The Biomedical Construction of Living Human Organs Derived from Reconstructed Planar Images

Here, I want to provide a brief introduction to clinical imaging modalities. Importantly, modern forms of medical imaging, such as computer tomography (CT) and magnetic resonance imaging (MRI), do *not* originate from optical information; rather they are generated from data sets of Cartesian coordinates. The data sets represent parallel, sequential layers of the body, which can be digitally restacked and realigned to form virtual volumetric images. In this way the body becomes a set of mathematical points hosting an infinite number of possible images that can be digitally extracted and made accessible for viewing. The neuroscientist Richard Wingate states, 'computerised reconstruction produces a facsimile of material substance that can be rotated, re-rendered, paused or magnified,' offering up a multitude of ways to engage with these image-objects.[38]

In tribute to the Renaissance anatomist Andreas Vesalius, the open access software commonly used to reconstruct clinical imaging data is called *InVesalius.* Vesalius was the first anatomist to publish an anatomical atlas that incorporated perspectival illustrations, his text *De Humani Corporis Fabrica*, which was released in 1543, depicted anatomy as existing in a three-dimensional matrix. In addition *Fabrica* was the first anatomical atlas produced on a printing press, allowing multiple copies to be made and distributed en masse.[39] In comparison, the software *InVesalius* enables volumetric images of the body to be created, reproduced and circulated through the

[38] Marius Kwint and Richard Wingate, *Brains: The Mind as Matter* (London: Wellcome Trust, 2012), 27.
[39] Arguably, the illustrations in *Fabrica* were created by the studio of Titian. Historically, Titian's students, Jan Stephan von Calcar and Domenico Campagnola are cited as being the most likely illustrators of the text.

Internet. Yet, the images created by *InVesalius* have an additional capability, they can be exported to rapid prototyping machines for fabrication into solid objects.[40] Unlike perspectival images, which relate to one particular [vision based] point of view, volumetric images indicate coordinates, locatable points in Cartesian space, that can be transported virtually to a 3D printer to enable a facsimile of the original scanned object to be realized.

'RP machines work by simplifying complex 3D problems [such as the body] into a series of simpler 2D problems,' as 'thin, 2D "layers" are combined or "added" together to form complete 3D objects.'[41] Essentially, 'real virtuals' produce a solid reality from virtual imagery.[42] Here, the Renaissance concept of the ideal, which was visualized as latent within the real, can now be materialized thereby allowing intangible truths to become palpable realities. However, in the process, images appear to be given a liminal position, simultaneously existing as both image and object with the ability to shape-shift by design. Still, there is a far more seductive side to biomedicine's appropriation of industrial design technology, as *living* 'real virtuals' are being made. Here, anatomical images are being transitioned into functioning body parts through a process called *organ printing*.[43]

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[40] 'Biomodelling has been defined… as the process of using radiant energy to capture morphological data of a biological structure and the processing of such data by a computer to generate the code required to manufacture the structure by rapid prototyping apparatus.' Paul D'urso, "Real Virtuality: Beyond the Image," *Virtual Modeling and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping,* ed. Paulo Jorge Bártolo (Leiden: Taylor and Francis Group/Balkema, 2005), 29.

[41] Ian Gibson, "Rapid Prototyping: A Review," *Virtual Modeling and Rapid Manufacturing,* 7.

[42] D'urso, *Virtual Modeling and Rapid Manufacturing*, 29.

[43] My first introduction to organ printing was in 2005, when I attended the *Virtual Modelling and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping* conference in Leiria, Portugal.

'Organ printing is a computer-aided robotic layer-by-layer additive biofabrication of functional living human organs.'[44] Essentially, organ printing is a biomedical variant of rapid prototyping technology. A leading pioneer of organ printing, Vladamir Miranov, states that 'the best way to explain what organ printing is to compare it with book printing, which was invented by [Johannes] Gutenberg in Germany [c1439].'[45,46] Miranov continues,

> In order to print a book you must have text, paper, ink, printing press and moveable type. [Similarly], if you want to print a human organ you must have a blueprint of an organ, bio-paper or (bio-processable hydrogel), bio-ink (or self-assembly tissue spheroids), [and a] bio-printer (or robotic dispensable device cartridge [to] contain all these living materials). [From this, you can] print functional living human construct, no need for transplantation.[47]

Miranov's analogy between organ printing and the invention of the Gutenberg press is twofold, as it refers to modes of production as well as to the significance of bio-fabrication as an invention. The implication is that organ printing will create a paradigm shift similar to that initiated by the Gutenberg press, effectively altering the way we produce, disseminate, access, and enact anatomical knowledge. Here, the Renaissance concept of the *ideal* is presented as warm, wet and implantable, and technology enters the body through the production of soft printed organs.

Are we in a process of becoming the poetic productions of industrial design? The body considered as a complex '3D problem simplified into a series of 2D problems,' to

[44] Vladamir Miraonov, *Organ Biofabrication*, produced by etv South Carolina ETV Commission, 2010 http://www.youtube.com/watch?v=aS54Phnvk6M (accessed June 30, 2012)
[45] Miraonov, *Organ Biofabrication*, (accessed June 30, 2012)
[46] This is the same invention that enabled the printing of Vesalius' text Fabrica.
[47] Miraonov, *Organ Biofabrication*, (accessed June 30, 2012)

exist, in part, as a facsimile. Essentially, printed organs are laminar assemblages constructed from planar images, which are able to integrate with the body seamlessly, without the possibility of rejection, as they are made from the patient's own cells. Perhaps understood as *subtle cyborgs,* that are susceptible to paginated pathologies, these bodies could live with the promise of infinite life yet realized as an infinite life of conscious repair.

Subtle Cyborgs: And on the Importance of Being an Image

Biomedical science's use of industrial design technologies has enabled the production of hybridized bodies. These bodies are cyborgs, of sorts, however they go beyond the generally accepted definition of 'couplings between organism and machine', which are the typical figurations of the posthuman.[48] Indeed, there are no obvious additions to the body or visible inclusions of technology, as the cyborg of organ printing occurs at a cellular level, through the microscopic ordering of flesh.

The sociologist Catherine Waldby refers to the posthuman as making explicit our inextricability from technics.[49] In her book, *The Visible Human Project: Informatic Bodies and Posthuman Medicine,* Waldby states,

> The posthuman can at best be understood as a point of view or insight made available by the contingency of technics, its driven and ongoing nature, and the incalculability of its consequences. The possibility of the posthuman is not to do with the transcendence of the human, its

[48] Donna J. Haraway, *Simians, Cyborgs and Women* (London: Free Association Books, 1991), 150.
[49] Waldby, *The Visible Human Project,* 46.

> replacement, but rather with the recognition and exposure of the networks of production which constitute human techno-genesis.[50]

Waldby suggests, 'the entire anatomical project, so important to the figuration of "Man", could be read as posthuman.'[51] Remember that for Waldby the posthuman is not a figuration, but rather an effect. According to Waldby, the posthuman occurs when the appearance of a new technology creates a *slippage* that exposes the assumptions of a prevailing view. In this way the posthuman can be considered as a momentary insight into and disturbance of our prior understanding of what it means to be human. This effect in turn enables a reevaluation of our *being* in the world. To a certain extent I adopt Waldby's stance, however I apply a limit to the technologies under consideration. In my research the effect of the posthuman appears with each new technology specifically implemented in the scientific imaging of anatomy. Thereby, the posthuman can be thought of as a way of seeing that is mobilized and shared through the production of images.

Historically, I consider perspective as the original posthuman.[52] Perspective was the first optical technology to enable a naturalistic, though somewhat idealized, depiction of anatomy to be made and I believe that the most important example of perspective, in relation to the history of anatomy, is the *Trinity* fresco in the Santo Maria Novello church in Florence, painted by Masaccio (1401 - 1428) circa 1425.

Masacchio's *Trinity* fresco is said to contain the first naturalistic representation of a human skeleton, 'the Florentine artist display[ing] a sensitivity which would not be

[50] Waldby, *The Visible Human Project,* 45.
[51] Waldby, *The Visible Human Project,* 20.
[52] In the context of my research I use the term *perspective* to refer to *linear perspective.*

equaled in anatomical illustration for decades.'[53] The fifteenth century biographer Georgio Vasari describes Masacchio's paintings as 'living portraits', asserting that the figures in his work appear to be alive, as 'he constantly tried to create the most lifelike figures with a fine animation and a similarity to the real.'[54] However, it is important here to consider other qualities of the *Trinity* fresco which further strengthen the sense of the image being 'alive.' As the dimensions of the fresco and its treatment of space elicit a dynamic engagement with the viewer, also. The art historian Martin Kemp provides a description of the work that highlights the phenomenological experience of viewing the *Trinity* fresco insitu:

> The fresco immediately declares to the spectator that he or she is seeing a particular structure from a particular place, and that the painted space has a reality contemporaneous with ours—we are looking at it here and now, standing at this spot on the pavement of the church at an existential moment.[55]

Importantly, the *Trinity* was the first image to display perspective in a prominent public place. In addition it was the first image to depict a life-size representation of a spiritual realm as if existing in physical space. The fresco seemingly invites the viewer to navigate this virtual realm as though it were a real world scene. The horizon line of the of the 20 feet high *Trinity* fresco is intended to match the eye level of the average person. As you approach, the image resonates with the body as a whole. The architectural space depicted in the painting not only appears to recede beyond the

[53] Bernard Schultz, *Art and Anatomy in Renaissance Italy* (1982; repr., Ann Arbor, MI: UMI Research Press, 2011), 47.
[54] Georgio Vasari, *Lives of Artists.* 1560. Trans. by Julia Conaway Bondanella and Peter Bondanella. . (Middlesex, England: Penguin, 1965), 103.
[55] Martin Kemp, *Seen/Unseen: Art, Science, and Intuition from Leonardo to the Hubble Telescope* (Oxford: Oxford University Press, 2006), 21.

picture plane, allowing it to open into a spiritual realm, but also seemingly advances into the space of the room in which the viewer stands. In this way, the church wall acts as an interface between two realms, the illusory and the real. Yet, the materiality of the fresco is minimal, as it seamlessly elides with the surface of the wall, the image appearing isolated and unbounded by the architectural surrounds; it is a screen, of sorts. Arguably, Masaccio's *Trinity* fresco is a precursor to the immersive spatial experience of computer-based virtual reality.

The existential '*here and now,'* that Kemp described, is reinforced in the painting by a memento mori inscription – *What you are I once was. What I am you will become* – which appears above the skeleton laid out on a funerary slab.[56] The skeleton seems to reside in the same architectural space as the viewer as it advances in front of the picture plane. Combined with the imagery, the memento mori can appear to the twenty-first century viewer as a portent issued from the Renaissance. Though it speaks not of the imminence of death, but of the imminence of imaging. That is to say, in this moment, at this particular site, signals the origin of our *becoming* image; a process that has unfolded for over four hundred years, in which bodies are being displaced by simulacra. This idea is important in relation to uncovering our investment in the 'anatomical gaze.'

[56] Kemp, *Seen/Unseen,* 21.

PART II

HISTORICAL CONTEXT

The Narrative of Anatomy

The history of the study of human anatomy is often presented in the form of a narrative, with its main protagonists, who include philosophers, anatomists, artists and theologians, cast as either hindering or hastening its advancement. It has been suggested that such narratives have developed, in part, because 'anatomy eventually became so basic to the Western conception of the body that it assumed an aura of inevitability.'[1] The perceived inevitability of anatomy, as the composition of our bodily matter, now appears intrinsic to the Western idea of identity. However if anatomy is considered to represent a given natural state of the body this understanding can discourage the possibility of realizing anatomy as a construct. Importantly, when anatomy is considered as a construct then identity is not found innately residing in the fleshy structures of the body, but is revealed in the ways in which we visualize the essential messiness that lies beneath our skin. Historically, anatomical knowledge has been predominantly based on the idea of making visible the previously unseen, of bringing to light, so to speak, our interior structures. But anatomical knowledge is more than this, as it also entails the conditioning of the eye. That is to say, anatomy can be regarded as the systematic presentation of the body to an eye that is already receptive and primed for the anatomical experience; it is essentially a culturally trained way of seeing. In the discussion that follows I examine some of the arguments and theories that surround anatomy's contestable history, its crystallization into a way of visualizing the body and its modes of revealing the materiality of the human form. My intention is not only to provide historical grounding for my research, but also to

[1] Shigehisa Kuriyama, *The Expressiveness of the Body: and the Divergence of Greek and Chinese Medicine* (New York: Zone Books, 1999), 117.

problematize the epistemology of anatomy, thereby allowing me to search for possible omissions and assumptions that expose our investment in the anatomical gaze.

My particular interest with regard to anatomy lies in attempting to explore the role that light plays in the translation of flesh into image. At first this may not seem an insightful topic as it could be argued that light, in one form or another, pervades all areas of human interest because essentially it is the environment in which all thought and action take place: even darkness is defined by its deficiency of light. Therefore why consider light in relation to our perception and imaging of human anatomy as being uniquely significant? An answer to this question is precisely what I attempt to trace and unfold through my art practice and what I aim to explore in the written part of my research, by investigating the historical precedents that expose light's influence on the visualization of anatomy. My approach is to consider anatomy and light not as isolated scientific entities, but as being embedded in their shared history of relational use. What has been pivotal to my research is the way anatomical knowledge is enacted and conveyed. In contemplating the instruments that are used to view, record and construct the visual knowledge of the anatomical body, I consider them not in isolation, but rather in the context and history of their use. The choreography of observer and instrument in the act of observation thus becomes an important aspect of my research. I will build on this idea throughout the discussion that follows. Already, however, I want to signal the possibility that light forms an environment in which all thought and action take place. We could therefore hypothesize that there is something unique about 'light environments' used in the beholding of the anatomical body, where typically there is no natural light.

As a physical entity light has undergone numerous technological advancements in relation to the study of anatomy. It no longer only illuminates the body but also penetrates it, as frequencies from the extremes of the electromagnetic spectrum are used in the production of modern medical images, i.e. X-rays, computerized tomography (C.T.) and magnetic resonance imaging (MRI).[2] I argue that the various forms of light used in the scientific imaging of anatomy contribute to shaping the Western ideas of the body, identity and subjectivity. By examining historical examples of light's influence on the construction of anatomical knowledge, I aim to gain insight into the contemporary influence of technologized light, in particular into how it affects our understanding of what it means to be human.

But why is an artist such as myself delving into the science of anatomy? It could be argued that this connection is nothing new and that anatomy, since its emergence as a science in the sixteenth century, has been reliant on the ability of artists to realize anatomical constructs. For example, in the Renaissance woodcut block prints and engravings were not only used to illustrate anatomical knowledge but also to disseminate and assimilate the view into a broader social and cultural context. Anatomical knowledge also appears as a curious mix of the observed and the ideal; therefore its meaning is never fully located within the structures of the body. We could thus say that anatomical illustrations offer a more accurate representation of what constitutes anatomy, as they embody the convergence of these two key

[2] Jerry D.Wilson, Anthony J. Buffa and Bo Lou. *College Physics.* 8th ed. (Upper Saddle River, NJ: Pearson Prentice Hall, 2009), 679. 'The electromagnetic spectrum is continuous. An electromagnetic wave (light) consists of time-varying electric and magnetic fields that propagate at a speed of *c* (3.00 x 108 m/s) in a vacuum. The different types of electromagnetic radiation (such as UV, radio waves, and visible light) differ in frequency and wavelength.' My inclusion of MRI may break with conventional views of light however it does not break with the laws of physics, as the frequency of MRI exists at one extreme of this continuous spectrum.

elements of the anatomical method – the observed and the ideal.[3] It could also be said that anatomy is a topic that should not be, and in reality cannot be, insulated from cultural concerns, for if anatomy influences ideas of the body, identity and subjectivity, as I have suggested, it is important that it be held up for questioning in a cultural realm.

The methodology that I employ in my project involves restating and redirecting my research questions towards earlier epochs in order to allow me to examine historical precedents in the performance of anatomical practice. By exploring historical concepts of the anatomical body and examining the construction of selected anatomical images, I want to address the following question: what role does light play in the translation of flesh into image? The aim here is to identify how artists and anatomists from previous eras observed and recorded the relationship between light and anatomy, and whether they did so purposefully or incidentally. I then examine the impact of these images in the context of their era, with particular emphasis on their ideological influence with regard to the body, identity and subjectivity.

I analyze only a relatively small selection of theories, images and observational techniques that have been derived from a variety of historical periods. The limited selection, based largely on the poetic aptness to my artistic project, allows for a more detailed review than would be possible in a broader survey, which would burden the study with much that is artistically uninspiring. In addition the diversity enables me to outline and compare the defining visual paradigms of selected eras. The importance of the selected eras is that they represent key historical moments in the redefining of

[3] Both of the terms can be defined by the word *visualization*, which refers to making visible to the eye or alternatively to forming a mental image.

vision. I consider these particular changes to vision in terms of how they have facilitated our desire to gain anatomical mastery of the body. I use a number of images from each epoch that exemplify important changes in the way we think about anatomy. The discussion is anchored in three main points: the origin of anatomy in Ancient Greece and the modes of visualization related to the period; the emergence of anatomy as a science in sixteenth-century Italy and the role of perspective; and the imaging practices of early microscopy in seventeenth-century England, explored through a study of Robert's Hooke's text *Micrographia* (1665). My aim is to uncover, through a process of comparison, the slippages and meeting points between these historically diverse modes of anatomical imaging, thereby exposing the underpinnings of their epistemological origins and enabling a search for light's influence in their construction.

Since anatomy is a science, which is fundamentally based on visual observations, any perceived hindering or hastening of its advancement is usually linked to a given individual or epoch's ability to see clearly. The numerous texts that document the historical development of anatomy are replete with discoveries made through acuity of vision. All manner of tools, optical instruments and modes of visualization that have been accumulated and compounded throughout history, are held up and judged on their facilitation of sight. Equally, states of almost seeing, falsely seeing, as well as a complete failure to notice are what typically define unfortunate individuals and epochs who are deemed as the hinderers to anatomy's progress. But does development always mean progress? Or is it a way of foregrounding society's embracing of the technoscientific imaginary? Before addressing these questions I want to begin by exploring the origin of the discipline of anatomy.

Anatomy from Ancient Greece: Visualizing the ideal within the real

The desire for systematic medical knowledge about the internal structures of the body is said to have originated in Alexandria in the fourth century B.C.[4] Bruno Snell has noted that in Greek epistemology 'knowledge *(eidenai)* is the state of having seen' and that the Greek intellect was structured around notions of visualization.[5] William M. Ivins offers a theory in opposition to this, as he suggests that Greek culture is based on a tactile, rather than visual comprehension.[6] Placing this debate aside for now, it should be remembered that historically 'anatomy is an anomaly.'[7] The Ayuredic, Chinese, Mesopotamian and Egyptian traditions did not embrace the practice of cutting up and inspecting the interior structures of the dead to enhance their medical knowledge.[8] However, to the ancient Greeks *anatomy* literally meant *dissection* and it referred to the action of making the interior of the body visible, that is to say bringing it to light. Therefore, when Aristotle and Diocles of Carystus were conducting animal dissections in the fourth century B.C. 'it signified a method of research rather than a degree of knowledge.'[9] In addition, we can consider their individual treatises on anatomy as attesting to a 'state of having seen.' The idea of *not* having seen – and here I refer to the realm of the invisible, rather than the unnoticed – took on an interesting dimension at this time. A distinction was made between knowledge that

[4] Heinrich Von Staden, "The Discovery of the Body: Human Dissection and Its Cultural Contexts in Ancient Greece," *The Yale Journal of Biology and Medicine* 65 (1992): 223.
[5] Bruno Snell, *The Discovery of the Mind: The Greek Origins of European Thought,* trans. T. G. Rosenmeyer (Cambridge, MA: Harvard University Press, 1953), 146.
[6] William M. Ivins, *Art and Geometry: A Study in Space Intuitions* (Cambridge: Harvard University Press, 1946), 6. For an interesting discussion which debates Ivins' theory see Martin Jay, *Downcast Eyes: The Denigration of Vision in Twentieth-Century Vision* (California: University of California Press, 1993), 22, footnote 6.
[7] Kuriyama, *The Expressiveness of the Body,* 118.
[8] Roy Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity From Antiquity to the Present* (London: Harper Collins, 1997), 8; Kuriyama, *The Expressiveness of the Body,* 111; Plinio Prioreschi, *A History of Medicine: Greek Medicine* (1998; repr., Omaha, NE: Horatius Press, 2001), 554.
[9] Ludwig Edelstein, "The Development of Greek Anatomy," *Bulletin of the Institute of the History of Medicine* III, no. 4 (April 1935): 235.

was attainable to the human and to the divine, which equated to the visible and the invisible respectively. However the unknown, the state of being invisible, was presented as containing the possibility of change. For example the physician Alcmaeon contrasted the visible not with the invisible but with the 'not-yet-evident', while the philosopher Heraclitus conceptualized visible signs as symbols that offered humans a glimpse into the unseen.[10]

Similarly in Christian theology, St Augustine in fourth century A.D. considered the revelation of the internal structures of the body in terms of a divine transition from the invisible to the visible.[11] However, this was not a vision that earth-bound humans could experience, as it was only attainable on resurrection. St Augustine believed that when humans dwell in the eternal now of heaven they would be able to gaze upon the perfection of the body as a whole and seemingly transparent entity, whereby they could admire all of God's design.[12] Intestines, wombs and all manner of viscera would be made visible, freed from their earthly functions to exist eternally as perfect 'useless' forms.[13] Augustine stated,

> …we should find in the internal organs, which make no display of beauty, a rational loveliness so delightful as to be preferred to all that gives pleasure to the eyes in the outward form – preferred, that is, in the judgement of the mind, of which the eyes are instruments.[14]

However, St Augustine's admiration of the internal organs of the body should not be confused with a desire to anatomize. For St Augustine the human body in this

[10] Snell, *The Discovery of the Mind,* 146.
[11] Andrea Nightingale, *Once Out of Nature: Augustine on Time and The Body* (Chicago: The University of Chicago, 2011), 48.
[12] Nightingale, *Once Out of Nature,* 14.
[13] Nightingale, *Once Out of Nature,* 15.
[14] Augustine *De civitate Dei* 22.30, 22.24; Henry Bettenson, trans., *St Augustine, Concerning the City of God Against the Pagans* (Middlesex: Penguin books, 1976), 1073.

divine state was to remain in aesthetic unity, as a complete and intangible body. A belief that is antithetical to the practice of anatomy. Indeed, St Augustine thought of anatomists, who 'have ruthlessly applied themselves to the carving up of dead bodies', as 'having probed into all the secrets of the human body, with little regard to humanity.'[15] It is clear that Augustine's vision of the internal organs was not intended for the mortal or secular eye, and it was certainly not a sight to be verified by the probing of the hand (not least one holding a knife).[16] To see the internal structures of the body was divine; to have that knowledge confirmed with the touch of the hand was another thing altogether.

Anatomy could therefore be described as a way of seeing, an approach to the body, whether it is animal or human, where the materiality of the body itself is the topic. However this provides only a partial definition, as anatomy is also a balance between the actual, that which is present to hand, and the ideal. What seems crucial to defining the anatomical gaze is the question of where this ideal is seen to reside. At first sight St Augustine's pronouncements seem not so very different from Platonic philosophy, which locates true knowledge in the unchanging being of ideal forms.[17] Where 'the things which are always the same can be grasped only by the reason,' Plato's ideal forms however 'are invisible and not to be seen.'[18] Plato's view on the physical world is that it exists in continuous flux, and is to be understood only as

[15] Augustine *De civitate Dei* 22.24. See also Bernard Schultz, *Art and Anatomy in Renaissance Italy* (1982; repr., Michigan: UMI Research Press, 2011), 13.
[16] However this raises the problem of having divine bodies, which comprise forms freed from their earthly function, existing in heaven with eyes that remain instrumental i.e. as organs that seemingly retain their earthly function.
[17] Plato *The Republic* Book X. Plato's theory of ideal forms is introduced in *The Republic*, discussed in *Phaedo*, and *Parmenides*, and appears again in *Timaeus* and *Laws*.
[18] Plato *Phaedo* 79a; Kuriyama, 126. Kuriyama discusses Plato's theory of ideal forms, which he relates to the history of anatomy.

shadows and simulacra, which ultimately obscure the ideal.[19] Consequently 'for Plato visible creation offered but dim glimmerings of the Ideal.'[20] In Platonic thought however, unlike St Augustine's belief, there was no prerequisite of leaving the real world in order to obtain insight into the ideal. Plato believed the ideal was a concept to be located in the mind's eye and that it could neither be ascertained in the real world nor attained through the senses.[21] There is no record of Plato ever having dissected, which aligns with his compounded mistrust of seeking knowledge about a world, which he already considered to be illusory, through senses he deemed untrustworthy, especially that of vision.[22] St Augustine's heavenly view of the internal organs is similarly divorced from the materiality of the world, though in a different manner to that of Plato, as with Augustine both the perceiver and the perceived are no longer physically present. In addition, visual perception is instrumental to the construction of St Augustine's notion of ideal form whereas for Plato it is not, in fact for Plato sight is inimical to the discernment of ideals. Anatomy required a philosophy that could unite form with matter and that would somehow allow form to appear inherent in, but also latent to, the material world, as it were awaiting discovery through the astute (visual) observations of an inquiring individual. As noted, neither Platonic nor Augustinian thought would suffice. It is Aristotle's theories that proved integral to the discipline of anatomy.

Aristotle's philosophies best support a definition of the anatomical gaze, as he believed that the ideal could be found in nature and was perceivable to a corporeal

[19] Plato *The Republic* 514a-521b. Plato's allegory of the cave provides one, oft-cited, example in regard to his view on the physical world.
[20] Kuriyama, *The Expressiveness of the Body*, 126.
[21] Plato *Phaedo* 79a-d.
[22] Plato *Phaedo* 79c. See also Kuriyama, *The Expressiveness of the Body*, 126.

eye.[23] Aristotle considered that the task of the anatomist was to look beyond the immediacy and gore of the visceral dissection to perceive the immanent forms fundamental to the structure of the body.[24] There is also no record of Aristotle having ever performed human dissection, however in his text *Parts of Animals* he provided a way of seeing, an approach to the body, either animal or human, where the materiality of the body itself is the topic. Aristotle stated,

> …we ought not to hesitate nor to be abashed, but boldly to enter upon our researches concerning animals of every sort and kind, knowing that in not one of them is Nature or Beauty lacking. I add "Beauty," because in the works of Nature purpose and not accident is predominant: and the purpose or end for the sake of which those works have been constructed or formed has its place among what is beautiful. If, however, there is anyone who holds that the study of the animals is an unworthy pursuit, he ought to go further and hold the same opinion about the study of himself, for it is not possible without considerable disgust to look upon the blood, flesh, bones, blood-vessels, and suchlike parts of which the human body is constructed. In the same way, when the discussion turns upon any one of the parts or structures, we must not suppose that the lecturer is speaking of the material of them in itself and for its own sake; he is speaking of the whole conformation.[25]

The theorist Shigehisa Kuriyama suggests that our desire to anatomize the body existed long before the practice of dissection and that the tension created between form and matter is key to understanding the history of anatomy.[26] This oppositional balance played out not only in the perception of individual organs, the parts created through the process of anatomization, but also in the theories that guided the

[23] Aristotle *Parts of Animals* 644b.
[24] Aristotle *Parts of Animals* 645a; Kuriyama, *The Expressiveness of the Body*, 127. Kuriyama discusses Aristotle's philosophy and its importance in relation to the history of anatomy.
[25] Aristotle *Parts of Animals* 645b.
[26] Kuriyama, *The Expressiveness of the Body*, 127.

methods of dissection. In the physical anatomization of an individual corporeal body it was simultaneously perceived as the construction of an ideal body (of anatomical knowledge). It is perhaps the concept of ideal forms that also facilitated a belief that animals, once passed under the anatomical gaze, could be used to deduce knowledge about the human body. That is to say when anatomy as a way of seeing, as a search for the ideal, overrides the material body at hand, anatomical knowledge becomes abstracted and transposable and can be read onto differing bodies. The shift from animal to human anatomy has proven a critical and highly debated question amongst historians, particularly as human dissection was limited to only a relatively short period.[27] Herophilius of Chalcedon and Erasistratus of Ceos were the first to perform systematic dissections of human bodies in ancient Greece in third century B.C. After this period, the methodical dissection of cadavers would not take place again for another seventeen hundred years, when it reappeared as a scientific practice in Renaissance Italy.[28] The anatomist *Rufus of Ephesus* in first century A.D. reflected on the loss when he compared his practice of animal dissection to the past practices of human dissection. 'We shall try and teach you how to name the parts by dissecting an animal that most closely resembles man…. In the past they used to teach this more correctly on man.'[29]

It has been argued that for the ancient Greeks the urge to anatomize the body was predicated on an aesthetic appreciation of a 'well articulated body', a body that

[27] Von Staden, "The Discovery of the Body: Human Dissection and Its Cultural Contexts in Ancient Greece," 223. See also Kuriyama, *The Expressiveness of the Body*, 117; Ludwig Edelstein, "The History of Anatomy in Antiquity," in *Ancient Medicine*, eds. Owsei and C. Lilian Temkin (Baltimore: Johns Hopkins University Press, 1967), 292.
[28] Von Staden, "The Discovery of the Body: Human Dissection and Its Cultural Contexts in Ancient Greece", 223; Bernard, Schultz, *Art and Anatomy in Renaissance Italy* (1982; repr., Michigan: UMI Research Press, 2011), 1; Kuriyama, *The Expressiveness of the Body*, 122.
[29] Kuriyama, *The Expressiveness of the Body*, 122. The translation in Kuriyama is taken from Rufus of Ephesus, *De corporis humani partium appellationibus* 9, in: C. Daremberg and C. E. Ruelle, *Oeuvres de Rufus d'Ephése* (1879 repr., Amsterdam, Adolf M. Akkert), 134.

displays a clear demarcation of its parts, positioned in harmonious symmetry, with bone and muscle presented as the defining forms.[30] Kuriyama notes:

> Present intuitions about human muscularity owe much to the history of Western art... the musculature so crisply delineated in engravings, paintings, and sculptures mirrored a vision of the body in which what was seen from the outside was inseparable from what was imagined, anatomically, beneath the skin and obscuring fat.[31]

The idea of seeing 'beneath the skin', where skin is seen as a boundary between world and anatomy, is a common theme in the epistemology of dissection.[32] Considered in these terms skin becomes a veil over anatomy, and not as being anatomical in itself. In actuality skin is the largest organ of the body. We know it scientifically as fact, which is digested in theory, but the status of the skin as an organ is often lost in practice among our optical delvings and dissecting of the cadaver. Still today in university medical schools this notion of skin as the boundary or veil appears embedded in the process of dissection.[33] The contemporary practice of dissection involves removing the skin from embalmed cadavers, essentially flaying the body or limb, to then enable the careful tweezing out of the fat that intricately cushions every vessel, nerve, muscle and organ. The dissected parts of the donated bodies are tagged, stored and used for instruction for a certain number of years; however, on a designated date, the separate parts of a cadaver are gathered up, placed in a coffin, and returned for cremation. Skin and fat are not *parts* that are returned having long

[30] Kuriyama, *The Expressiveness of the Body*, *134-143.*
[31] Kuriyama, *The Expressiveness of the Body*, 112-115.
[32] Von Staden, "The Discovery of the Body: Human Dissection and Its Cultural Contexts in Ancient Greece", *The Yale Journal of Biology and Medicine* 65 (1992), 227-231. Von Staden provides a detailed discussion of skin, and the practice of cutting skin, within the culture of Ancient Greece; linking the practice to philosophy, religion, politics as well as the study of anatomy.
[33] The example I provide is from my own experience as I was employed for a year as a prosector (dissector of corpses for anatomical display) in a university medical school.

since been treated as bio-hazardous waste. Their liminal position meant that in the original dissection they were removed and discarded as the *formless* obscurers of anatomical knowledge. Seemingly, as divine forms, fat and skin just don't make the cut.

This discussion thus far has been about anatomy, without mention to its relationship to light. This is because my focus is on light and anatomy depicted in images, where light and the body are shown as physical rather than spiritual entities. And these images did not emerge until the Renaissance.

In the Theatre of the Renaissance: Cadavers, Candles and Chiaroscuro

In the Renaissance, Western culture's fascination with ideal form found expression through image. Perspective, invented by Florentine architect Filippo Brunelleschi (c.1425), provided a naturalistic pictorial space in which varied concepts of the ideal could be graphically realized.[34, 35] Here, ideal forms, from the earth-bound to the divine, could be shown harmoniously existing within a three-dimensional matrix. In relation to anatomy, perspective enabled the internal spaces of the body, and the organs they contain, to be realistically depicted in their respective spatial relations. To the Renaissance observer it would have seemed as though the body could be visually opened up and entered into with the eye, exclusively. However, it was not the rotting fleshy body of the visceral cadaver that was being presented, but the idealized body, willingly suspended in its display of perfect form. The apparent 'willingness' of the cadaver to undergo the act of dissection was a demonstration of the religious and philosophical notion of *Nosce te Ipsum* – Know Yourself. As perspective not only halted the process of bodily decay by providing a pictorial space for the body's naturalistic representation, it also allowed the Renaissance anatomist to meaningfully locate the body in a cultural context. Jonathan Sawday in his book *The Body Emblazoned: Dissection and the Human Body in Renaissance Culture* observed that,

> What the Renaissance anatomist strove to achieve in the dissection theatre was not "clinical detachment" but, instead, a form of cultural location. The

[34] Filippo Brunelleschi (1377-1446) was the first person to paint perspective compositions, however in 1435 the Florentine philosopher and architect Leon Battista Alberti (1404-1472) wrote the first treatise on linear perspective titled, *De Pictura (On Painting)*.

[35] For technical information about the construction of Brunelleschi's paintings, see Samuel Y. Edgerton, *The Mirror, the Window, and the Telescope: How Renaissance Linear Perspective Changed Our Vision of the Universe* (New York: Cornell University Press, 2009), 44-76; Martin Kemp, *The Science of Art: Optical themes in Western art from Brunelleschi to Seurat* (New Haven: Yale University Press, *1990), 11-15, 344-345.*

> body had to be "placed" within a nexus of complementary discourses, so that its full symbolic significance would be appreciated by those gathered to watch its progressive disintegration.[36]

To some extent, perspective achieved what the anatomist could only strive to obtain in the real world space of the anatomy theatre. Renaissance perspective provided a pictorial space that could bring form and matter together, where the divine and the physical could be seen to coexist and bodies appeared to reflect concepts of the ideal and the real. This meant that the anatomical body could be depicted as a liminal figure, with its materiality seemingly complying to both the sacred and the secular, thereby allowing it to be meaningful in, and to be accepted by, the two realms simultaneously. In this way, the illustrational narratives of perspective made it possible for anatomists, angels and cadavers to reside together in a cohesive space.

An emphasis on space as a physical, measurable quality has been a constant in the epistemology of anatomy since its inception as a science in the sixteenth century. In the Renaissance an inseparable alliance of body and space was formed. In the example of perspective, the key element, which proved so vital to the illustration of anatomy, was not the optical technology's ability to show objects three-dimensionally, but rather its capacity to depict objects as existing together in continuous relative space. A perspectival representation does not show simply a cluster of objects; instead it displays a coherent space, from a fixed viewpoint, with objects existing in it. This is an important distinction in relation to anatomy, because the relative positioning and size of the body's lumens, sinuses, cavities and orifices together with the correct positioning and size of the individual fleshy parts is essential to the naturalistic

[36] Jonathan Sawday, *The Body Emblazoned: Dissection and the Human Body in Renaissance Culture* (London: Routledge, 1995), 63.

portrayal of the internal structures of the human body. Therefore the gaps and recesses of the body can be thought of as being as integral to the study of anatomy as the organs. Jonathan Sawday asserts in his writings on the Renaissance culture of dissection, 'the study of anatomy *was* the study of the organization of space.'[37] Importantly, perspective not only embodied this concept; it also provided the method to visually disseminate this view.

In regard to architectural space, the anatomy theatres of the Renaissance were the first purpose-built spaces specifically dedicated to the study of anatomy. The design of the *Theatrum Anatomicum* manifested, and restated, the alliance of 'body and space.' By centrally positioning the dissector's slab at the base of a funnel-shaped auditorium, the anatomy theatre, which was encircled with multiple viewing galleries, created an intensely focused observational space for the staging of cadaveric dissection.[38] The structure 'permitted a maximum and evenly distributed visibility and emphasized the rationality of the relations of part to whole, both in the body itself and between body and space.[39] Combined with the contemporaneous invention of perspective these quantifiable spaces signaled a grounding of vision in a secular arena and positioned a seeing eye in relation to a physical world. John Berger in his oft-cited book *Ways of Seeing* provides a description of the seemingly 'ocularcentric' nature of perspective:

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[37] Sawday, *The Body Emblazoned,* 86.
[38] 'The word *theater*, as has often been remarked, shares the same root as the word *theory*, *theoria*, which meant to look at attentively, to behold.' Martin Jay, *Downcast Eyes: The Denigration of Vision in Twentieth-Century French Thought* (California: University of California Press, 1993), 23. For a history of the word, see David Michael Levin, *The Opening of Vision: Nihilism and the Postmodern Situation* (New York: Routledge, 1988), 99.
[39] Catherine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine.* (London: Routledge, 2000), 59.

> The convention of perspective, which is unique to European art and which was first established in the early Renaissance, centres everything on the eye of the beholder. It is like a beam from a lighthouse – only instead of light travelling outwards, appearances travel in. The conventions called those appearances *reality.* Perspective makes the single eye the centre of the visible world. Everything converges on the eye as to the vanishing point of infinity.[40]

Equally, it could be argued that perspective as a convention relies on our real world experience of touch, which is gained through our interaction with, and movement through, the actual concrete places we encounter in our daily life. For example you can never see more than three sides of a solid cube, this is true both in perspectival images and in reality, but we know a cube has six sides from tactile experience. As we turn a cube in space we observe a resolving sequence of views that coalesce into a dimensional object. The same can be said of our understanding of cubes on a larger scale, as we walk in and around architectural spaces. Therefore, by incorporating tactile memory, shapes in perspectival images can be perceived as tangible objects. Indeed, this act of visualization effectively animates the image, as we intuit the movements required to physically negotiate the virtual realm as though it were a real world scene. Arguably, the haptic vision offered by perspective complements the Renaissance study of anatomy.

The sixteenth century anatomist Andreas Vesalius, who is considered the founder of modern human anatomy, believed that anatomical knowledge should be heuristically gained through the practice of dissection.[41] Vesalius not only asserted that

[40] John Berger, *Ways of Seeing* (London: BBC, 1972), 16.
[41] Vesalius and his contemporaries who, in their urge to overturn Galenic authority, stressed the primacy of 'ocular evidence' in their explorations of the body. The important difference between their undertakings and those of classical authority, they continually claimed, was that, unlike Galen and those who followed Galen, they had *seen* the body with their own eyes.' Sawday, *The*

you should observe the anatomical body with your own eyes, but also that 'you yourselves should feel with your own hands, and trust them' in the study of anatomy.[42] Significantly, Vesalius' text De Humani Corporis Fabrica (1543) was the first anatomical atlas to use perspectival illustrations; in addition it was the first printed anatomical atlas.[43] Hence, Fabrica was a facsimile of an anatomical body – an incorruptible and reproducible archive – that *enacted* a way of seeing. Here, anatomical illustration was 'not so much the elucidation of a statement as a statement itself,' as the acquisition of anatomical knowledge entailed the conditioning of the eye.[44] Indeed, Vesalian anatomy can be regarded as the systematic 'hands-on' presentation of the body to an eye that is already receptive and primed for the anatomical experience; it is essentially a culturally trained way of seeing, and *Fabrica* facilitated, and disseminated, this view.

Similarly, Leonardo da Vinci invokes a palpable body when he describes his anatomical renderings of shoulder muscles drawn in perspective. '[M]y depiction of the human body will be shown to you as if you had a real man before you…as if you had the same member in your hand and went on turning it gradually until you had complete knowledge.'[45] The art historian Martin Kemp considers da Vinci,

> a supreme visualizer, a master manipulator of mental 'sculptur[e]', and almost everything he wrote was ultimately based on acts of observation and cerebral picturing. It is symptomatic of his visual imagination that he

Body Emblazoned, 26. In my research I do not refer to Galen, because my concern is not with the history of medicine as such, or the scientific 'accuracy' or 'inaccuracy' of anatomical images and texts. Rather I am interested in anatomy as a culturally defined way of seeing the body.

[42] Baldassar Heseler, *Andreas Vesalius' First Public Anatomy at Bologna, 1540: An Eyewitness Report by Baldassar Heseler*, ed and trans. by Ruben Eriksson (Uppsala and Stockholm: Alqvist and Wiksells, 1959), *292-293.*

[43] Arguably, the illustrations in *Fabrica* were created by the studio of Titian. Historically, Titian's students, Jan Stephan von Calcar and Domenico Campagnola are cited as being the most likely illustrators of the text.

[44] Erwin Panofsky, "Artist, Scientist, Genius: Notes on the 'Renaissance-Dämmerung,'" *The Renaissance: Six Essays*, ed. Wallace K. Ferguson et al., 121-182 (New York: Harper and Row, 1962), 146.

[45] Leonardo da Vinci, *The Muscles of the shoulder, arm and neck* (fol. 9v, p.95).

> could undertake three-dimensional geometry through a form of spatial and sculptural modelling in his mind. …If he could not 'see' it, he could not do it or, rather, did not consider it worth doing.[46]

However, exactly what was da Vinci *seeing* as he dissected by candlelight alone in his studio? Candlelight is a light of proximity that cannot extend far into the darkness. It is erratic, creates flickering shadows, and produces heat. All of which is inimical to the viewing and preservation of a rapidly decaying body.[47] In a notebook da Vinci emotively describes 'passing the night hours in the company of these corpses, quartered and flayed and horrible to behold.'[48] In part, I imagine the horror of his beholding being defined by the wavering quality of the light. Under candlelight a cadaver appears a twitching mass of indefinable contours, as flesh dissolves into shadow and subverts the anatomical gaze. However, da Vinci presents an unusual case study. Drawing on his previous detailed examinations of light in nature, da Vinci was not only able to visualize ideal forms, he could also conceive of an idealized light. This enabled him to look beyond the immediacy and gore of the visceral dissection to perceive the immanent forms fundamental to the structure of the body. Therefore his anatomical illustrations comprise 'acts of observation and cerebral picturing,' which do not reflect the horror he had expressed in words.

Vesalius also worked by candlelight, though in vastly different circumstances.[49] His dissections were public affairs, often with hundreds of people in attendance. A

[46] Martin Kemp, *Leonardo da Vinci: Experience, Experiment and Design.* London: V&A, 2006), 48.
[47] In the Renaissance, the decay of the body and the melting of the wax would have dictated the duration of the dissection.
[48] Leonardo, da Vinci, *The Notebooks*, ed. Irma A Richter (Oxford: OUP, 1980), 151.
[49] It should be noted that Vesalius was not an artist and did not create the illustrations in *Fabrica*, however he closely supervised the making of text.

sixteenth-century medical student, Baldassar Helser, recounts the mise en scène of one of Vesalius' candle-lit dissections:

> A table on which the subject was laid, was conveniently and well installed with four steps of benches in a circle, so that nearly 200 persons could see the anatomy…. [no one] was allowed to enter before the anatomists and after them, those who had paid 20 sol. More than 150 students were present and D. Curtuius, Erigius, and many other doctors, followers of Curtius. At last, D. Andreas Vesalius arrived, and many candles were lighted so we all should see.[50]

Importantly, Renaissance perspectival representations were the first images to show light acting as a physical, rather than as a spiritual, entity. Indeed, 'shadow, the absence of light, became one of the unique hallmarks of light in Renaissance art,' as 'from the fifteenth century onward, with few exceptions, light was something that flowed *on* rather than an essence that pierced *through.*'[51,52] Previously, light had been used to support the symbolic display of the 'philosophical and religious knowledge of the interior of the whole, or scripturally complete, individual.'[53] However, perspective allowed for the pictorial secularization of light. Whether as an artifact of the process or appearing by design, light, depicted in perspectival images, became an entity that appeared not only to 'flow on,' but also *reflect off* surfaces, thereby interconnecting objects in space through relative illumination.

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[50] Helser, *Andreas Vesalius' First Public Anatomy, 85.*
[51] Leonard Shlain, *Art & Physics: Parallel Visions in Space, Time, and Light.* 1991. (repr., New York: Harper Perennial, 2007), 55.
[52] An example of light depicted as an 'essence that pierced *through'* the [anatomical] body is seen in the first illustrated anatomy book *Commentaria super anatomia Mundini* (1522) by Jacopo Berengarius da Carpi. (The book is based on an earlier unillustrated text *Anathomia corporis humani*, written in 1316 by Mundinus [Mondiono de Luzzi].) The woodcut print depicts an anatomical body emanating shards of luminosity, creating an aureole light.
[53] Sawday, *The Body Emblazoned*, 118.

In reality, a directly lit object reflects light. This *reflected light*, though diminished in intensity, enters the form shadows on nearby objects.[54] In effect, *reflected light* is the conveyance of [visual] information from one surface onto another surface through the transmission of light. To put in other words, the luminous glow of a form shadow, created by *reflected light,* reveals, to some extent, the colour and surface quality of the original object, as well as its proximity.

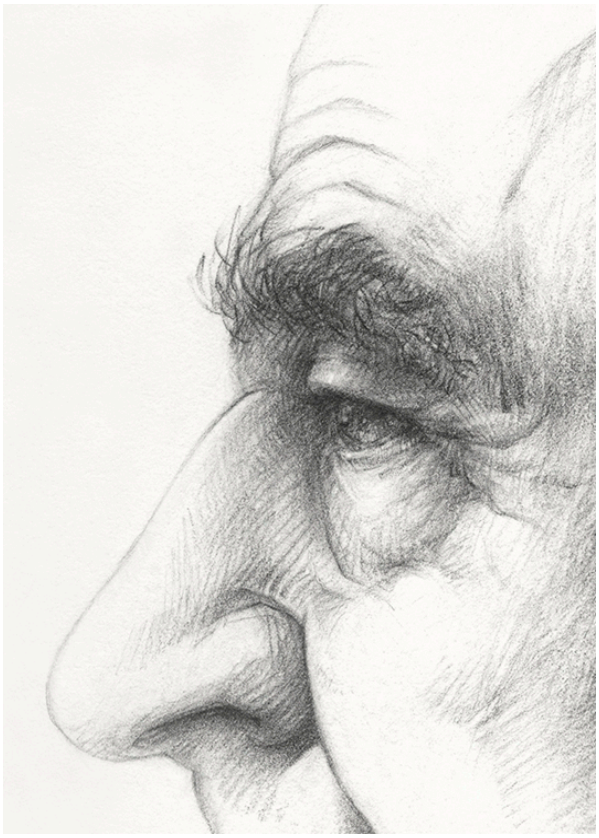

Figure 3. *Stelarc*, (detail) 2010. Pencil drawing.

Light rendered in perspective is a graphic abstraction. In traditional perspectival drawing line-work is used to convey either the fall of light across forms, or, alternatively, to reveal the plasticity of forms. In the former, shadows are blocked-in with parallel lines that are angled perpendicular to the direction of the light. In this way, chiaroscuro carves out the simple masses of rendered forms.[55] For instance, in a portrait, light can be used to show the side and front planes of the human head, see figure 2. However, when light is used to reveal the detailed plasticity of forms, the

[54] Leonardo da Vinci was the first artist to document the qualities of reflected light.
[55] 'Chiaroscuro (lt. 'light-dark') In painting, the technique of modelling form by almost imperceptible gradations of light and dark. Its invention is generally associated with the career of Leonardo da Vinci.' Edward Lucie-Smith, *Dictionary of Art Terms* (London: Thames & Hudson, 2003), 53.

line-work follows the surface contour of the form, see figure 1. Importantly, if the path of light is perceived as broken or illogical in an image, the illusion of plasticity and dimension collapses. A general rule that can be followed in relation to form shadows is that *all information exists in the half-light*. By this I mean, that all the information about the object itself, that is to say, the shape of the form and the texture of its surface, are revealed at the edge of a form shadow, where the form turns from the shadow into the light. Again, this information relates to the sense of touch, as texture is a tactile quality.

This discussion has presented the study of anatomy as being founded on the ability to confirm visual knowledge with the touch of one's hand, with this understanding being the premise for perspective. However, the invention of microscopy in the seventeenth century would challenge this understanding of anatomy and undermine perspective as a way of seeing. In perspectival images 'representation was a physical, tangible act of illustrationally taking empirica in one's arms'; however, 'with the popularization of microscopy … touch dropped out of our visive experience of the world.'[56]

[56] Barbara Maria Stafford, *Body Criticism: Imaging the Unseen in Enlightenment Art And Medicine* (Cambridge, MA: MIT Press, 1993), *36.*

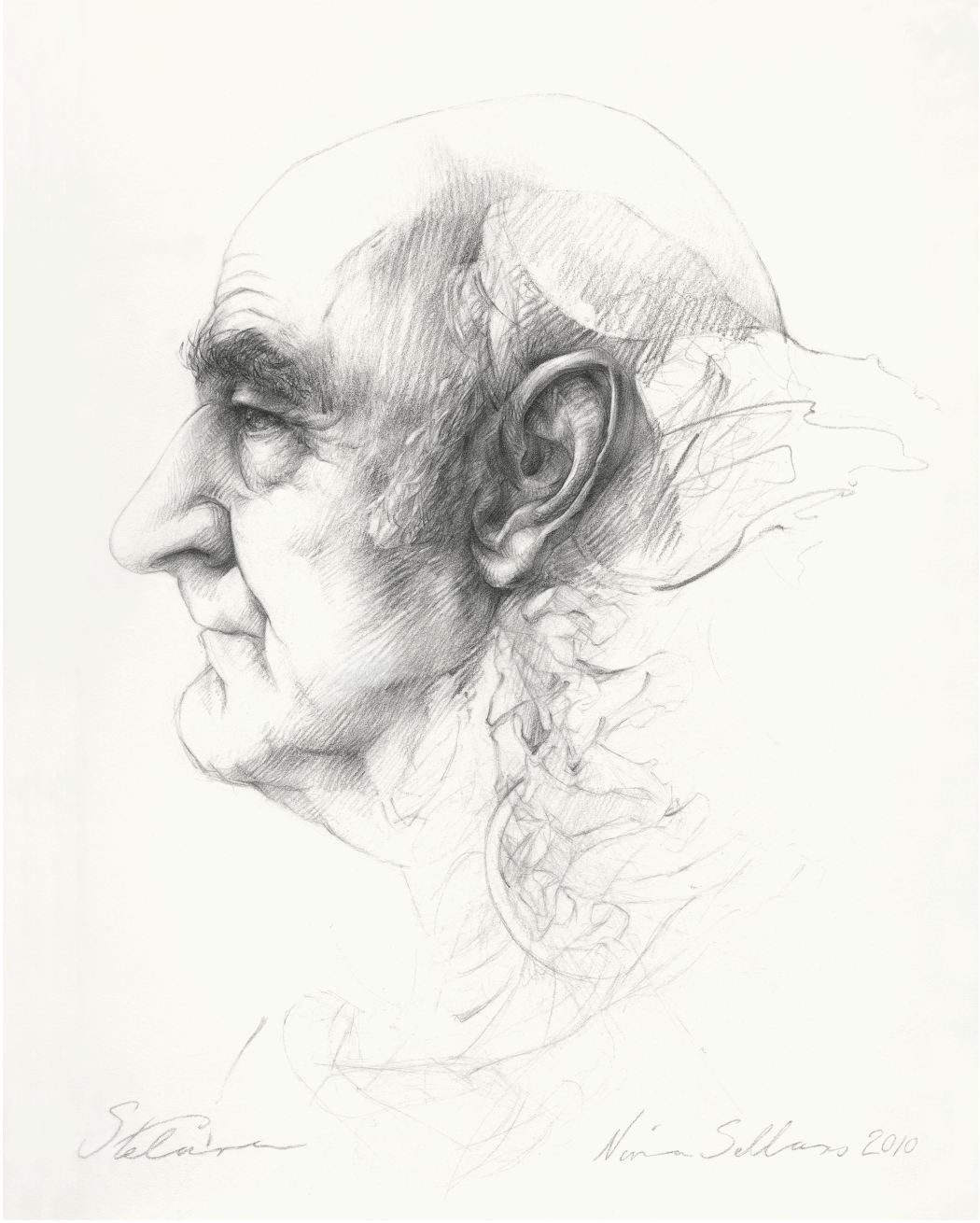

Figure 4. *Stelarc*, 2010. Pencil drawing. Dimensions: 45cm x 35cm.

Robert Hooke's Micrographia: A Guide to Navigating the Almost Invisible World of Seventeenth-century Microscopy

The contemporary anatomical body seems to be increasingly considered as a *small place* constructed of *magnified visions.* The body is thus seen as constituted by a multitude of cells forming miniature interlacing architectures, which can host numerous microorganisms, both good and bad. In part this vision can be said to originate from the invention of the microscope, with its ability to extend our visual perception into these previously invisible corporeal structures. Here I want to place aside the debates and circumstances that surround its invention to emphasize instead microscopy's influence on our perception and understanding of anatomy, as microscopy has not only allowed us to see more but also to see differently. This is an important issue for a body that is so strongly defined by the processes used to behold it. As anatomy now appears intrinsic to the Western conceptualizations of the body, any shift in its visualization also must challenge our ideas of identity and subjectivity. In what follows I want to explore this idea of *seeing differently,* by examining a period in the early history of microscopy illustration, when microscopic vision was first observed and recorded by a viewer whose understanding of the visual world was predominantly shaped and defined by perspective.

In this section I propose to investigate the popularization of microscopy that occurred in seventeenth century England by drawing on Robert Hooke's publication *Micrographia: or some Physiological Descriptions of Minute Bodies made by Magnifying Glasses with Observations and Inquiries thereupon (1665)* as my primary example.

Hooke was an artist and natural philosopher.[57] His book *Micrographia* was an instant best seller and is considered one of the most important texts from early microscopy. My aim here is to explore the ways in which Hooke adapted to this new way of seeing and how he related the latter to the existing visual framework of perspective. Simply described, microscopes magnify the appearance of small objects. However in the example of Hooke, I want to suggest that perhaps it is more interesting to question the set of actions that were required in the making of his magnified visions. In taking this approach what appears of particular significance is the choreography of observer and instrument in the act of observation.

Hooke's experience of microscopic vision can be thought of as fundamentally altering his engagement with the world. In this way microscopy is considered as not only modifying sight, but also impacting on the body as a whole. I explore this theory through an investigation of Hooke's making of *Micrographia,* and expand on the idea to connect it to Hooke's invention of a wearable camera obscura. I conceptualize Hooke's camera obscura as an extension and amplification of his phenomenological experience of microscopy, and as a somewhat logical sequel to being immersed in the microscopic view. The premise of my argument is as follows: microscopy can be said to have reconfigured the intuitive understanding of space, removing touch from the process of vision and, most importantly with regard to the study of anatomy, separating form from matter.

It can be said that to study a particular *thing* as isolated and objectified is to adopt a traditional scientific approach to a subject. Through a process of systematic observation, documentation and archiving, the data collected about a *thing* can be

[57] Natural philosopher is the precursor term for scientist.

assembled into a body of knowledge. Embedded in this method is the expectation that there is an inner world of an observer which is separate from an outer world to be observed, that is to say, the role of the observer is to be a detached subject who acts as the rational witness. This methodology is reliant on a demarcation of disparate spaces, aimed at defining a '*there* to my *here'*. In microscopy a slippage nevertheless occurs, as notions of interior, exterior, depth and orientation become harder to determine and maintain. This phenomenon can be considered to be not only inherent to the observed object and to the technology of the microscope, but also to the viewer's perceptual immersion in a magnified vision. As the world, which we experience in both spatial and temporal terms, is radically disrupted in the microscopic view, visual leaps are made from one scale to another that effectively suspend our sense of continuity, and destabilize our concept of location. In Hooke's era this sense of destabilization related equally to the microscope and to the telescope, as these contemporaneous inventions provided the possibility of being able to look into the microcosm and the macrocosm respectively, with both technologies influencing the spatial perception of the observer. In the following passage from *Micrographia* Hooke compares the vision supplied by these two instruments, where he imagines the removal of all distance through the use of optical glasses so as to unite heaven and earth:

> there were to be hoped a perfection of *Dioptricks,* and a transmigration into heaven, even whil'st we remain here upon earth in the flesh, and a descending or penetrating into the center and innermost recesses of the earth, and all earthly bodies; nay, it would open not onely a cranney, but a large window (as I may so speak) into the Shop of Nature, whereby we might be enabled to see both the tools and operators, and the very manner of the operation it self of Nature; this, could it be effected, would as farr surpass all other kind of perspectives as the vast extent of Heaven does the small point of the Earth, which distance it would immediately remove, and unite them, as 'twere, into one, at least, that there should

> appear no more distance between them then the length of the Tube, into the ends of which these Glasses should be inserted. [58]

To understand the impact of microscopic vision more fully it is useful to compare it to perspective. In many ways microscopic vision and perspective appear to be juxtaposed, with the traits of one exposing the qualities of the other. In contrasting microscopy and perspective what becomes most apparent is their respective treatment of space. The Renaissance invention of perspective allowed for the plastic illustration of anatomy and enabled the body to be depicted as existing within a three-dimensional matrix. In the Renaissance 'the study of anatomy *was* the study of the organization of space'.[59] Perspective not only embodied this concept; it also provided the method to visually disseminate this view. However, the idea of anatomy as residing in a rational coherent space is challenged with the advent of microscopy, as the microscope provides an immersive and seemingly irrational vision that appears to exist without any spatial markers. But how could a particular understanding of space, which had been so central to defining anatomy, now be seemingly dislocated and removed from its methodology? And what happened to that other key element that was said to underlie the study of all human anatomy – the tension between form and matter? [60] Did this also collapse in the microscopic extension of vision?

Renaissance perspective provided a pictorial space that could bring form and matter together, where the divine and the physical could be seen to coexist and bodies appeared to reflect concepts of the ideal and the real. This meant that the anatomical

[58] Robert Hooke, *Micrographia: or some Physiological Descriptions of Minute Bodies made by Magnifying Glasses with Observations and Inquiries thereupon* (London: The Council of the Royal Society of London, 1665), 177.
[59] Sawday, *The Body Emblazoned,* 86.
[60] Kuriyama, *The Expressiveness of the Body,* 124-128.

body could be depicted as a liminal figure, with its materiality seemingly complying to both the sacred and the secular, thereby allowing it to be meaningful in, and to be accepted by, the two realms simultaneously. This quality was essential for the Renaissance study of anatomy, as anatomists were embracing Humanist ideals but at the same time they did not want to defy the prevailing religious dogma of Christianity. If the study of anatomy was to continue and to remain significant, it needed to become assimilated with the cultural and religious views of the era. That is not to say it was a cynical move on the part of the dissectionists to somehow 'slip the anatomical body past the clergy unawares', for they too considered their task to be that of revealing God's design.[61] Anatomists were embedded in a process of synthesizing these two worlds, and perspective provided a space where these ideas could be visualized and played out. Perspective allowed for religion and the study of anatomy to be brought together and set within a cultural context, with the two domains not being seen as mutually exclusive or separated from society. However this alliance underwent a change in the seventeenth century with the emergence of microscopy, as the latter technique not only offered a new way of seeing but also disrupted the previous understanding of space. Microscopy's optical compression of space appeared to have the effect of emptying it of its cultural and religious resonances. The possibilities offered by the previous illustrational narratives for anatomists, angels and cadavers to reside together in a cohesive space were not part of the imagery facilitated by microscopy. For the seventeenth-century microscopist the enlargement of vision created a reverence for small things, with God now being sought in the details of His design.

[61] Sawday, *The Body Emblazoned, 105-110.*

Most importantly, in comparison to perspective, microscopy removed touch from the process of vision. In perspectival images 'representation was a physical, tangible act of illustrationally taking empirica in one's arms'; however, 'with the popularization of microscopy … touch dropped out of our visive experience of the world.'[62] I suggest that this occurred not only because of the intangible size of the specimens, but also as a result of the optical separation of form from matter. This phenomenon transpired because the optics of the compound microscope transformed the object under observation into a state of a virtual specimen, as in the process of increasing magnification. When something is being viewed through sets of multiple lenses, what is actually being observed is a virtual image, which exists *between* the lenses. The process of compounding lenses essentially makes an image into an object, that is to say, the *look* of the specimen (comprising volumes without mass) supplants its referent and becomes the *thing* under observation. This is where the division of space and the certainty of location, as well as our notion of the real, start to become problematized in relation to scientific methodology.

In his writings on art and geometry William Ivins provides an interesting theory in regard to vision and our intuitive understanding of space. He states that 'the eye has a point of view' and 'sees "there" where it is not'. He argues the 'result is that visually things are not located in an independently existing space, but that space, rather, is a quality or relationship of things and has no existence without them'.[63] But what happens to the quality of space when 'there' is to be defined by a virtual object? And, further, what happens when an exact 'there' appears to exist simultaneously in two separate locations? We accept logically that this is the case in microscopy, but this

[62] Stafford, *Body Criticism, 36.*
[63] Ivins, *Art and Geometry,* 5.

acceptance is accompanied by the realization that the two 'theres', so to speak, look nothing alike. In the example of Hooke we have to say '*almost* nothing alike, as the low magnification of his microscope only allowed him to view the familiar as enlarged and intricately detailed. Therefore for Hooke this virtual object, the parasitic image, is unable to become completely separated visually from its host specimen, as it is still recognizable and appears somewhat related. This process must have frustrated Hooke's logic of space as well as his understanding of sight, resulting in Hooke himself becoming a liminal figure caught between two very different ways of seeing. In part this is why I find Hooke of interest for this project, as he is positioned on a threshold, effectively opening up a space of visual and conceptual uncertainty which can be questioned and explored. In relation to my research, however, Hooke also presents a potential problem: essentially *Micrographia* is celebrated for its images of insects and plants and for its study of optics yet it does not directly relate to the central topic of my research, which is the study of human anatomy.

Indeed, *Micrographia* does not contain any images of human anatomy and Hooke is not generally considered an anatomist. However, the moment that he represents is of great consequence for my project because, as previously explained, the aim of my arts practice is to explore some of the ways in which light impacts our negotiations and imaginings of the human anatomical body. I consider light as the architect of anatomy's exposure influencing our perception of these structures. From this statement it becomes apparent that I position light as an active instigator rather than just a passive illuminator of anatomical knowledge. In my investigation I look at light not only in relation to perception, but also in relation to the optical technologies used in the visualization of anatomy. In part my fascination with Hooke is that he appears to embody a vision on the precipice of change; transitioning from a

perspectively framed viewpoint inherited from the Renaissance to the disorientating immersion of the microscopic view. Both of these optical instruments – perspective and microscopy – offer a distinct mode of visualization, which I argue is defined by their individual technological configuring of light. The fact that the structures depicted in *Micrographia* are not human is counterbalanced by the insight the book provides into a particular way of seeing, as *Micrographia* presents a microscopic view embedded into a perspectival construct, which I conceptualize as a hybridization of vision.

As stated previously, I consider anatomy and light not as isolated scientific entities, but rather as being embedded in their shared history of relational use. Therefore what is crucial to my research is the exploration of ways in which anatomical knowledge is enacted and conveyed. My interest is therefore not in *things* as such, but rather in our relation to things. It is for this reason that the choreography of observer and instrument in the act of observation is an important element in my research. In this way I consider *Micrographia* not only as a seventeenth-century document that visually details microscopic specimens, but also as testament to the phenomenological engagement that was incited by the microscopic view. Hooke's text relates to one of the central ideas that I put forward in my thesis: namely that light-directing technologies create and delineate a task envelope, which the observer operates within. As previously noted, the term *task envelope* is usually associated with the instructional specifications of robotic machinery; it delineates the area covered by a piece of equipment when it is in use and determines an envelope of operational space. I argue that the task envelope of a light-based technology defines a perceptible limit to both the observer's action and understanding by determining *what* they see and by instigating *how* they see it. The term also implies that the impact of light extends far beyond just that of sight. The development of technologies such as Hooke's compound

microscope, which have allowed for the magnification of sight and intensification of light, enable us not only to see more but also to see differently. What is significant in the example of Hooke is that he was a drawer and a visual communicator of great skill who was able to convey in images his own personal experience of seeing differently. He then circulated this vision through his publication of *Micrographia*; printed in London in 1665. It is arguably the first illustrated book on microscopy.

Micrographia introduced microscopic vision to seventeenth-century England, thereby exposing the culture of the day to an extraordinary new concept of sight that effectively disrupted both the prevailing sensibility of scale and the intuitive understanding of space. In relation to my work *Micrographia* provides an opportunity to explore an early attempt at hybridizing two modes of visualisation, those of perspective and microscopy. The distancing provided by history provides a certain amount of objectivity. This in effect allows *Micrographia* to be reflected on in relation to its impact on both the scientific and cultural perceptions of the era. In addition, any implications that this early example of a hybrid vision has on contemporary imaging of the body can also be sought. To introduce *Micrographia* I use the subject of one of the book's most well known illustrations, as I consider the flea that Hooke drew as representing a nexus of concerns. The insect can be thought of as playing host to both images and bacteria and providing a narrative that highlights the future importance of microscopy. *Micrographia* was published in 1665 during the Great Plague of London. Although fleas were the carriers of the plague-causing Yersinia pestis bacterium, this discovery would not be made until the late nineteenth-century, when microscopy would be used as a diagnostic tool. For now, in the context of Hooke's era, the microscope offered a way of revealing God's design in the structures of little things such as fleas, offering up a wondrous new vision of the divinely created universe. In his

description of the flea, Hooke begins by admiring the Creator's purposeful design of its parts, but then turns to focus on the flea's beauty:

> But, as for the beauty of it, the *Microscope* manifests it to be all over adorn'd with a curiously polish'd suit of *sable* Armour, neatly jointed, and beset with multitudes of sharp pinns, shap'd almost like Porcupine's Quills, or bright conical Steel-bodkins; the head is on either side beautify'd with a quick and round black eye K, behind each of which also appears a small cavity, L, in which he seems to move to and fro a certain thin film beset with many small transparent hairs, which probably may be his ears; in the forepart of his head, between the two fore-leggs, he has two small long jointed feelers, or rather smellers, MM, which have four joints, and are hairy, like those of several other creatures; between these, it has a small *proboscis,* or *probe,* NNO, that seems to consist of a tube NN, and a tongue or sucker O, which I have perceiv'd him to slip in and out. Besides these, it has also two chaps or biters PP, which are somewhat like those of an Ant, but I could not perceive them tooth'd; these were shap'd very like the blades of a pair of round top'd Scizers, and were opened and shut just after the same manner; with these Instruments does this little busie Creature bite and pierce the skin, and suck out the blood of an Animal, leaving the skin inflamed with a small round red spot. These parts are very difficult to be discovered, because, for the most part, they lye covered between the fore-legs. There are many other particulars, which, being more obvious, and affording no great matter of information, I shall pass by, and refer the Reader to the Figure.[64]

Hooke custom-designed his microscope; it is made clear in *Micrographia* that he understood optics well. As an informed observer who intended to actualize his vision into images, he had the quandary of conceptualizing this virtual flea, this parasitic image-object, as somehow existing in a perspectival framework. Perhaps if he had not trained as an artist, or if he had been ignorant of the physics behind this vision, the impact would not have been the same. In addition Hooke believed that

[64] Hooke, *Micrographia*, 162.

> true Philosophy … is to begin with the Hands and Eyes, and to proceed on through the Memory, to be continued by the Reason; nor is it to stop there, but to come about to the Hands and Eyes again, and so, by a continual passage round from one Faculty to another, it is to be maintained in life and strength[65]

Therefore it can be imagined that for Hooke the separation of touch from vision, and form from matter, would not have been unproblematic. I see the images in *Micrographia* as suggestive of this being the case. When Hooke translates his microscopic view into his drawings, a kind of transition takes place, as he effectively solidifies the virtual forms through the process of perspective, thus making the intangible appear tangible and within reach.

The illustrations in *Micrographia* present a bewildering view that fuses perspective, which is generally conceived as providing a window onto the visible world, together with microscopic visions that effectively seduce the reader into a previously hidden, and almost invisible, world. I say 'almost invisible', as the 50x lens magnification that Hooke used only allowed him to see 'unfamiliar surface detail on familiar objects'.[66] This is far less magnification than, for example, Alexandre Yersin required in 1894 to observe, and identify, his namesake plague-causing bacterium – the same bacterium that had previously torn through London completely unseen, and unknown, in Hooke's era. However that is not to say that to 'see' is to recognize: things are never that simple. Hooke would have required a framework of knowledge, which was not yet in place, to be able to comprehend the diagnostic significance of this vision. In contrast Yersin pursued a vision that would match a working hypothesis,

[65] Hooke, *Micrographia,* 7.
[66] Stephen Inwood, *The Man Who Knew Too Much: The Strange and Inventive Life of Robert Hooke 1635-1703* (London: MacMillan, 2002), 67.

where *looking for something* became the prerequisite to *seeing it*. For Hooke seeing was an experience in itself.

Micrographia therefore presents one of the rare occasions in scientific history where the scientist is also an artist, with a single adept observer producing both the text and images. Hooke provides the readers of *Micrographia* with a first-hand visual record of his impressions. This is an important point not only in relation to my own research but also to early microscopy in general, as the "subject matter and methodology, after all, excluded all witnesses save the sole observer at the eyepiece; illustrations had to take the place of viva voce testimony."[67] In a presentation he gave to the Royal Society 1694, Hooke stated, "tho' a Description in Words may give us some imperfect Conception, and Idea, of the Thing so describ'd; yet no Description, by words, can give us so full a Representation of the true Form of the Thing describ'd, as a Draught, or Delineation of the same upon paper."[68] In this statement Hooke's use of the term 'true form' appears to reflect the search for the observed *real* and conceptualized *ideal* that also underlie anatomical illustration. In an example from *Micrographia* Hooke describes the difficult task of locating 'true form' in microscopic specimens,

> because of these kind of Objects there is much more difficulty to discover the true shape, then of those visible to the naked eye, the same Object seeming quite differing, in one position to the Light, from what it really is, and may be discover'd in another. And therefore I never began to make

[67] William Ashworth, Jr., "The Scientific Revolution: The Problem of Visual Authority" (paper presented at the Conference on Critical Problems and Research Frontiers in History of Science and History of Technology, Madison, WI, 30 0ct.-3 Nov. 1991).
[68] Robert Hooke, "An Instrument of Use to take the Draught, or Picture of any Thing. Communicated by Dr. Hook (sic) to the Royal Society Dec. 19, 1694," *Philosophical Experiments and Observations of the late Eminent Dr. Hooke*, ed. W. Derham (London: Royal Society, 1726), 293.

> any draught before by many examinations in several lights, and in several positions to those lights, I had discover'd the true form.'[69]

In the preceding statement it is never quite clear whether the 'true form' that Hooke seeks is an amalgamation, generalization or underlying divine structure. However, when he states that it is much easier to discern the true shape of objects that are 'visible to the naked eye', I suggest that his conceptualization of visibility relates to tangibility and to being able to confirm visual knowledge with the touch of one's hand. This is our quotidian experience of vision and it is precisely this understanding of sight that provides the foundation for perspective. Indeed, perspective relies on our prior tactile engagement with, and movement through, the real world. The images in *Micrographia* that Hooke created while using his low magnification compound microscope can therefore be thought of as residing not only on the margin of the visible and the invisible but also on the margin of the tangible and the intangible. This is partly where Hooke's frustration highlighted above comes from, I suggest.

In another, more specific, example of Hooke's search for 'true form' he considers the eye of a fly, which he has studied in detail:

> The Eyes of a Fly in one kind of light appear almost like a Lattice, drill'd through with abundance of small holes; which probably may be the Reason, why the Ingenious Dr. Power seems to suppose them such. In the Sunshine they look like a Surface cover'd with golden Nails; in another posture, like a Surface cover'd with Pyramids; in another with Cones; and in other postures of quite other shapes; but that which exhibits the best, is

[69] Hooke, *Micrographia*, 17.

> the Light collected on the Object, by those means I have already describ'd.[70]

The light Hooke is referring to, 'which exhibits the best', is of his own invention. Not only did Hooke custom-design his compound microscope to improve the quality of the magnification, he also designed an illumination system to intensify the light for viewing specimens. In Hooke's description of the invention he states,

> to procure and cast a sufficient quantity of light on an Object in the night, I thought of, and often used this, Expedient… using a piece of convex glass and a large Globe of Glass with clear Brine. By means of this Instrument duly plac'd, as is exprest in the Figure, with the small flame of a Lamp may be cast as great and convenient a light on the Object as it will well indure; and being always constant, and to be had at any time, I found most proper for drawing the representations of those small Objects I had occasion to observe.[71]

The book, famous for its detailed illustrations, is less known for its critique of the physical qualities of light. However, *Micrographia* is filled with discourses and graphics regarding the effect of light: on objects, in optics, as well as on perception. In one section Hooke provides a long explanatory description of the role of light in seventeenth-century microscopy, going into detail on how to capture light from a south-facing window or directly from the sun. But then he offers an alternative, 'for when there are many Objects to be met with in the night, which cannot so conveniently be kept perhaps till the day'.[72] Hooke was effectively creating a little environment of intimate investigation that was delineated by artificial light, thus

[70] Hooke, *Micrographia*, 17.
[71] Hooke, *Micrographia*, 13.
[72] Hooke, *Micrographi*a, 13.

making two *task envelopes* with regard to light and microscopy, one created by the illumination system, the other by the optics of magnification.

In relation to *Micrographia* I argue that the impact of the microscopic view can be discerned in several ways. Firstly, it can be seen in the treatment of visual space, as the images present a microscopic view embedded in a perspectival construct that I conceptualize as a hybridization of vision. There is an inherent tension created by this particular hybridized vision. Microscopy's optical flattening of space, which I argue Hooke treats as a visual compression of the three-dimensional matrix of perspective, appears to conflict with Hooke's sculptural modelling of the specimens. As I said earlier, perspective and microscopy offer distinct modes of visualization, which I argue are defined by their individual technological configuration of light. It is also important to keep in mind that the hybridization that I am referring to is not a fusion of illustrational techniques, that is to say a simple pastiche of drawing methods, occurring on the surface of the paper. It is rather a hybridization of optics that influenced Hooke's perception. In this way the images can be thought of as indicative of Hooke trying to make sense of this new hybridized vision.

The low magnification of Hooke's microscope means the specimens displayed in *Micrographia* appear tethered to a perspectival world, but monstrously outsized, as they seemingly struggle to escape through the picture plane.[73] Some insects are depicted with their legs severed by the harsh cut of the perspectival framing e.g. the great belly'd gnat (Schem.XXIX). Others such as the louse (Schem. XXXV) seem trapped just beneath the picture plane, whereas a fly (Schem. XXXIX) ruptures the surface of the

[73] Inwood, *The Man Who Knew Too Much*, 67. This sense of struggle would have been amplified for Hooke as he often used live insects as specimens, which he would incapacitate either by sticking their legs in wax or stupefying them with alcohol.

image as if breaking through. It is important to remember that these are Hooke's illustrations, which he made while he observed the (often living) insects through the eyepiece of the microscope. Like the specimens, he too was caught between two very different ways of seeing. In the text Hooke also juxtaposes notions of the microscopic with terms that link to perspective, e.g. when he states that 'penetrating into the center and innermost recesses of the earth, and all earthly bodies; nay, it would open not onely a cranney, but a large window (as I may so speak) into the Shop of Nature'. [74] However here the window of perspective, albeit large, does not provide a view out onto the world, but rather has the viewer positioned outside, looking in. In another section Hooke expresses his desire to 'Microscope in these smaller creatures, quietly peep in at the windows, without frighting her out of her usual byas.'[75] However I suggest that for Hooke it would have also seemed that these 'earthly bodies' were meeting him half way, with his realization that these virtual-object-images were in actuality residing inside the drawtube of his microscope.

In *Micrographia* the way in which Hooke connects the text and the images also appears to reflect the impact of the microscopic view. Hooke creates visual links that require the reader's eye to leap back and forth between the text and images. These jumps occur throughout the layout of the book and in effect they create a network of information. I equate this to the visual leaps made in microscopy, going from one scale to another, which effectively suspend our sense of continuity and destabilize our concept of location. Hooke employs various ways to refer readers back to the illustrations, at times involving simple statements such as 'All the other Contrivances are obvious enough from the draught, and will need no description'. More

[74] Hooke, *Micrographia,* 177.
[75] Hooke, *Micrographia,* 146.

interestingly, at other times the linear progression of the text is deliberately punctuated by symbols that form part of a directive – to look away from the text – and look to the images. Hooke uses capitalized letters as symbols, each relating to a relevant site on an image that the reader is to locate. The letters in their new symbolic function have the effect of interrupting rather than constructing words. This transition of – word-symbol-image – is what we have become accustomed to seeing in anatomical illustrations.

However the impact of the microscopic view is most apparent in the magnitude of the large folio illustration pages, as, when opened out, they are much larger in size than the actual book. The contrast of scale between book and page makes the images appear as illustrational ruptures that seemingly challenge the structure of the book as well as its capacity to archive this new vision. In addition the images themselves appear to reiterate this rupture to the visual organization and understanding of space, with their size far exceeding the 50x lens magnification used by Hooke. In this way they seemingly portray not only the look of the magnified specimens, but also allude to the immensity of the viewing experience. The flea is one such image that unfolds from *Micrographia* (Schem. XXXIV); however, it is by no means the largest illustration. That status belongs to the image of a louse (Schem. XXXV), with dimensions four times the size of the book (it measures almost two foot in length when fully opened).

There is another possible approach that can be taken to considering the impact of the microscopic view in *Micrographia*, and that is to examine the book in its role as a conveyor of information; or to use Marshall McLuhan terminology, to think of *Micrographia* as a medium. *Micrographia* is not a manuscript; rather, it is a printed book. As we know, printed books have the ability to duplicate visual knowledge en

masse. McLuhan states that the invention of 'typography… provided the physical means of extending the dimensions of the private author in space and time.'[76] In this way *Micrographia* acted as a carrier, a host, which enabled microscopic vision to permeate the homes of seventeenth century England. In addition, the printed book is a highly visual medium that is intended for an individual reader, and in many ways reflects the experience of the lone microscopist as both types of activities are aimed at a solitary observer.

Two diary entries from Samuel Pepys, who was a politician and naval administrator of the time, express his first-hand engagement with *Micrographia*. He writes that having purchased a copy he 'there took home Hooke's book of microscopy, a most excellent piece, and of which I am very proud.'[77] *Micrographia* then crosses the threshold of Pepys' home and continues to enchant him. The following day Pepys' diary entry reads: 'Before I went to bed I sat up till two o'clock in my chamber reading of Mr. Hooke's Microscopicall Observations, the most ingenious book that ever I read in my life'.[78] *Micrographia* is evidently not just a passive conveyor of information. Rather it assisted in shaping and accentuating seventeenth-century society's engagement with microscopic vision, habituating the eye to looking into the intangible. In this description the microscope appears as a domesticated extension of vision; however a certain anxiety related to this new way of seeing could also be sensed. It has been noted that texts such as 'Gulliver's Travels could not have been written

[76] Marshall McLuhan, *The Gutenberg Galaxy: The Making of Typographic Man* (Toronto: University of Toronto Press, 1962), 131.
[77] Samuel Pepys diary, 20 January 1665.
[78] Samuel Pepys diary, 21 January 1665.

before the period of microscopic observation, nor by a man who had not felt at once the fascination and the repulsion of the Nature which that instrument displayed.'[79]

To briefly summarize the discussion thus far, I have emphasized that Hooke used a low magnification compound microscope in the making of *Micrographia* and that the instrument created two separate optical effects (conceptualized as two separate technological configurations of light) which created a set of perceptual tensions for Hooke. Firstly, the low magnification used by Hooke resulted in the compression but not complete flattening of optical space. To gain insight into the impact of this phenomenon I compared and contrasted it with linear perspective —another optical technology with its own inherent mode of configuring light that also influences perception. I have argued that *Micrographia* presents a microscopic view embedded into a perspectival construct, which I conceptualize as a hybridization of vision. I use the term *almost* in respect to this hybridization of vision to suggest that the qualities of these two optical instruments, when combined, meant that Hooke was seeing into an *almost* intangible, *almost* invisible realm. This positioned him on a threshold between two ways of seeing. Secondly, the compounding of lenses in his microscope generated virtual images that complicated ideas of reality. I argue that these two optical effects – the partial compression of optical space and the creation of virtual images – caused frustration for Hooke that can be witnessed in his drawings for *Micrographia.*

A question now arises that relates to Hooke's choice of instrumentation. In the following excerpt from *Micrographia* he describes the technological extension of the eye, stating that

[79] Marjorie Nicholson, *The Microscope and the English Imagination* (Northampton, MA: Smith College, The Department of Modern Languages, 1935), 50.

> The next care to be taken, in respect of the Senses, is a supplying of their infirmities with Instruments, and, as it were, the adding of artificial Organs to the natural; this in one of them has been of late years accomplisht with prodigious benefit to all sorts of useful knowledge, by the invention of Optical Glasses. By the means of Telescopes, there is nothing so far distant but may be represented to our view; and by the help of Microscopes, there is nothing so small, as to escape our inquiry; hence there is a new visible World discovered to the understanding.[80]

The preceding statement from *Micrographia* implies that his aim was to extend vision to its furthest possible limits. Yet if this was indeed the case then why did he not use a single lens microscope that would have offered him a much higher magnification, in fact almost five times more than the compound microscope? The instrument was available to him, and he had used it before, and beneficially it would have optically flattened space more than the compound microscope, somewhat alleviating the tension of being *between* these two ways of seeing. (Without space, perspective does not exist.) In addition, as the instrument had only one lens, no virtual images could be generated through the compounding of lenses, thereby negating any confusion about what is real. What then were the disadvantages for Hooke in using the single lens microscope? I suggest that a partial answer can be found in examining the design of the single lens microscope and then considering the phenomenological engagement that was incited by the two separate instruments.

The single lens microscope comprises a little droplet of polished glass, with a diameter of less than three millimetres, which is contained in a hand-held mount to be positioned close to the eye. The instrument appears more akin to a miniature

[80] Hooke, *Micrographia*, 5-6.

magnifying glass than to our current idea of a microscope. However, it could achieve a magnification of 240x. In the Preface to *Micrographia* Hooke instructs on how to make a simple lens, however he also describes the instrument as 'very troublesome to be us'd, because of their smallness, and the nearness of the Object'.[81] In a lecture in 1678 Hooke again indicated his aversion to the simple lens microscope stating,

> I have found the use of them offensive to my eye, and to have much strained the sight, which was the reason why I omitted to make use of them, though in truth they make the object appear much more clear and distinct, and magnifie as much as the double Microscopes: nay to those whose eyes can well endure it, 'tis possible with a single Microscope to make discoveries much better than with a double one…' [82]

I suggest that Hooke's discomfort with the single lens microscope was because it gave no externalized space for him to conceptualize the image. That is to say the image neither resembled the original specimen, nor existed as a virtual image therefore in Ivins terms there seemingly was no 'there' to define this act of seeing. Perhaps the single lens microscope provided Hooke no buffer to the effects of magnification as the image effectively affronted his eye; locating a 'there' likely to be injurious to the eye. Whereas the compound microscope could provide a place for the virtual image object to be contained. In the latter the image, as object, exists in the drawtube casing in-between the lenses, somewhat assisting in defining a 'there' to the observer's 'here', but with all the complications that a virtual 'there' provides. Nevertheless I propose this provision of space was an important element for Hooke, providing him with the ability to conceptualize things as residing in a coherent space, as being somewhere, but also as being somehow contained. I imagine it to be all the more important when the

[81] Hooke, *Micrographia*, 16.
[82] Robert Hooke, *Lectures and Collections; Microscopium* (London: Royal Society, London, 1678).

image no longer resembles the original specimen, as would be the case with the single lens microscope.

In considering Hooke's use of the single lens microscope, in comparison to the compound microscope, I return to examine the choreography of observer and instrument in the act of observation. I adopt an approach influenced by Marshall McLuhan's idea that the formation of a new technology provides relief from an over-stimulated sense or function by disconnecting it from the body. The process numbs us to the realization that the new technology is an extension of ourselves therefore it appears to us as an *other* which fascinates, automatically creating a *closed system* between body and technology.[83] I consider Hooke's use of a single lens microscope as an instance of an overstimulated sense. However rather than providing relief through technological extension, by 'the adding of artificial Organs to the natural', I conceptualize it is a sustained irritation,[84] i.e. the use of the single lens microscope can be visualized as a tugging, pulling and extending of the cornea, which artificially amplifies its ability to focus, though never severing its anatomical connection to the eye. In contrast it can be imagined that the compound microscope effectively disconnected, and provided relief for, Hooke's over extended eye by providing a space for the optical image to reside away from the eye's surface. For Hooke this freestanding instrument constitutes the *other*, a technology that fascinates him.

McLuhan argues that an opportunity to stand outside the *closed system* is presented at the moment when two mediums combine and develop into a new form

[83] Marshall McLuhan, *Understanding Media* (London: Routledge, 1964), 45-52.
[84] Hooke, *Micrographia, 6.*

through a process of *hybridization*.[85] He states that the alternating perspectives provided by the initial contrast have the effect of heightening our awareness, as the traits of one medium expose the qualities of the other. It is this approach that I adopted in examining the initial contrast that took place in early microscopy, when the microscopic view met with perspective. However in addition I argue that each optical technology has a distinct mode of visualization, which is defined by its relationship to light. Therefore I conceptualize the hybridization of media as uncovering the individual technological configuration of light that is distinct to each optical instrument. If thought of in relation to the anatomical body, which is a body predominantly defined by its visual mediation, this process of hybridization can be conceptualized as a combination of two separate theories of the material body, from which a new concept of the body is formed. In the following section I return to Hooke to explore this idea of *hybridized vision,* as he seemingly exemplifies the frustrations and fascinations that McLuhan highlights in relation to technology. I introduce Hooke's invention of a wearable camera obscura, which I consider to be a form of McLuhanian *closed system*. However I also explore the device in terms of Hooke's phenomenological experience, as being both embodied and embedded in a (mediated) world.[86] I imagine Hooke in the Heideggerian sense of *being-in-the-world* in that he is literally thrown into a process of making sense of the world which begins with being perplexed by his own existence. In this way the wearable camera obscura becomes a way of making sense of the immersive visual experience of microscopy.

I conceptualize Hooke's camera obscura as an extension and amplification of his phenomenological experience of microscopy, and as a somewhat logical sequel to

[85] McLuhan, *Understanding Media*, 45-61.
[86] McLuhan, *Understanding Media*, 45-52.

being immersed in the microscopic view. Yet initially the connection to microscopy may not seem apparent, as his camera obscura did not magnify vision. Again I place aside the quality of magnification, the microscope's ability to magnify the look of small things, to base my argument instead on the traits of microscopy that I previously outlined. I stated that microscopy reconfigured the intuitive understanding of space; removed touch from the process of vision; and most importantly, in relation to the study of anatomy, separated form from matter. These traits allow for the impact of microscopy to be considered in relation to the body as a whole, with the idea relating back to my use of the term *task envelope.* I argue that the task envelope of a light-based technology defines a perceptible limit to both the observer's action and understanding by determining *what* they see and by instigating *how* they see it, the term implying that the impact of light extends far beyond just that of sight. I argue that Hooke's wearable camera obscura provided him with a way of exploring some of the frustrations that were raised in his initial engagement with microscopy. In this way I consider it is a return to *Micrographia* and his experience of using the compound microscope, which had enabled him not only to see more but also to see differently. It is this process of *seeing differently* that I suggest Hooke is revisiting with his camera obscura.

In 1694, at the age of sixty, thirty years after he made *Micrographia,* and only several years before he went blind*,* Hooke presented a new invention to the Royal Society of London. It was a camera obscura of sorts, which he said he had designed with seafarers and wayfarers in mind. He basically considered it an aid to 'curious navigators' and travellers that would allow them to visually document new worlds, irrespective of their drawing ability. In Hooke's written submission he suggests that the device was capable of faithfully capturing almost anything:

> not only of the Prospects of Countries, and Coasts, as they appear at Sea from several distances, and several Positions: but of divers In-land Prospects of Countries, Hills, Towns, Houses, Castles, and the like; as also of any Kind of Trees, Plants, Animals, whether Birds, Beasts, Fishes, Insects; nay, of Men, Habits, Fashions, Behaviours; as also, of all Variety of Artificial Things, as, Utensils, Instruments, Engines, Ships, Boats, Carriages, Weapons of War, and any other Thing of which an accurate Representation and Explanation, is desirable.[87]

Hooke's invention was thus a wearable camera obscura that was so large and enveloping of the body that the user appeared to be an optical instrument more than a human being. The user's identity was subsumed as his/her entire upper torso, including the head, shoulders, arms and hands were encased and concealed within. As an anonymous observer, seemingly swallowed by their instrumentation, this hybrid human/instrument was to wander the world, where according to Hooke he/she could depict all *things* great and small indiscriminate of scale. These *things* were to be discovered by the observer's locomotive *being* in the world, as a traveller in unknown lands connecting to the world through a mediated vision, where it can be imagined that tripping and uncertainty would also become part of the observer's visual experience. A standard camera obscura, though it may be portable, is not wearable and requires both instrument and observer to remain still, as being still is the basic prerequisite for capturing an image. This highlights one of the most unusual aspects of Hooke's invention as he seemingly presents movement as a design feature. But in his descriptions it is never made clear how this is actually possible, and on reflection the device, and its uses, begin to appear improbable. However Hooke's camera obscura is

[87] Hooke, "An Instrument of Use to take the Draught, or Picture of any Thing," 292.

not fiction, it did exist, but my question is was it really designed for travellers wanting to document their sightseeing? Or did Hooke provide this description only as a playful justification for his experimentation with altered perception. Perhaps Hooke himself was perplexed by what may have been an inexplicable desire to construct this device.

The only image of Hooke's invention is a woodcut print which accompanies the written submission he made to the Royal Society (see fig. 3). The picture is of a man walking through a landscape while wearing the camera obscura, but the instrument itself is illustrated as a cutaway that allows the user to be fully seen so in effect his upper body appears as the internal workings of an image-making machine. However, this would not be apparent to anyone externally witnessing the use of the device; instead, they would see the lower half of a human body appearing to be providing locomotion for a somewhat distended head, which has only one eye. But it is more than this, as the eye appears to dominate the head having absorbed the four other main senses – hearing, touch, taste and smell. This optical device has also delegated the only visible fleshy part of this hybrid/man instrument, the legs, to playing a secondary role in this act of seeing. It is here I imagine McLuhan's concept of the *closed system* is being played out to an absurd extreme. Hooke's fascination with the *other,* which he experienced as microscopy, has now driven the body into the optical instrument. It is not that the wearable camera obscura magnifies his view, but it does replicate the enveloping, mediated vision provided by microscopy and, most importantly, it creates an intangible view.

Figure 5. Robert Hooke's Drawing Instrument. "An Instrument of Use to take the Draught, or Picture of any Thing. Communicated by Dr. Hook (sic) to the Royal Society Dec. 19, 1694".

Hooke is once again immersed in a vision where notions of interior, exterior, depth and orientation are hard to define, and the demarcation of disparate spaces, aimed at defining a 'there to the observer's here', are equally slippery to explain. The world for Hooke appears collapsed onto the glass ground plate, which acts as a screen, bringing everything close to hand as both hand and eye are set the same task of *seeing.* The world effectively becomes an image to Hooke. A visual experience opens up that is

more akin to a twentieth century heads-up display than to a seventeenth-century camera obscura. It challenges the expectation that there is an inner world of an observer that exists separately from an outer world to be observed. Vision is no longer *of* something, but is rather defined as an (all encompassing) experience. To add to the confusion, there is also the task of having to determine where vision, in this extended technological eye, is actually located. Does it reside on the glass plate, in the fingertips, or is it circling indefinably within the interior space of the instrument?

Making his vision even more complex is that the image most likely appeared to Hooke as inverted and reversed on the camera obscura glass ground plate. Interestingly, and taking a slight tangential step into experimental psychology, this disorientating view would have had a durational limit because, depending on how committed Hooke was to his experiment, his brain would eventually adapt to the 'artificial organ' by self-correcting the vision.[88] However, once the device was removed the brain would go through the process again in reverse. Of course this was unlikely to be Hooke's intention, though he did seem to expect some dedicated wearing of the instrument. In one passage Hooke describes a mariner standing on the deck of his boat wearing the instrument, glancing 'time to time' at the coastline, while remaining stationary in his relative position as the ship traverses the sea. He states that in wearing his device "the Mariner may easily and truly draw the Prospect and from Time to time denote the Rising thereof, as he does nearer and nearer approach it, and the Depression, or Sinking of it, as he does recede."[89] Not only does this vision seemingly have no fixed horizon to allow for an image to be made, negating any practical claim as a recording instrument, Hooke also appears to equate vision to the drawtube focus of the compound microscope, with the mariner's vision drawing in and out with the tide.

[88] Ivo Kohler, "Experimental Goggles," *Scientific American* 206 (1962): 62-86.
[89] Hooke, "An Instrument of Use to take the Draught, or Picture of any Thing," 295-296.

I suggest that Hooke's conversion of the camera obscura into a wearable technology enabled him to be immersed in a technologically mediated vision. It was as if Hooke had made a model that allowed him to imagine his body positioned inside the drawtube of a compound microscope, where he could move through the virtual image. As with microscopy, Hooke's sense of touch is limited to experiencing the world through mediated sight, disconnected from the immediacy of material things, as he can no longer touch what he can see. The whole process can be understood as Hooke taking the *task envelope* of microscopy and reconfiguring its relationship to the body, and to space. It is also an attempt to find another way of exploring the perceptual and conceptual tensions raised by microscopy. Therefore Hooke's camera obscura can be thought of not only as an amplified visual experience and a new way of experiencing images, but as also offering another possible way of experiencing the body as a whole – similar to that engendered by microscopy.

Microscopy affects our relationship to space by raising questions about where vision is located as well as about how we define what is real. Arguably, no other optical instruments have influenced the visualization of anatomy more than perspective and microscopy, with the majority of modern scientific imaging not only being derived from these two ways of seeing, but increasingly appearing as a fusion of the two, i.e. the online anatomies that provide virtual fly-throughs of even the smallest anatomical architectures. To gain insight into how these two visions were originally reconciled would seemingly offer a better understanding of contemporary visions of anatomy, where multiple sets of microscopic data are stacked and realigned to create virtual immersive spaces for us to navigate through. However I am not saying what is being experienced is a re-enactment of the original hybridization of microscopy and

perspective, important differences appear; differences that I relate to Hooke's experimentation with the camera obscura.

Here I want to reflect on observations that I previously made in Part I, *'Friending Anatomy: The Online Presence of Virtual Anatomies*.' I suggest that there are similarities between Hooke's phenomenological experience of imaging and our own contemporary engagement with images. As it could be said that, to a large extent, we no longer look at images, but rather we interact with visuals. Importantly, and somewhat similarly to Hooke, the methods that we now use to create and view images are appearing to complicate prior notions of reality, e.g. augmented reality, mixed reality, virtual reality. It would appear that any contemporary definition of the word *image* will need to question where the image appears, how it appears, and how it relates to reality. In other words, it will need to interrogate whether the viewer is assimilated into the view of the image, or more interestingly, whether the image is behaving like an object.

Figure 6. Virtual reality goggles and gloves. Courtesy of NASA, 1986.

Figure 7. Hooke's Drawing Instrument (detail), 1694. Courtesy of the Royal Society.

PART III

BODY OF WORK

Oblique

This chapter is a discussion of my photographic installation *Oblique* (2008). *Oblique* stands apart from my later research projects as it presents the anatomical body more literally, and viscerally, than the subsequent works which are comparatively structural and abstract in design. *Oblique* is the starting point, and initial entry into, this studio-based research.

The aim in Oblique is to create a photographic installation imbued with a baroque sensibility to light. The work essentially elides a digitized light and a 'painterly' illumination, which I present as a hybridizing of two optical media. The project is intended as a poetic positioning of anatomy that exposes the slippages and meeting points between two light-based technologies, *new* and *old* respectively. Here, anatomy is conceptualized as the aesthetic chimera of two optical configurations.

I explore two themes in Oblique; firstly, the role that light plays in the photographic capture of the anatomical body; secondly, a baroque sensibility to the depiction of light and space, in particular the use of *chiaroscuro* to construct images.[1] The conceptualization of space has played a significant role in my approach to making *Oblique,* and is an essential element to this research project, as I consider anatomy to be the art of locating organs in space, with the 'positioning of the body within a three-dimensional matrix [being] key to anatomical understanding.'[2] In *Oblique* I conceptualize *photographic space* as being delineated by light and existing as three

[1] 'Chiaroscuro (lt. 'light-dark') In painting, the technique of modelling form by almost imperceptible gradations of light and dark. Its invention is generally associated with the career of Leonardo da Vinci.' Edward Lucie-Smith, *Dictionary of Art Terms* (London: Thames & Hudson, 2003), 53.

[2] Jonathan Sawday, *The Body Emblazoned: Dissection and the Human Body in Renaissance Culture* (London: Routledge, 1995), 86.

separate, but interrelated, sites; the *recording space* of the photographer; the *pictorial space* of the photographic print; and the extended space of the *photographic installation* – a union of visual spaces, which are all defined and linked in their relationship to light. Indeed, the light required for the original exposure and capture of the image is transposed through each of these sites. Equally, I consider *baroque space* as being determined by light, with light at this time being used not only to heighten the plasticity of forms but also to extend the appearance of space.

Heinrich Wölfflin in his analysis of Baroque architecture states that the baroque style 'thought first of the effects of light: the unfathomableness of a dark depth, the magic of light streaming down from the invisible height of a dome, the transition from dark to light.'[3] Both in Baroque architecture and theatre the emphasis was on manipulating space and light to create dynamic sensory engagements thereby viscerally engaging the viewer in an unfolding drama that was to equate to an ecstasy of divine revelation. Indeed, 'it is the Baroque era that first uses light as an essential element in the creation of mood.'[4] Yet, in the discipline of painting an equivalent sense of drama was evoked through the intensification of *chiaroscuro,* which effectively pushed tonal qualities into *tenebrism*, thereby creating strong contrasts between light and shade.[5] In addition, Baroque artists ruptured the previously ordered, and seemingly rational space, of perspective, as 'the Renaissance ideal of perspectivally

[3] Heinrich Wölfflin, *Renaissance and Baroque*, trans. Kathrin Simon (London: Cox & Wyman, 1964), 63.
[4] Wölfflin, *Renaissance and Baroque*, 123.
[5] Fred S. Kleiner, Christin J. Mamiya and Richard G. Tansey, *Gardner's Art Through the Ages,* 11th ed. (New York: Harcourt College Publishers, 2001), 732. *Chiaroscuro* is associated with the work of the Renaissance artist Leonardo da Vinci. *Tenebrism*, from the Italian word tenebroso or 'shadowy' manner, originated from the paintings of the Baroque artist Caravaggio. The figures in Caravaggio's paintings emerge from shadowy dark backgrounds that seemingly envelop the characters, creating a sense of theatricality in the images whereas da Vinci's figures are evenly illuminated with imperceptible gradations of tone from light to dark, providing plasticity to the rendered forms.

guided representation…is replaced by a baroque concern with complex, dynamic motion and multiple perspectives that are dependent on the position of the viewer in relation to the work.'[6] For these reasons, I consider *baroque space* and its dynamic choreography of viewing as being determined by the era's sensibility to light. In the baroque style 'the individual, defined and plastic form has ceased to matter; compositions are in the mass effects of light and shade and the most indefinite of all elements have become the real means of expression.'[7]

The depiction of light in a Baroque painting can be thought of as constructing the composition. '[A] single tone serves to hold together whole groups of objects and contrast them with other groups.'[8] Unlike Renaissance painting, which aimed at delineating individual forms, the baroque style 'thinks only in masses, and its elements are light and shade.'[9] In this way Baroque art presents a clear break from the previous aesthetic of the Renaissance. Renaissance artists depicted light as neutral and even, with light being thought of as an idealized light. This highlights an important difference, as Baroque artists 'arrived at [tonal] differences optically, not conceptually or in terms of some ideal.'[10] Essentially, Renaissance light gave plasticity to the rendered forms and provided an appearance of clarity and coherence to compositions. In contrast, the half-light that appears in baroque images creates ambiguous areas, as visual information appears to be purposefully 'lost and found' in the interplay of light and shadow. Here, light plays the role of bringing forth information, but it also directs the eye of the viewer by withholding information from sight.

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[6] Angela Ndalianis, "Architectures of Vision: Neo-Baroque Optical Regimes and Contemporary Entertainment Media," *MIT Communications Forum, 2.* http://web.mit.edu/comm-forum/papers/ndalianis.html (accessed August 2012).
[7] Wölfflin, *Renaissance and Baroque*, 85.
[8] Wölfflin, *Renaissance and Baroque*, 31.
[9] Wölfflin, *Renaissance and Baroque*, 31.
[10] Kleiner, *Gardner's Art Through the Ages,* 757.

I argued previously that the task envelope of a light-based technology defines a perceptible limit to both the observer's action and understanding by determining *what* they see and by instigating *how* they see it. The light directing technologies that I consider in *Oblique* are photography and chiaroscuro, the latter being innately related to linear perspective. 'For perspective is by nature a two edged sword: it creates room for bodies to expand plastically and move gesturally, and yet at the same time it enables light to spread out in space and in a painterly way dissolve the bodies.'[11] *Oblique* can be thought of as an envelope of vision created by the hybridization of two media that defines not only the view of a surgical scene but shapes our perception of the [anatomical] body.

The method that I use in the production of my studio work involves the purposeful combination of *new* and *old* optical technologies, which is essentially a practical adaptation of a McLuhanian concept. In Marshall McLuhan's text *Understanding Media* he explores the idea of 'hybrid energy' and asserts that the hybridization of media creates 'new force and energy by fission or fusion.' McLuhan contends that the compounding of media offers the 'opportunity to notice their structural components and properties.'[12] His assertion is that in the initial moment that two media meet, the traits of one expose the qualities of the other.[13] In my appropriation of this idea my objective is to produce images and installations that contain elements which are seen to alternate between states of juxtaposition and union, with the traits of one medium exposing the qualities of the other. In relation to my research I argue that each optical technology has a distinct mode of visualisation,

[11] Erwin Panofsky, *Perspective as Symbolic Form.* 1927 (repr., New York: Zone Books, 2009), 67.
[12] Marshall McLuhan, *Understanding Media: the Extension of Man* (New York: New American Library, 1964), 54.
[13] McLuhan, *Understanding Media*, 53.

which is defined by its relationship to light. Therefore I conceptualise the hybridization of media as uncovering the individual technological configuration of light that is distinct to each optical instrument.

The *Oblique* images originated from an opportunity that I had to photograph, as part of my own research, one of the two *Ear on Arm* surgeries undertaken by the performance artist Stelarc.[14] The surgeries are stages in an extended process of construction, for an arts project that is still awaiting completion. Stelarc describes the *Extra Ear* project as an 'ongoing and yet to be fully realised' work.[15] The *Extra Ear* project was initially envisaged in 1996. In describing his work in 2012 Stelarc states:

> An extra ear is presently being constructed on my forearm: A left ear on a left arm. An ear that not only hears but also transmits. A facial feature has been replicated, relocated and will now be rewired for alternate capabilities. At present it is only a relief of an ear. The third surgical procedure will implant a miniature microphone that, connected to a wireless transmitter, will Internet enable the ear in any wifi hotspot, making the ear a remote listening device for people in other places. This additional and enabled EAR ON ARM effectively becomes an Internet organ for the body, an alternate anatomical architecture. A publicly accessible, mobile acoustical organ.[16]

My particular interest in the surgery lay in the spectacle of the theatre. My intention was not to document the mise en scéne as such, providing a utilitarian

[14] The first surgery was for the subcutaneous insertion of a skin expander into Stelarc's left forearm. The second surgery, which forms the subject of this work, allowed for the extraction of the utilized skin expander and the removal of an unanticipated necrotic section of skin, followed by the insertion of a Medpor ear scaffold that was implanted with the miniature microphone. (Medpor is a biocompatible porous material used to create surgical implants.)
[15] Conversation with Stelarc, Melbourne, October 2008.
[16] Email from Stelarc, June 2012.

recording of the process, the space, and its protagonists.[17] Rather my aim was to focus tightly on the left arm – the site of the *Ear on Arm* construction. The opportunity to photograph the surgery allowed me to explore the impact of light in regards to the perception of anatomy, witnessed and mediated through the lens of the camera. In *Oblique* Stelarc's body is seen as a non-moving body – non-performing, unaware and unconscious – his *stillness* intensified by the culmination of general anaesthesia and by the photographic capture of the scene. Here he embodies my definition of the anatomical body as being a *still* body comprising inanimate structures. However, in *Oblique* the anatomical body provides the foundation for the surgical body. 'Anatomical knowledge [being] a precondition for all internal surgical practice, which allows interior organs to be exteriorised and treated in linkage with life-support systems,' or in this instance allows an organ to be replicated, relocated and linked into the web.[18] Importantly, *Oblique* is an interpretation of the surgery, which reflects the concepts that motivate my research, and presents just one possible perspective taken from the real time experience of viewing the *Ear on Arm* operation.

[17] In this instance I was not employed to film the surgery and was working to my own agenda.
[18] Catherine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine* (London: Routledge, 2000), 51.

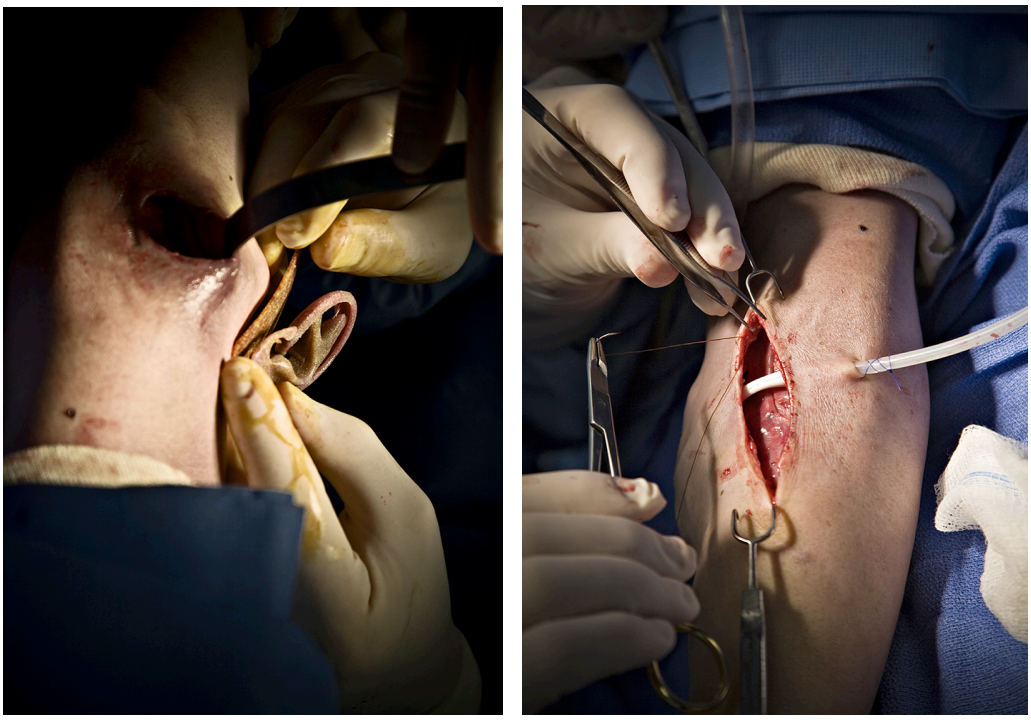

Figure 8. *Oblique,* panels two and three, when hung as a set of four. Dimension of each Photograph: 163cm x 108cm. Digital ink jet images printed on Hahnemühle 308gsm Photo Rag paper.

My intention in *Oblique* is to visually situate Stelarc's body between a surgical theatre and the theatricality of the baroque style thereby engaging the viewer in an unfolding [anatomical] drama. Each image combines a photographic close-up with a centrally illuminated subject that emerges from a proscenium of darkness. Reminiscent of a seventeenth-century stage, the proscenium hides the 'behind the scenes' machinery to frame a select, lit area of action for 'front of house' viewing. In offering a glimpse of an ongoing surgical spectacle, *Oblique* seemingly participates in the rupture of the body ideal. The twisted bodies, discoloured flesh and extensions of the body into pictorial space that are inherent to the Baroque era are transformed here into a surgically extended body, which reveals a palette of mannerist-like flesh formed by a mix of iodine stains and restricted blood flow. The 'irregularly shaped pearl' of the baroque has become a cultivated pearl here: an artificial ear scaffold seeded with the performance artist Stelarc's living cells. *Oblique* thus provides an ambiguous space for an anatomically augmented body.

To create *Oblique* it necessitated merging the recording possibilities, and limitations, of the medium of photography, together with the visual qualities of the surgical scene being portrayed. The media theorist Joanna Zylinksa describes the process of photographic mediation of *Oblique:*

> With *Oblique*, a photographic art project which entails enclosing, freezing, and carving the body into a particular form, Sellars repeats the surgeon's master "cut" with a click of the shutter, which frames and fragments the body spectacle at hand..[19]

In *Oblique* the combination of framing, depth of field and focal length, defines a three-dimensional *recording space* that extends out from the lens of the camera and into the arena of the operating theatre.[20] Printed full frame, *Oblique* provides a view into the operating theatre that replicates the artist's sight through the lens. However in the photographic print new possibilities, and limitations, emerge, as the view through the lens can be enlarged in the making of the print, allowing details that were latent in the original scene to be made visible. The weave of the surgical gauze, pores in the skin and the sweat visible in the transparency of the latex gloves, now all appear

[19] Sarah Kember and Joanna Zylinska, *Life After New Media: Mediation as a Vital Process* (Cambridge, MA: MIT Press, 2012), 88.

[20] The Extra Ear surgery was performed in a private operating theatre in Encino, Los Angeles. It was a small space containing a number of people, including the plastic surgeons, Malcom Lesavoy, Sean Bidic and William Futrell. There were also three nurses and an anaesthetist assisting, though they do not appear in *Oblique.* The surgery was conducted under general anaesthetic therefore the theatre also contained all the necessary equipment used to administer the anaesthesia to Stelarc and to monitor his body during the two-hour long procedure. Those who were observing rather than participating in the surgery had to remain outside a two-foot exclusion zone around his body to maintain the sterile conditions. The Discovery Channel, as part of a documentary titled 'Medical Mavericks', sponsored the surgery and their film crew, consisting of a director, cameraperson and sound engineer, were also in attendance. In total there were upt to twelve bodies in the room, including Stelarc. With an excess of people and medical apparatus it necessitated working in agreement, with a choreography of movements developing enabling us to work in and around each other. I received Australia Council for the Arts funding to photograph the surgery as part of my own research.

larger than life, drawing the viewer closer into the scene. Enlargement also enabled a visually disembodied forearm to be transformed into an anthropomorphic whole.

In addition, photographic prints provide the possibility of reorientating the original view thereby enabling subjects to seemingly defy gravity. Adopting this approach for the presentation of *Oblique* allowed mass and weightlessness to appear juxtaposed in the prints, as gravity became an unstable quality that could be easily disconnected from the reality of the scene. Thus the influence of the optically defined space extends out from the image, engaging the viewer in the destabilising scene, as weightlessness is a quality that is *felt* by the viewer, not only something that is *seen*. Indeed, there is no static viewpoint, or point of rest, offered by *Oblique.* This unease also plays out in the polycentric composition, with its repeated focus on the surgical site, which effectively displaces a point of view with a multiplicity of views. Yet, if a centre were sought to this set of images, it would be found existing *between* the second and third print.[21] The combined imagery of the two prints creates a black void, the 'unfathomable dark depth of the Baroque,' which appears bisected by a white void, comprising the photographic edge of each print (see fig. 8 and fig. 12).

[21] These two prints are central in the *Oblique* series when they are hung as a set of four, but also when they are hung as a set of six. *Oblique* was hung as a set of six for the exhibition *Human+: The Future of Species*, Science Gallery, Dublin 2011, and as a set of four for my PhD exhibition *Optics of Anatomy and Light,* Fehily Contemporary, Melbourne, 2012.

Figure 9. *Oblique,* installation at Guildford Lane Gallery, Melbourne, 2008. (View towards gallery entrance.) The solo exhibition consisted of nine framed prints.

Figure 10. *Oblique*, installation at Guildford Lane Gallery, Melbourne, 2008. (View of the gallery space.) The solo exhibition consisted of nine framed prints.

Figure 11. *Oblique*, documentation of installation, (detail) *Human+: The Future of Our Species,* Science Gallery, Trinity College, Dublin, 2011. Documentation of the first four prints in the set of six, which were hung unframed.

In *Oblique* the repose of the anatomical body contrasts with the surgical stretch of the skin, it can be thought of as a *still* body embedded in action. Yet, the anaesthetized body can also be thought of as being animated by the affect of light, as 'light and shade contain by nature a very strong element of movement, ' with the baroque style evoking 'an illusion of constant change.'[22] The medium of photography pulls the viewer into proximity to this surgical scene, as the close-ups provide the haptic vision of an anatomist, magnified tenfold. However, the 'anatomical gaze' is subverted in *Oblique,* as the body becomes a series of masses and voids with contours that dissolve into shadow.

It is this quality of light that links the images in *Oblique,* as the play of light melds the separate masses comprising flesh, latex, fabric and instrumentation into an unyielding dynamic composition that remains impenetrable to anatomization. But this

[22] Wölfflin, *Renaissance and Baroque*, 31.

is only partly true, as there is a limit to this spectacle. For in *Oblique,* baroque ruptures are met with photographic cuts and in a way each installation of *Oblique* has been an attempt to negotiate the neo-classical framing of photography. To frame a scene through the viewfinder of a camera is to provide a view of the world cut on all four sides and seemingly this will never resolve with an aesthetic defined by unlimited extension. To a large extent, *Oblique* has to rely on visceral spectacle to defy the physical frame.[23]

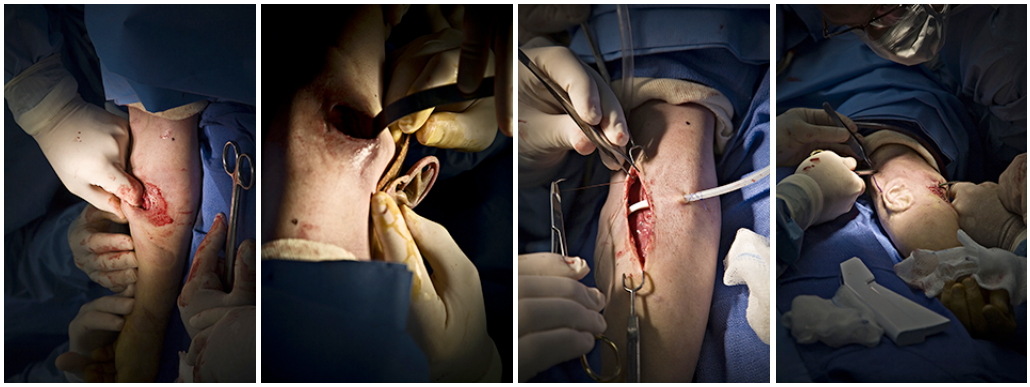

Figure 12. *Oblique,* the set of four prints that were shown at Fehily Contemporary, Melbourne, 2012. Dimensions: 163cm x 430cm. Digital ink jet, Canson Rag Photographique 310 gsm. In this installation of the work the prints were hung unframed and were overlapped, to make one large panoramic piece.

To view a complete set of the *Oblique* images and, if desired, to download a PDF of the exhibition catalogue, please see: http://www.ninasellars.com/?catID=6
This site also shows documentation of the solo exhibition of *Oblique* at Guildford Lane Gallery, 2008. Here, the exhibition comprised nine framed images.

Professor Joanna Zylinska wrote the catalogue essay, *The Cut of the Artist: Sellars' Anatomy Lesson,* for the *Oblique* exhibition, Guildford Lane Gallery, Melbourne, 2008.

Following this, the catalogue essay was edited to, *The Artist, The Surgeon, and the Philosopher*, and included in a MIT Press publication by Professor Sarah Kember and Professor Joanna Zylinska, titled, *Life After New Media: Mediation as a Vital Process,* 2012.[24]

[23] The final vesion of *Oblique* is shown unframed and as a set of four prints, which overlap to form one composite image. However, *Oblique* was initially exhibited as a series of nine framed prints in the solo exhibition at Guildford Lane Gallery, Melbourne, 2008.
[24] Sarah Kember and Joanna Zylinska, *Life After New Media: Mediation as a Vital Process* (Cambridge, MA: MIT Press, 2012), 86-95.

Oblique has been shown in several exhibitions:

- Guildford Lane Gallery, Melbourne, *Oblique* (solo exhibition), 2008.
- Australian Experimental Art Foundation, Adelaide, *Duetto, 2010.*
- Science Gallery, Trinity College, Dublin, *Human+: The Future of Our Species, 2011*
- GV Art, London, *Art and Science: Merging Art and Science to Make a Revolutionary New Art Form* (curated by Robert Devcic and Professor Arthur I. Miller), 2011.

The photographs were taken in 2006, the exhibition photographs were printed at Pharos Editions, Melbourne, 2008. Digital ink jet images printed on Hahnemühle 308gsm Photo Rag paper. Image size: 163cm x 108cm

Figure 13. *Oblique.* Documentation of the surgical room in Encino, Los Angeles, 2006.

Figure 14. *Oblique,* the end photograph in the set of four, as well in the set of six
Dimensions: 163cm x 108cm.Digital ink jet image printed on Hahnemühle 308gsm Photo Rag.

The Anatomy of Optics and Light

This section is a discussion of my light installation *Anatomy of Optics and Light* (2009). Here the body is abstracted into a diagrammatic image. The installation is the second work in a series of four created for this studio-based research.

The aim throughout this research project is to investigate not only how light affects what we see and experience in relation to the anatomical body, but also how these perceptions and experiences are articulated through images and engaged with outside the medical context. In *Anatomy of Optics and Light* I examine these questions by exploring the relationship between the anatomist, the artist and the public audience in their shared observations of the anatomical body. Enacted within a notional space of an anatomy theatre – a space whose design and philosophy go back to the Renaissance – the questions and relations are addressed through a series of mediations and relocations of the anatomy theatre. In *Anatomy of Optics and Light* the theatre is translated from its medical incarnation into an art gallery installation, which then undergoes yet another act of translation, with the theatrical space of the gallery being transposed into the virtual realm, where it is accessible as an interactive screen space online.[25]

The *Anatomy of Optics and Light* installation engages with multi-scale representations and imaginings of the body. It incorporates a diagram of a nervous

[25] *Anatomy of Optics and Light* was shown at Shifted Gallery in Melbourne, Australia, as part of a joint exhibition with Joanna Zylinska, titled *Solid States/Liquid Objects.* Dr Melissa Miles wrote the exhibition catalogue essay. The exhibition was held in conjunction with the international symposium *Solid States/Liquid Objects: Discourses of Mediation,* which was organised by the artist and hosted by the Faculty of Art & Design, Monash University, Melbourne. The online version of Anatomy of Optics and Light can be accessed on: http://www.ninasellars.com/anatomy-of-light/

system, which is visualized as a hybridization of human tissue and light, and which exists as part of the technological environment. Magnified and extended across the gallery walls, it escapes the usual diagrammatic confines of a page or screen and even eludes the artistic capture of framing. What is enacted here is not a body *within* a space; rather, a space is being defined *by* a body. In other words, viewers are presented with a spacious soma which invites a total sensory engagement with the abstracted corporeal structure. In a traditional anatomical theatre onlookers would gather in encircling stalls above a central stage where an anatomist would stand, opening a cadaver for display. However, in *Anatomy of Optics and Light* this schema is reversed. It is now the anatomical body intended for display that encircles the room, with the body that was to be viewed replaced by a viewing body. Viewers are thus not immersed in a representation of a visceral dissection room, nor are they invited to inspect a figurative wet body. Instead, a diagram surrounds them, with the discernable fleshy 'stuff' receding from sight and supplanted by a nervous system that has been translated into the diagrammatic language of electric circuit board design. It depicts the motor nerves that enable breathing and the movement of the arms, legs and head, showing the four main nerve plexuses – sacral, lumbar, brachial and cervical – that run from the spinal cord into the neck and limbs, as shown in figures 15 and 18. Certain sections of the nervous system have been extended or stretched, but the linear order and connectivity within the individual plexuses have been maintained: the plexuses are stitched together to make a visually integrated whole, but not a whole coherent body. The term *diagrammatic language* signals that an abstract approach is being used here, which is produced through conceptualization rather than an attempt to represent. The diagrams reveal a desire to understand and extrapolate ideas from appearances. *Appearing* and *thinking* are therefore not opposed to each other; rather, the former is

the initial stage of the latter, with phenomenological engagement serving as an *a priori* to both.

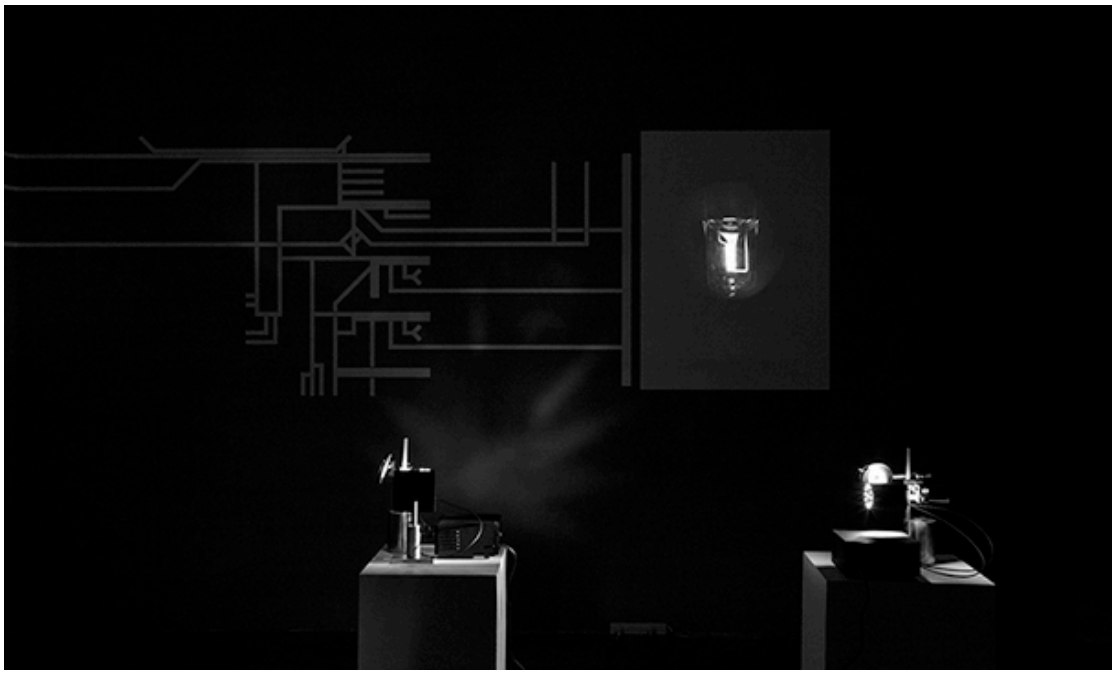

Figure15. *Anatomy of Optics and Light*, installation detail (cervical plexus diagram; inverse camera obscura image; two inverse camera obscuras), 2009.

The installation contains five devices, which I call *inverse camera obscuras.* They had been specially made for the exhibition.[26] Each identical device is built from lathed brass. It houses a small light bulb and supports a ground glass lens with an adjustable diaphragm aperture (see fig. 16). The usual working mechanism technique of the *camera obscura,* i.e. that of portraying an external scene onto an interior wall, has been inverted here, with an object contained within a small internal space being imaged and projected out. It is an interior that has been ousted for observation. The lens magnifies and projects the light emanating from a small bulb contained within the construction, so a 1-centimetre tall light bulb forms a 1-metre tall image on the opposite gallery wall. The light here not only transmits the image but also becomes the

[26] Dr Matthew Sellars, senior research fellow at the Laser Physics Centre, Research School of Physical Science and Engineering, Australian National University, assisted with the technical realisation of this project.

image. The bulbs cannot be viewed or accessed directly; they are accessible to the viewer only as real time images.

Figure 16. *Anatomy of Optics and Light*,
(inverse camera obscura), 2009.
Dimensions: 27cm x 21cm x 14cm.

Dust and small imperfections in the glass are magnified along with the glowing filaments, all in sharp focus, and offered up for close inspection, making visible what would have otherwise remained hidden (see fig. 17). The multiple *inverse camera obscura* images link and illuminate the diagrammatic lines, but they also act to displace the central focus of the installation. The idea behind this set-up was to increase the impression of the installation forming a body/light environment, where one element

does not dominate or act independently from the other. In other words, what we are presented with is a system or nexus of body and light. The body presented here is not only to be seen but also to be experienced via a process of all-sensory *listening.* It is a dispersed, abstracted body that exists, and surrounds the viewer, in the half-light of the gallery space. The externalized

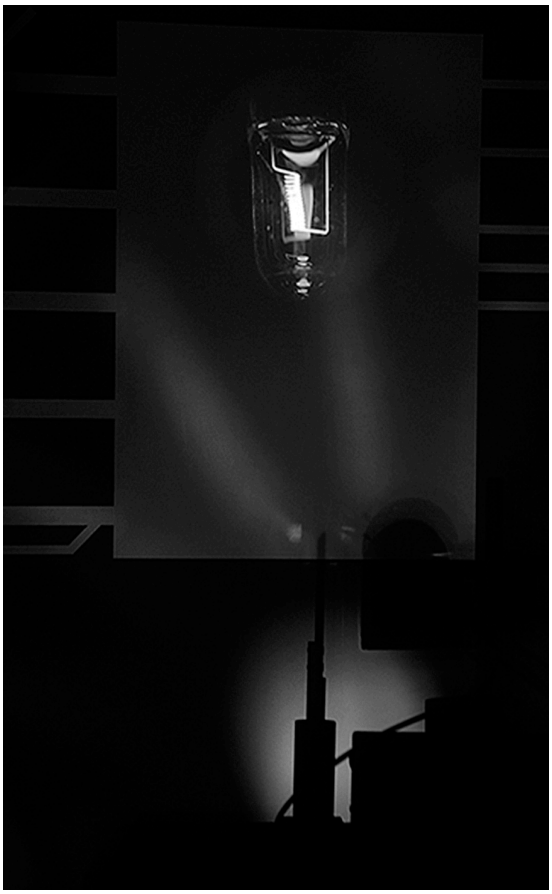

Figure 17. *Anatomy of Optics and Light*, installation detail (inverse camera obscura image), 2009.

nervous system seemingly embraces the viewer both visually and aurally, with the power amps that provide the electricity to the *camera obscuras* creating an audible hum that permeates the room. The combination of such simple technologies is aimed at exploring questions regarding how light affects what we see and experience in relation to the anatomical body and the ways in which these perceptions and experiences are articulated through images.

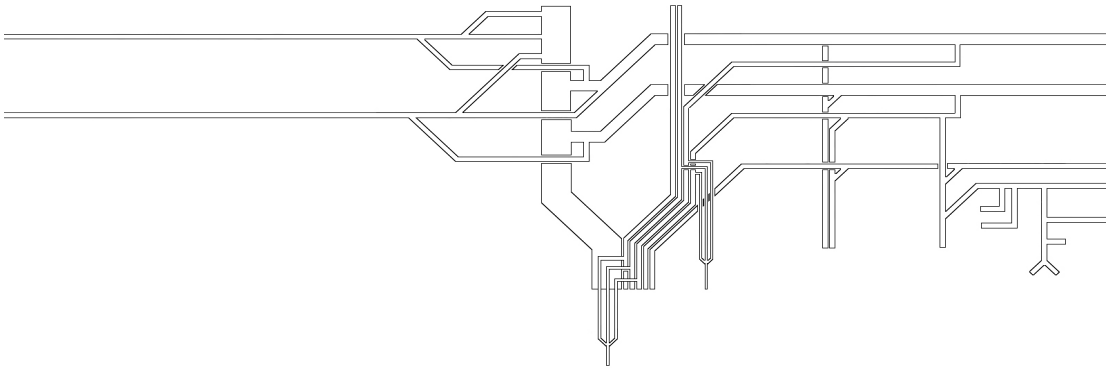

Figure 18. *Anatomy of Optics and Light.*
Diagram of sacral plexus, 2009.

Anatomy of Optics and Light incorporates the use of contemporary technologies not only in the making of the *inverse camera obscuras* but also in the creation of the drawn images. There is a certain clinical precision to the schematic lines of the diagrams adhered onto the gallery wall, with the computer-generated graphics converted into laser-cut vinyl. My aim here was to uncouple the *line* from the *mark* of the artist and to emphasize instead the *cut* of technology. It is a visual analogy that refers to medical scans, with their precision, abstractness and absence of any *first-hand* mediatory mark of a human observer. As a comparison, in the Renaissance the process of manual dissection – guided by an observing, corporeal eye – was mirrored in the hand of the artist. The draw of the artist's blade equated the draw of the engraver's scribe, with both exploring and exposing the interior of the body. *Anatomy of Optics and Light* is purposefully devoid of the emotive direct interplay of the artist's body with a medium and is accompanied by the absence of an instantly recognizable image of the anatomical.

Neither the corporeal body nor the mark of the maker is apparent in the installation. Instead, both have been visibly mediated by technology. The diagrams and

the large rectangular sections that act as the *camera obscura* projection screens, as well as the exhibition wall text, were all produced by using the same method. The micro thin pearlescent-white vinyl, peeled from adhesive backing sheets in 4-metre long sections and pressed onto the dark walls of the gallery, creates a continuity in the work that links text, line and screen. At the end of the exhibition, when the power was turned off, the images and light patterns instantly disappeared. The elastic-like vinyl was then pulled and separated from the walls. It was in that moment that the diagrams appeared at their most corporeal, even fleshy, taking the form of sticky, knotted and visceral lines gathered on the gallery floor.

The installation was subsequently subject to another act of translation. It has been translated into compressed digital information to allow it to operate as an interactive panorama for the purpose of its publication in the international online journal *Culture Machine* (see Appendix C). This kind of visualization offers an additional way of exploring and engaging with the space and takes the investigation of the body from the visceral 'cut and slice' to a virtual 'click and drag'. The eye of the viewer has been extended out from the body into the virtual room. Most importantly, it has become an eye that, to its greatest advantage, has been separated from a vestibular system. It is therefore not inhibited by dizziness or disorientation.

Speed and *spin* can thus be used as tools of investigation as it is now the room itself that is turning with the draw of a hand and not the viewer. The displacement of the audience and the dispersion of the body are also more apparent through the mediation of the Internet, where the viewer plays audience participant and is offered a certain anonymity and accessibility. The space is always available to the viewer to be entered, downloaded, transferred, sent, relocated, expanded, flattened and

repositioned at will. It has been disconnected from its real world position and the volition of its maker.

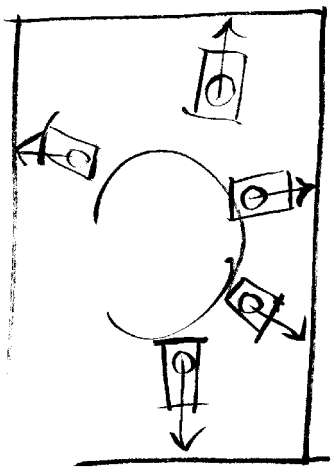

Figure 19. *Anatomy of Optics and Light,* installation layout.

The online interactive panorama of *Anatomy of Optics and Light* can be viewed at:
www.ninasellars.com/anatomy-of-light/

The article "Anatomy of Optics and Light" written by the artist for the online journal *Culture Machine* can be viewed at:
www.culturemachine.net/index.php/cm/issue/view/22
Alternatively see Appendix C.

Anatomy of Optics and Light was shown at Shifted Gallery in Melbourne, Australia, as part of a joint exhibition with Joanna Zylinska, titled *Solid States/Liquid Objects,* 2009. Dr Melissa Miles wrote the exhibition catalogue essay. The exhibition was held in conjunction with the international symposium *Solid States/Liquid Objects: Discourses of Mediation,* which was organised by the artist and hosted by the Faculty of Art & Design, Monash University, Melbourne.

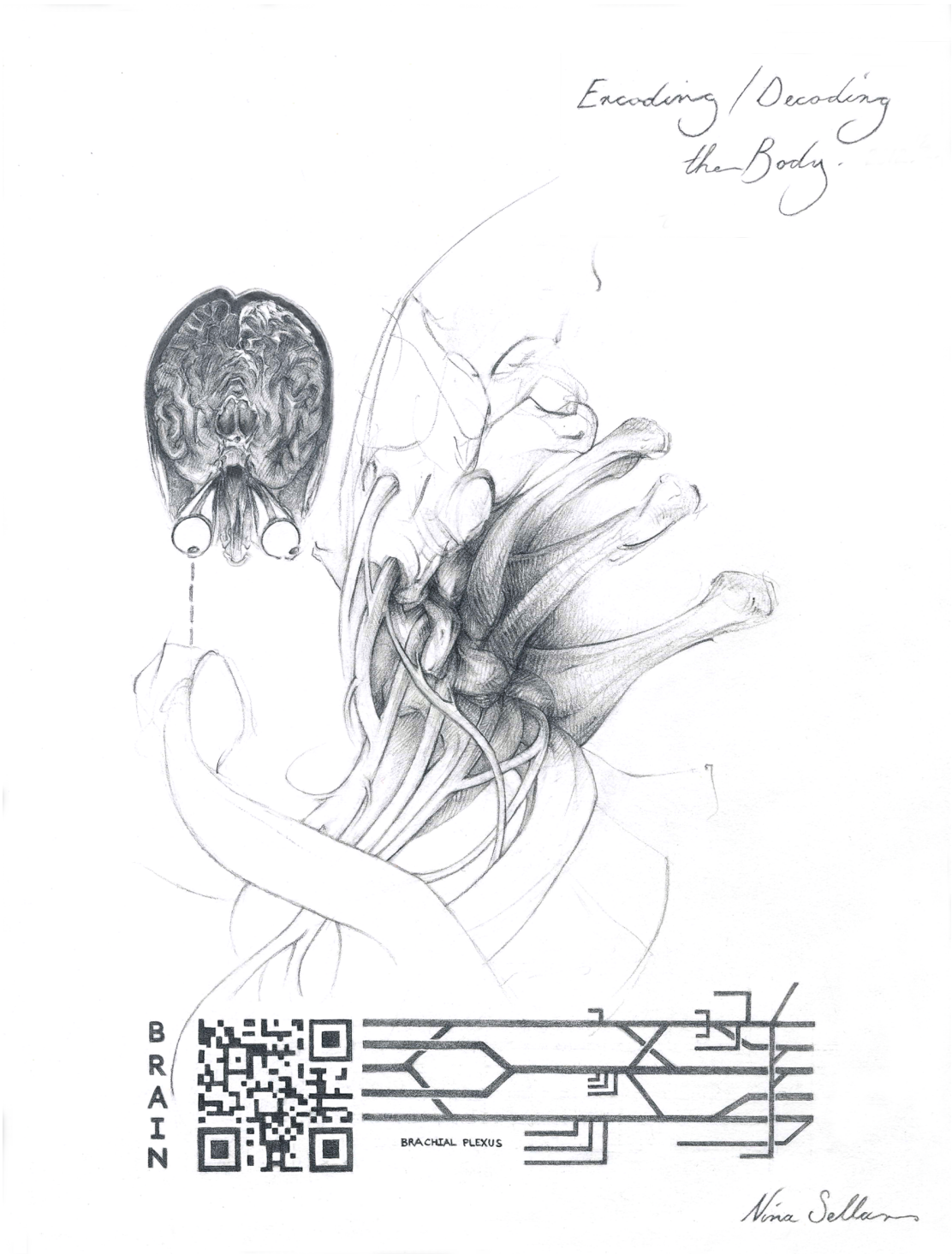

Figure 20. Page from artist's journal: pencil sketches for the works *Anatomy of Optics and Light* and *Scan,* 2009-2012.

Lucida

This chapter contextualizes my light installation *Lucida* by positioning the work in a particular history and understanding of anatomical observation that I refer to as the *anatomical gaze*.[27] In the following discussion I conceptualize our contemporary fascination with transparency and the virtual, and our acceptance of both, as viable methods of observation, originating from nineteenth century microscopy. The third work in a series of four, created as part of my studio-based research, *Lucida* is a poetic exploration of light in relation to the microscopic study of cells.

In the twenty-first century we have become increasingly captivated by scientific images of our internal anatomy. Technologies that enable the virtual unfolding of the corporeal body, i.e. computerized tomography (CT) and magnetic resonance imaging (MRI), provide coordinates for realms that exist beyond what is normally visible. CT and MRI use frequencies from the extremes of the electromagnetic spectrum to penetrate, map and ultimately image the anatomical body, thereby unveiling a subcutaneous spectacle that is only attainable to the human eye through the mediation of technology. This amassing of possible views creates a sense of infinite depth, which far outweighs our perception of a body that was previously defined in terms of, and as, surface. With the perceptible limit of the anatomical body no longer linked to anything tangible, our corporeality seems to be expanding exponentially. Equally there is a sense of transparency about the body – which, as a result of its multiple imagings, can feel open, isolated and lacking a boundary. Through the image-making process there emerges an apparent transference or even switch-over of the

[27] The term *anatomical gaze* denotes the naturalization of medical imagery in our everyday lives as a result of their increased proliferation in visual and media culture.

prior corporeal characteristics, with anatomical images gaining increased substantiality, and the physical body developing transparency.

In my light installation *Lucida* I explore the changing perception of the anatomical body in the current visual and media culture. My intention is to provide an intermediary and not just illustrational vision that plays on the boundaries of this perceptual shift – where light no longer only illuminates surfaces, but also defines, and

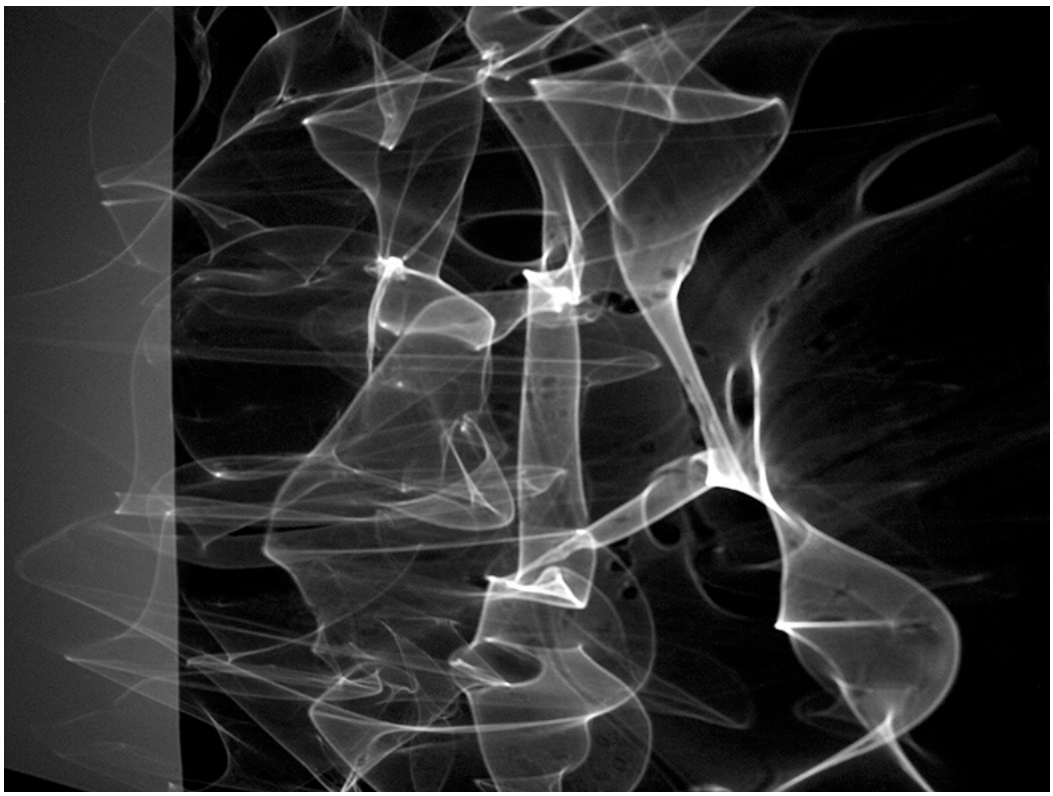

Figure 21. *Lucida,* installation detail. Fehily Contemporary, Melbourne, 2012.

magnifies, transparent volumes without mass.[28] Therefore in *Lucida* I examine the transition from a vision based implicitly on tactile knowledge to the focus of this artwork, which is the immersive spectacle that is inherent to the fabricated visual

[28] The prototype of *Lucida* was titled *Lumen.* The title of the installation reflected the desire to conceptualize anatomy as being determined by light, it is a play on the double meaning of the term *lumen,* being a unit of luminous flux, and alternatively, the central cavity of a tubular or other hollow structure in an organism or cell.

spaces of virtual anatomy, whereby the viewer is also an active producer of the image/body. In *Lucida* I place emphasis not so much on the specifications of imaging modalities, but rather the network of relations and discourses in both culture and science that have been initiated by these technologies. To this end, the images in *Lucida* defy classification as photographs, radiological scans or three-dimensional computer graphics, but allude to all three and are believable as scientific images, while existing exclusively as an artwork.

In the context of my research I view anatomy as primarily the art of locating organs within space. This is the case regardless of whether the space under consideration is a physical space that contains a palpable visceral body, which has its artistic correlate in the sixteenth century representational drawing technique of linear perspective, or, alternatively, whether it is a virtual space, where the body remains intangible, designed to be experienced predominantly by the eye, i.e. the three-dimensional computer reconstructions comprising radiological scans, which allow for fly-throughs of interior bodily spaces. Here surface is depicted as diaphanous and permeable, and seemingly exists to emphasize a sense of interiority and extension, rather than as a dividing boundary between forms. The juxtaposition of these two modes of seeing reveals that the treatment of surface offers an important site of difference that can provide insight into the dynamic relationship of observer, anatomy and light.

Lucida is a poetic exploration of light in relation to the microscopic study of anatomy, a desire that is reflected in its methodology. I have adopted a phenomenological approach, influenced by Heidegger, as a way to actively open up my investigation into light. As light only really exists *for us*, in Heideggerian terms,

referentially, that is to say, our understanding of light is discursive as it unfolds with use and in relation to other *useful things*. To see light as a *useful thing* is to consider it as being meaningful through its relational connection to the world. It appears through the very action of being useful, which is initiated via a network of relational needs, wants, tasks and desires.[29] The pervasive quality of light allows it to be conceptualized in my research as forming a matrix that links image, method and vision. Here, the body is suspended and unfolded as another *useful thing* and visualized as anatomy. Pivotal to this process, and to this space, is an observer who is already receptive and primed for the anatomical experience.

As noted previously, the central idea that I put forward in my thesis is that light-directing technologies create and delineate a *task-envelope*, which essentially defines a perceptible limit to both the observer's action and understanding by determining *what* they see and by instigating *how* they see it. My interest is not in *things*, but in our relation to *things,* therefore it is not the instrumentation existing as objects that appeals to me, rather it is the phenomenological engagement required for their use. I consider anatomy and light not as isolated scientific entities, but as being embedded in their shared history of relational use, and of being useful. In this way I imagine the observer forming part of an operational optical space. With this hypothesis in mind, *Lucida* was devised as a way of exposing slippages and meeting points between different ways of visualizing anatomy.

The idea behind the construction of *Lucida* is to create a hybrid space, made by juxtaposing two differing modes of scientific observation, as the work merges elements

[29] The electromagnetic spectrum could be considered as a historical record of how we have found light to be *useful*.

of the camera obscura with concepts of microscopy. Both of these technologies comprise light, lens, space, image and observer, but in differing configurations, with each instrument determining a distinct viewing experience. In the example of the compound microscope, its invention in the seventeenth century not only enabled the magnification of sight, but also reconfigured the intuitive understanding of space, removing touch from the process of vision and, most importantly with regard to the study of anatomy, separating form from matter. The increased magnification and clarity of the nineteenth-century compound microscope provided yet another quality, as it enabled the *look* of the specimen (comprising volume without mass) to supplant its referent. That is to say, the virtual image, no longer resembling its host specimen, becomes the *thing* under observation and, to a certain extent, gains autonomy.

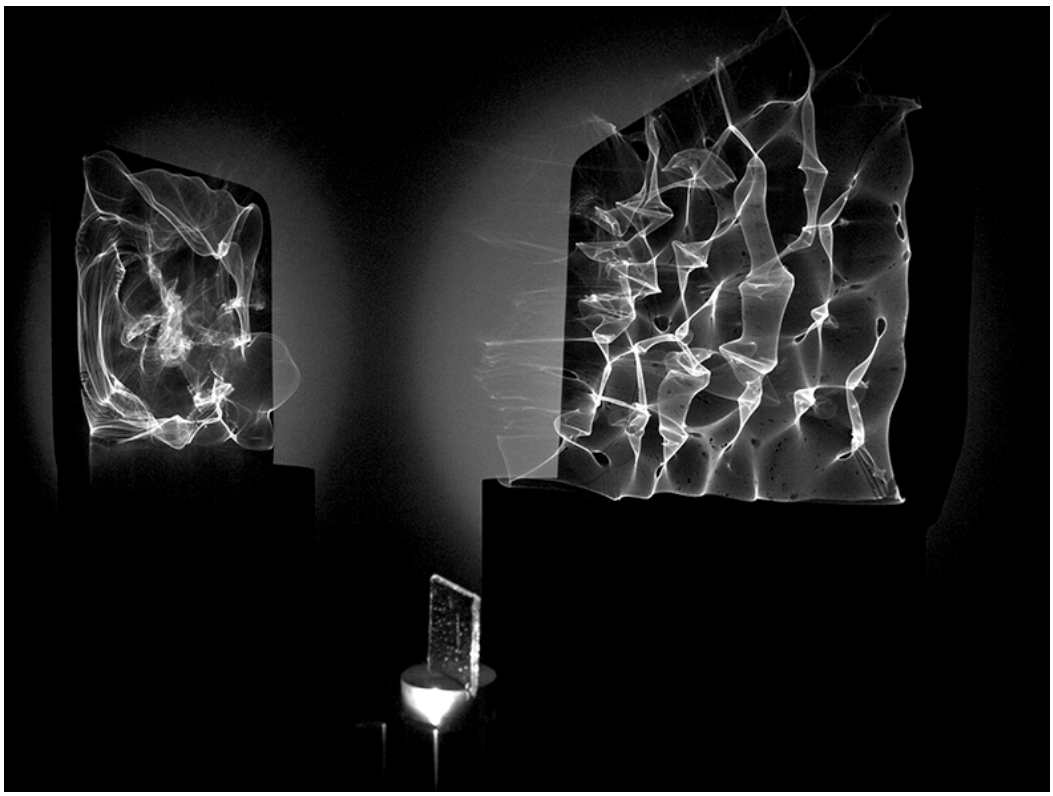

Figure 22. *Lucida,* installation. Fehily Contemporary, Melbourne, 2012. Image dimensions: height 120cm x variable width (x 2). Dimensions of glass stand: 12cm x 8cm. Dimensions of glass: 9cm x 9cm.

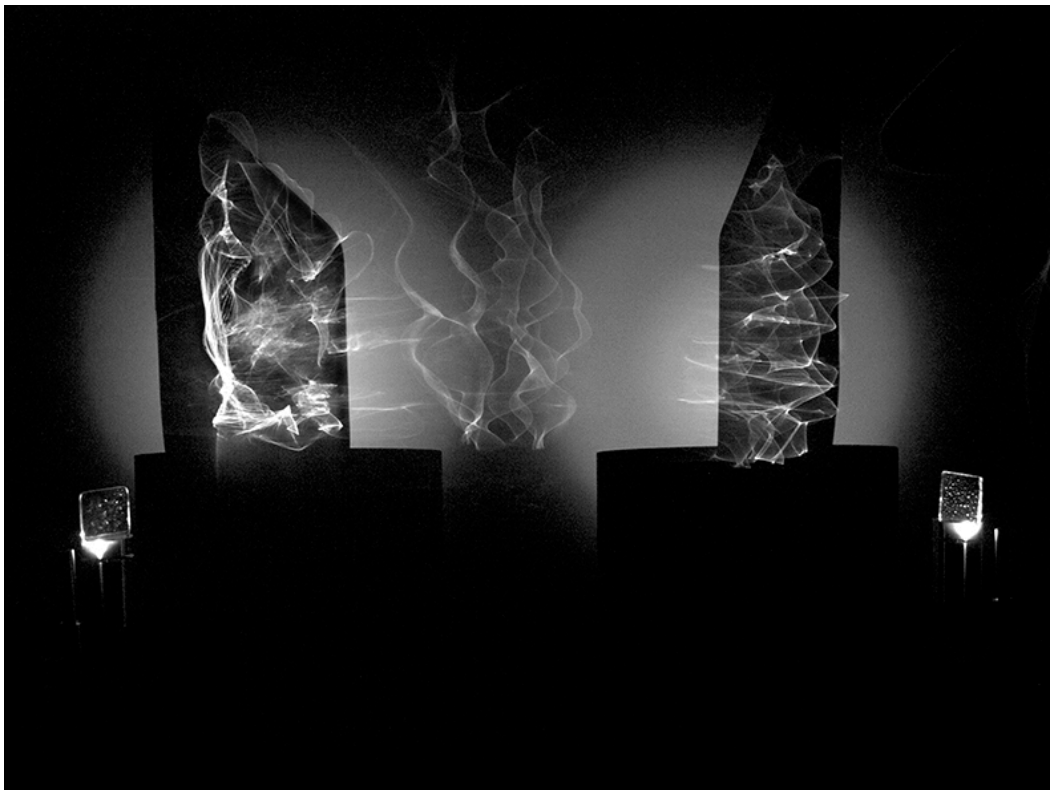

Figure 23. *Lucida,* installation. Fehily Contemporary, Melbourne, 2012. Image dimensions: height 120cm x variable width (x 2).

A laboratory, of sorts, *Lucida* is designed to extend the public experience of viewing anatomy beyond that of looking at documentation of some past anatomical event.[30] The work is to intuit a visual discourse that engages the viewer in a phenomenological investigation of this hybrid, and somewhat ambiguous, observational space. Imagined as a camera obscura room, *Lucida* is both an observational space as well as an instrument that makes images. Essentially, *Lucida* functions as an autonomous, imaging making machine that creates analogue images in real-time, without generating a permanent record. In *Lucida*, generating sight is a whole body experience, as viewers are free to move around the darkened space, to inspect both the magnified images of microscopic structures, which animate the gallery walls, as well as the instrumentation from which they emanate. Here, the camera

[30] The laboratory can be thought of as a theatre for anatomy considered at a cellular level.

obscura plays the role of being 'a model simultaneously for the observation of empirical phenomena *and* for reflective introspection and self-observation.'[31] In this instance, to observe ourselves observing anatomy and to reflect on the 'anatomical gaze.'

Arguably, contemporary anatomical images depict not so much the spectacle of anatomy clarified for public consumption, but rather fabricate visuals that both promote, as well as facilitate, the technoscientific construction of the body. Indeed, to be an anatomical body necessitates our internalization of the technoscientific imaginary that enables us to visualize our existence as such. Engaged in this approach we consider ourselves being in a continual process of advancement, the body perceived as evolving with each new development made in technologically mediated vision. As a result, a way of *seeing* becomes a way of *being* in the world. In regard to microscopy, it could be said that from the nineteenth century onwards we have become increasingly transparent and open to manipulation as we monitor the body at a cellular level and engineer it through the microscopic ordering of flesh.[32]

Indeed, I locate the moment of change that initiates our contemporary vision of anatomy occurring in the nineteenth century with the clinical study of living cells.[33] The science of cytology brought with it the notion of *transparency* as a standardized method of visualizing anatomy. Increased magnification made possible by nineteenth-

[31] Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century.* 1990 (repr., Cambridge, MA: MIT Press, 1992), 40.
[32] Most people in the Western world can visualize their body as being constructed of cells. However, their visualization is usually derived from scientific images that have been enhanced using computer graphics and popularized through the current visual and media culture, rather than from any direct experience of viewing cells through a microscope.
[33] Robert Hooke coined the term cell in 1665, but he was viewing a 'dead box and not a living entity.' Brian J Ford, Robert Hooke's Micrographia (Palo Alto: Octavo Editions 1998). http://www.brianjford.com/a98-hooke.htm (accessed 15 September 2012)

century advancements in optical technology 'seemed to make life itself transparent, to enable the viewer to look *into* and *through* the object, not at it.'[34] Isobel Armstrong in her book *Victorian Glassworlds: Glass Culture and the Imagination 1830-1880* describes this period in English history as giving rise to 'crystophilia', which she defines as a desire for transparent legibility that was initiated by the modernization of glass production.[35] There appeared to be a broader desire for both a practical and conceptual accessibility to the visual world, which not only permeated the construction of scientific knowledge, but also entered the cultural imagination of the era. Kate Flint in her book *The Victorians and the Visual Imagination* observes that,

> Victorian ways of seeing, in broad terms, were both modelled upon, and effectively legitimated by, certain dominant strands within contemporary science, especially the work of physiologists, and of natural scientists, whose work with the microscope in particular provided an endless source of comments filtering into popular culture about how the invisible could be brought to view, and how knowledge and control over the world could thus be obtained.[36]

As I noted previously, the intensified magnification and clarity offered by the nineteenth-century compound microscope provided another equally important quality to our modern vision of anatomy. Not only enabling a proximity to the previously unfamiliar, the modern microscope also created a virtual image, a parasitic image specimen, which did not resemble its host. No longer recognizable as simply an enlargement of that which was already attainable to the naked eye, as experienced by

[34] Isobel Armstrong, *Victorian Glassworlds: Glass Culture and the Imagination 1830 - 1880* (Oxford: Oxford University Press, 2008), 329.
[35] Armstrong, *Victorian Glassworlds, 330.*
[36] Kate Flint, *The Victorians and the Visual Imagination* (Cambridge: Cambridge University Press, 2000), 8.

Robert Hooke in the seventeenth-century, the image now appeared as alien, autonomous and severed from its source, so that object and image bore no similarity.

Similarly to microscopy the images in *Lucida* act as parasitic virtual specimens of spatiotemporally co-existent material hosts, with the two bearing no resemblance. The connection between the glass and their projected architectonic images is only made apparent by their matched incremental rotation. Rarely synchronizing, as the separate glass plates move at different speeds and in opposing directions, they create a choreography that is controlled but not prescriptive. In *Lucida* glass acts simultaneously as the vessel, lens and medium, and light is seen not as a passive illuminator of interior anatomies, but rather as an instigator to their construction.

However, the images in *Lucida* do not record any *real* human anatomy, instead they present plausible, fictional anatomies that reference cytology, the study of living cells. The images occur through an interaction between light and glass that takes place in the gallery; there is no material thing being imaged, as such. Indeed, determining exactly what is being imaged, and locating where the various images reside, becomes somewhat difficult to define. In this way, my research has gone from investigating the role that light plays in the translation of flesh into image, to being a study of the anatomy of light. Indeed, in *Lucida* the body is seemingly displaced by optics.

What am I then presenting in the *Lucida* installation; is it anatomical images of the human body, an explication of medical imaging methods or an analysis of scientific modes of observation? In a way it relates to all three, but in practice it offers none of these. Instead, what is laid bare in *Lumen* is an appropriated phenomenological experience, which has been removed from a scientific context and stripped of its original protagonists, so that it can be relocated, and engaged with, in the cultural context of an art gallery. My working methodology has led me to focus not on *things* as objects but on our *engagement* with things, to a point where the original things are no longer needed. References to people, cadavers, anatomical images, medical equipment, all start to disappear from my work. Instead, what becomes more important is the attempt to elicit and unfold that initial, first-hand phenomenological experience so that it exists and resonates as if it were the original one, though inevitably operating by analogy.

Figure 24. *Lumen* installation

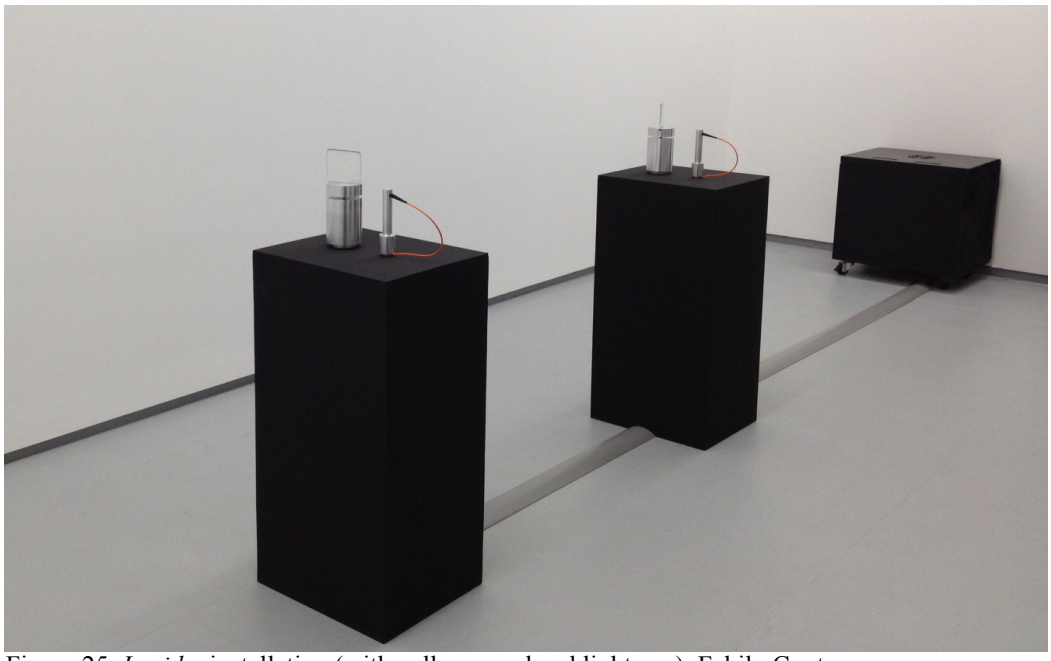

Figure 25. *Lucida,* installation (with gallery overhead lights on). Fehily Contemporary, Melbourne, 2012. Dimensions approx: height 90cm x width 400cm x depth 45cm.

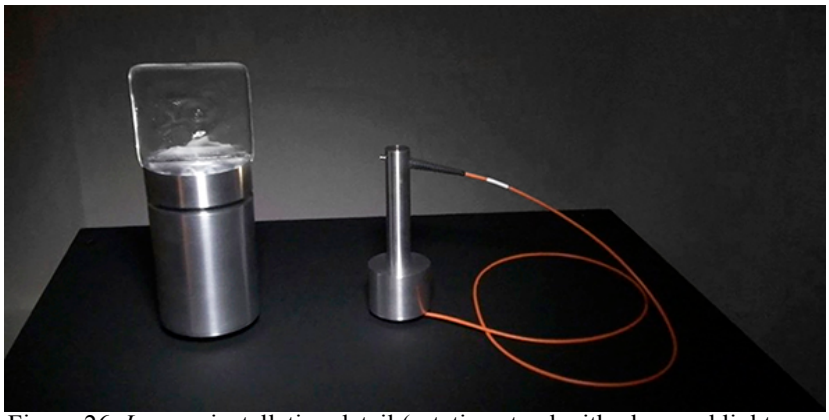

Figure 26. *Lumen,* installation detail (rotating stand with glass and light source) Dimensions of glass stand: 12cm x 8cm. Dimensions of glass: 9cm x 9cm. Documentation by Professor Stelarc (Still from video, GV Art, London, 2011).

Technically, the installation consists of optic fibre cables, coupled to a plasma arc light, which produce small, intensely bright, sources of light that are made visible to the viewer. The fibres direct light at micro-fractures that were created by mixing glass of different refractive indices. The pieces of glass, displayed on separate rotating stands, move in discrete, incremental steps.

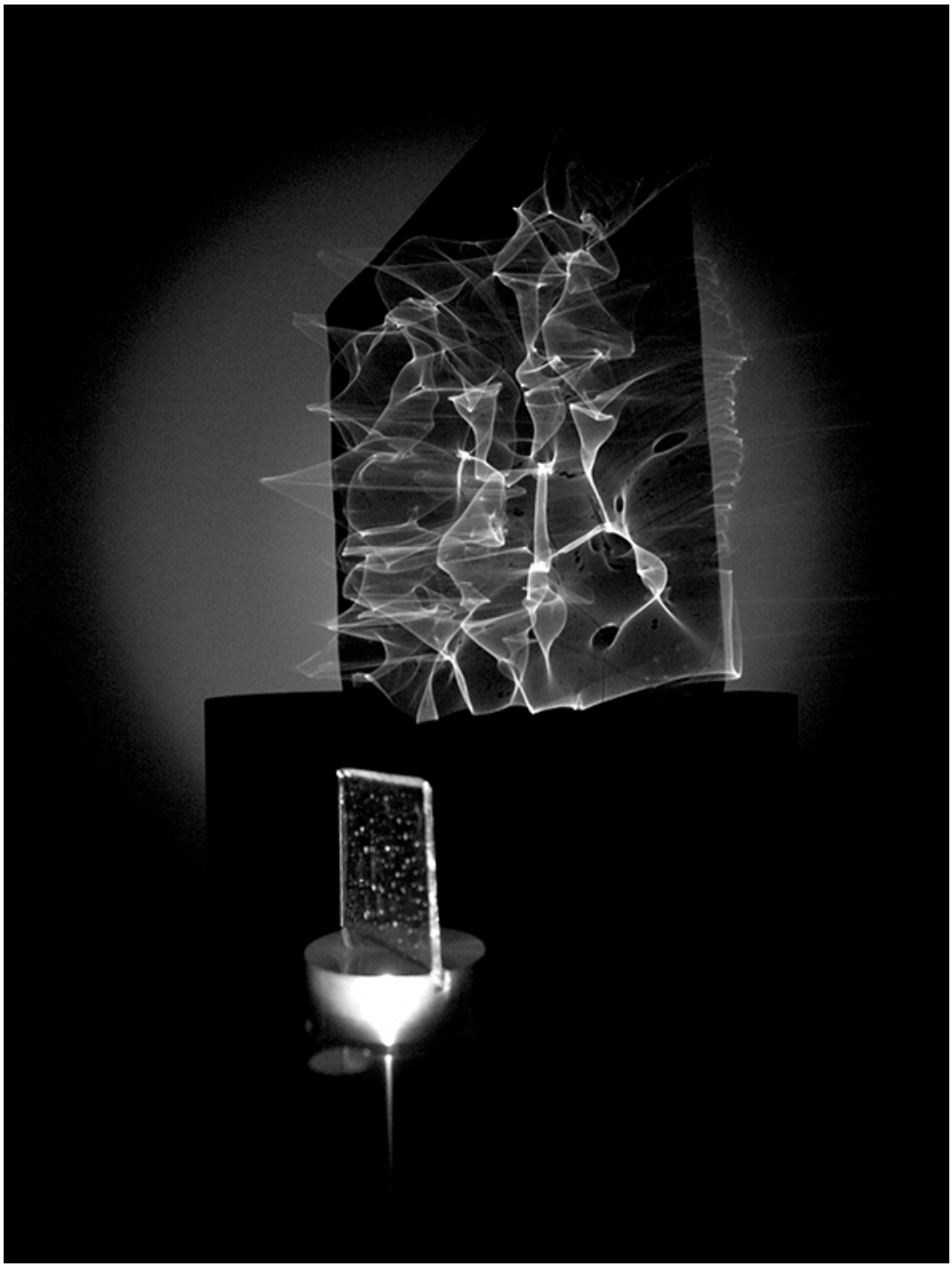

Figure 27. *Lucida,* installation detail. Fehily Contemporary, Melbourne, 2012. Dimensions: height 130cm x variable width. Dimensions of glass: 9cm x 9cm.

The work has been exhibited as a single glass plate (the prototype titled *Lumen*) and also displayed with two glass plates (*Lucida*). In *Lucida* the movement of the glass seemingly creates a choreography, between cells and tissue culture specimens, which appears random, but at times synchronizes (approximately once every 20 minutes).

Figure 28. *Lumen,* installation detail, GV Art, London, 2011. Documentation by Professor Joanna Zylinska.

Lumen was exhibited at GV Art gallery in London, as part of a group exhibition titled *'Art and Science: Merging Art and Science to Make a Revolutionary New Art Form'* (curated by Robert Devcic and Emeritus Professor Arthur I. Miller) 2011.

Lucida was exhibited at Fehily Contemporary, Melbourne, 2012.

This project was initiated during an artist's residency at the Pilchuck Glass School, Seattle, USA, in 2008. It was then developed with the assistance of the Laser Physics Centre, Research School of Physics and Engineering, Australian National University, in 2011. Craig MacLeod (technician/mechanical engineer) assisted with the fabrication and Dr Matthew J. Sellars (quantum physicist) was the advising scientist.

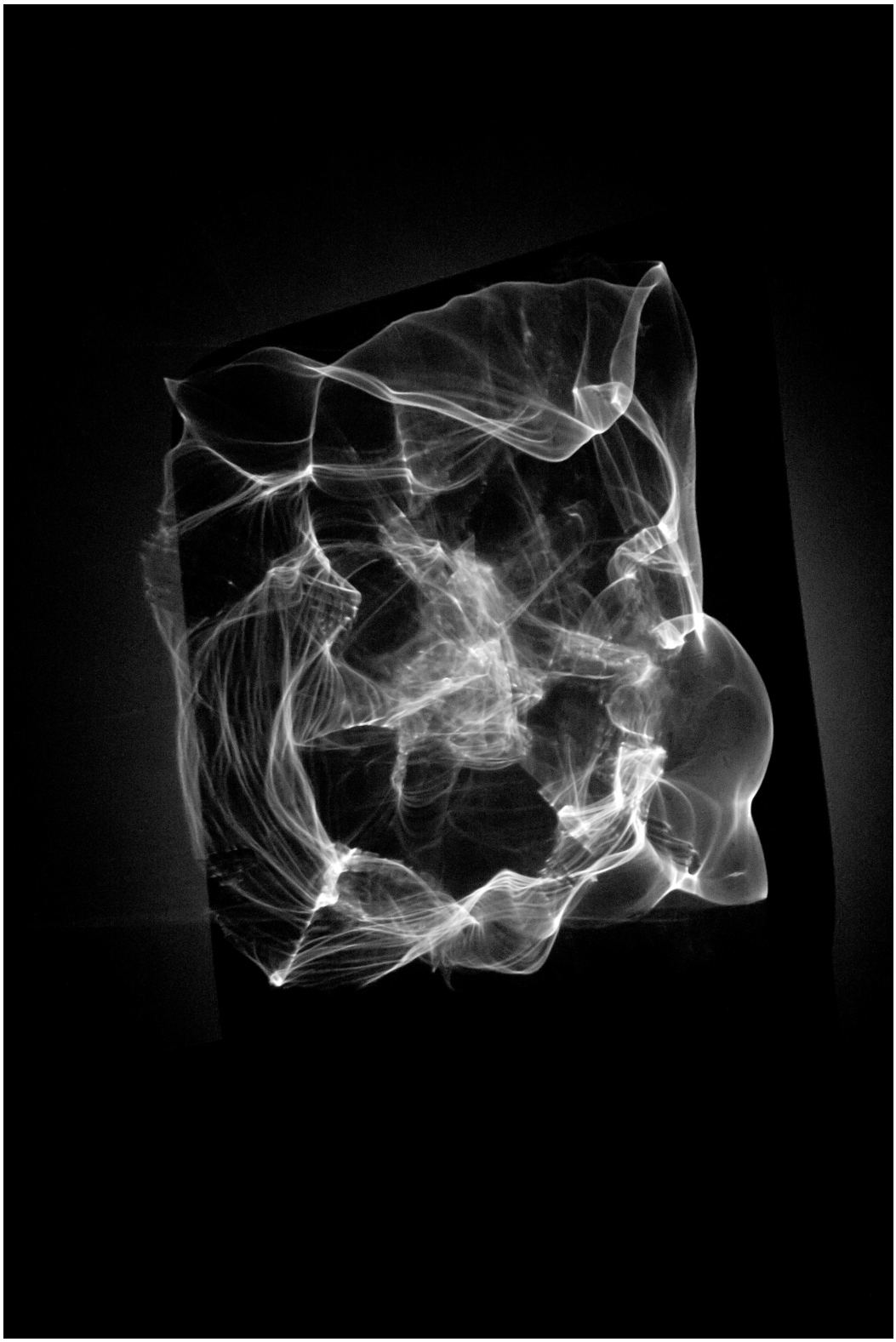

Figure 29. *Lucida,* installation, detail. Fehily Contemporary, Melbourne, 2012.
Image dimensions: height 130cm x variable width.

Scan

This chapter is a discussion of my artwork *Scan*, which is a mixed reality interactive artwork that utilizes smart phone technology. *Scan* is the fourth and final work created for this studio-based research.

Scan is intended as a poetic questioning of the possible interactions that may occur when radiological visuals of the body escape the confines of their scientific context. In *Scan* the objectified scientific body is mobilized into social (interactive) spaces through a series of art installations. In part the following discussion examines the social life of these previously 'institutionalized' bodies.

A planar cross-sectional scan of the body can appear to an untrained eye as simply an abstract image, dislocated not only from a fleshy thus representational body, but also, when viewed outside the medical context, from the body of knowledge which is required for its understanding. What is being seen and not seen by an untrained eye when it views this unfamiliar representation of the body? The answers to these questions lie, in part, with the latent animation that is embedded in scans, which evoke a living body that is visualized as part of a diagnosis. In other words, to decode a scan one must understand the initial process of its encoding. The latter is not exclusively based on technological operations but is rather combined with an accumulation of information and understanding gained from the auscultation, palpation and percussion of a living body, i.e., the diagnostic *listening to the patient*'s body. Therefore, to encode and decode meaning in medical images involves not only total sensory engagement with a living anatomical body but also a need for these observations to be combined with theoretical medical knowledge. To an untrained eye, a seemingly abstract medical

scan only announces the presence of a body, with the scan accepted in its role as a signifier of the body, which has been mediated by technology. In *Scan* I appropriate a set of MRI images and animate them in such a way as to make them too slippery for diagnosis. Thereby the MRI evade their utilitarian function, but remain signifiers of a 'medicalized' body. The animation is then placed online and linked to a QR code, which enables the animation to be downloaded via mobile communication devices, i.e. smartphones.

In this way, *Scan* is also intended as an exploration of the phenomenological experience of being both embodied and embedded in a (technologically mediated) world. Here I adopt the Heideggerian sense of *being-in-the-world*, that of being literally thrown into a process of making sense of the world, which begins with being perplexed by our own existence. This awareness is discursive and unfolds through a questioning of how the world comes into view for us as being meaningfully present, with meaning residing not in things or in perception but in our actions. This idea relates back to the key concept that I put forward in my thesis, which is that light-directing technologies create, and delineate, a task envelope of operational [optical] space of which the observer forms an essential element. In *Scan,* I extend the concept of the *task envelope* to incorporate the Web, as I explore the set of actions required of a viewer who is operating in mixed realities.

There is choreography to viewing art, which actively engages the viewer in what art historian Ernst Gombrich referred to as the *beholder's share*, as 'the mind of the beholder has its share in the imitation.' Here, the artwork forms a link between the imagination of both the artist and the viewer, Gombrich describing the elegance of this exchange as the *sprezzatura* of a heightened imagination. In his oft-cited text *Art and*

Illusion Gombrich discusses the theory of *sprezzatura*, quoting from the sixteenth century guide to social graces *The Book of the Courtier* by Baldassare Castigilone:

> The true artist, like the true gentleman, will work with ease. This is Castiliglione's famous doctrine of *sprezzatura*, the nonchalance which marks the perfect courtier and the perfect artist. "One single unlaboured line, a single brushstroke, drawn with ease so that it seems that the hand moved without any effort or skill and reached its end all by itself, just as the painter intended…. It is an art in which the [artist's] skill in suggesting must be matched by the public's skill in taking hints. [However], the literal-minded… [are] excluded from this closed circle.[37]

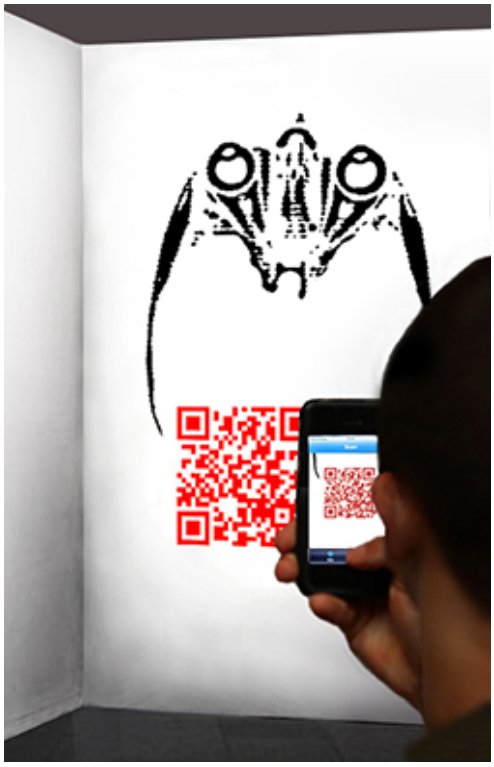

Figure 30. *Scan* – graphic being scanned with a smart phone to access online animation.

Figure 31. *Scan* – the online animation viewed on a smart phone (iPhone).

The *beholder's share* in a digital world is the *sprezzatura* of the smart phone. It is the nonchalant ease with which a person connects to the Internet, allowing him or her

[37] Ernst H. Gombrich, *Art and Illusion: A Study in the Psychology of Pictorial Representation* (Princeton: Princeton University Press, 1960), 163-165.

to move effortlessly through augmented, and mixed, reality. An individual's mastery of the visual technological coding of their environment enables him or her to exist simultaneously in real and virtual environs, and to do so with ease. In this way *Scan* can be described as 'an art in which the [artist's] skill in suggesting must be matched by the public's skill in taking hints,' with both parties required to be 'in the know' with technology.[38]

There are four versions of *Scan* thus far, with each installation of the work generating ideas for the next exhibition.

SCAN – VERSION ONE – (SMART PHONE)

Scan is a mixed reality interactive piece that utilizes smart phone technology. Essentially, the work consists of two elements: a graphic wall image that is presented in the gallery space and an online auto-play animation. The wall image contains an encoded body of information in the graphic form of a QR (quick response) code, which can be decoded using a QR reader on a smart phone.[39] The code links to, and activates, the online animation, which comprises MRI (magnetic resonance imaging) scans of my brain.[40] In this way the artist's brain has been encoded and decoded, and made visible through multiple acts of mediation.

[38] Gombrich, *Art and Illusion, 163-165.*
[39] QR (Quick Response) codes are matrix codes that function as physical hyperlinks, i.e. they normally appear as 'real' images that when scanned, using the appropriate technology and software, provide access to the Internet and form a direct link to a selected online site. Free QR scanner software and additional information about QR codes are available from http://reader.kaywa.com or for iPhone users QR readers are available from the App store.
[40] The images used in *Scan* show the artist's brain after surgical treatment for a brain tumour that left her blind for a period of 1½ years.

The wall image is derived from a MRI scan taken from the animation. The scan, which shows a transverse cross-section of my head, forms the beginning and end of the cyclic auto-play animation. The sequence of scans takes the viewer from the middle of the brain up to the top, then returns down to the base of the spine and rises again to pause briefly at eye-level before repeating. However, the brain has been removed in the wall graphic and is replaced by the QR code; only the eyes and the outline of the skull from the original scan remain.

The main conceptual imperative in regard to the installation of the work is that the graphic image be placed directly onto the gallery wall, i.e. not as a framed picture. The image is to seamlessly integrate with the 'skin' of the building, in this way the surface of the building acts as an interface into the internal architecture of the body. The image elides with a real world space and is simultaneously a threshold into the virtual realm. To this end the graphic wall image comprises micro-thin laser cut vinyl film that adheres directly onto the gallery wall.

In *Scan* the brain is not only dematerialized, but also mobilized, taking it from the physical space of the body to its liminal position in the art gallery. Here the brain is made available through another act of mediation. The animation of the brain, which exists in the virtual space of the Internet, can be dispersed into the personal space of real world gallery visitors via their smart phone. The act of scanning the image enables viewers to leave the exhibition with effectively a little brain playing in the palm of their hand.

SCAN – VERSION TWO – (iPAD MINI)

In this installation of *Scan* the graphic image is installed in the gallery space, as seen in version one, however it is also accompanied by an iPad mini attached to a plinth. This allows the viewer to hold a life-size version of the brain (as an animation) and also enables viewers without a smart phone to access the work.

SCAN – VERSION THREE – (PERFORMANCE)

In this version of *Scan* the physical body of the artist forms part of the artwork and in effect replaces the graphic wall image, which is not used. The QR code is applied directly to my forehead, eliding skin and code in the form of stick-on tattoo. I sit in the gallery space with my eyes closed and remain still with no social interaction. However gallery visitors can approach and if they wish they can use their smart phone to scan the QR code, enabling them to view the interior of my skull.

Figure 32. *Scan* – version three – the performance. Documentation of the artist in the gallery space.

Figure 33. *Scan* – a still from the online animation component of the artwork.

The brain scan is virtual, animated, and somewhat interactive, as it is transposed from the code on my skin to being an animation that appears in the hand of the viewer. In this moment the viewer is not looking at an image as such but engaging with a reflection that exposes the inner materiality of my body. A body that is not so different from their own. Juxtaposed with the physical body of the artist the animation can appear as a virtual memento mori, or as a 'digital revenant' that has returned from the web. The record of this meeting between artist, viewer and digital ghost departs with the viewer, as the link to the brain animation remains on their smart phone and can continue to play. However I am unaware about who has seen inside my head.

SCAN – VERSION FOUR – (CITY INSTALLATION) *(proposal for Festival of New Media and Video Transitio_MX05 in Mexico City in 2013)*

In this version of *Scan* a city space provides the anatomical theatre for a performative act of anatomy. Multiple sites are selected within a 500-metre radius from the art gallery. At each of these sites large-scale graphics of the *Scan* image are rendered directly onto the external surface of a building. These sites act as multiple interfaces to the internal architecture of the body and mark out the perimeter of a notional anatomy theatre. I stand each day of the exhibition in a public site near the gallery at a set time, for a set duration with a QR code on my forehead, similar to that seen in version three. Passersby can scan the code with their smart phones thereby linking them to the animation. This installation creates a choreography of viewing which allows the viewer, through a mediated vision, to socialize with the internal structures of my head (outside the gallery context).

Figure 34. *Scan* – the wall image, 2012. Laser cut vinyl film 140cm x 97.5cm, which links to an online animation.

Scan has been shown in several exhibitions:

- Wellcome Trust London, *Brains: The Mind as Matter,* 2012
- Ian Potter Museum, Melbourne University, *The Anatomy Lesson,* 2012
- Fehily Contemporary, Melbourne, *The Optics of Anatomy and Light,* 2012

CONCLUSION

Beginning with the premise that anatomy is a science predominantly based on visual observation, and therefore itself open to visual investigation, this thesis is an attempt to develop a different way of thinking about the anatomical images of the human body that are increasingly circulating in the current visual and media culture; one that reaches beyond the strictly defined discipline of anatomy. My principal concern is not with the history of medicine, or the structures of the body as such, or even the scientific accuracy or inaccuracy of anatomical images and texts. Instead, my interest is in considering the science of anatomy as a construct and as a conditioned way of seeing the body, which I argue has been instigated by our technological use of light. Essentially a creative study of the scientific discipline of human anatomy and its relationship to light, in which the body and light are considered as physical entities embedded in a shared history of relational use, this studio-based investigation is also, inevitably, a study of our ontology and epistemology – it is a study of who we are and how we visually construct knowledge.

In the exegesis, the historical and contemporary context chapters sketch out a series of dynamic observational spaces, in which the choreography of observer and instrument in the act of anatomical observation unfolds discursively. Appearing in various guises, these performative acts of anatomy are examined in an attempt to uncover key moments in anatomy's history that have challenged, and ultimately altered, our perception of the human body. In investigating the enactment of anatomical knowledge, I consider the observer as forming part of an operational (optical) space in which the act of *seeing* is spatial and intimately related to touch. Essentially, the scientific study of anatomy is based on a vision that aims to isolate and

objectify the body, thereby designating a *'there'* to a rational observer's *'here',* yet in the study of anatomy *'there'* is also presented as tangible and within reach. I introduce the Renaissance optical technology of linear perspective as the original artistic correlate of this way of seeing and throughout the text I highlight perspective as a continuing influence on our contemporary understanding of anatomical images. Conceptualized as a *haptic* vision that is also a Cartesian space, perspective embodies an innate tension in my research. To engender the sense of '[touch] directly involves the threshold of self and other', which inherently risks the collapse of rational space, as we imagine not only how an object feels, and how it makes us feel, but also how the object may be moved by our touch.[1]

In my research, *surfaces* both depicted in images and considered in material form manifest as key sites for examination, exposing the relevance of touch to the study of anatomy and, more importantly, providing a place where concepts of vision can be redefined through a process of juxtaposition. The tactile illustration of surface in perspectival images compared to the transparency of surface inherent to the microscopic study of cells, where surface acts as both a barrier and a medium to infinitesimal anatomical spaces, appears significant. The majority of modern scientific imaging not only is derived from these two ways of seeing, but also increasingly appears as a fusion of the two. Essentially, perspective images evoke palpable realities, while transparency, in combination with magnification, enables visual access to what lies beyond our physical grasp. Interactive fly-throughs of virtual anatomies provide a mix of accessibility and tangibility that allow us to traverse even the smallest anatomical architectures and, to a certain extent, experience them as being within

[1] Marius Kwint, Christopher Breward and Jeremy Aynsley, ed. *Material Memories: Design and Evocation* (Oxford: Berg, 1999), 5.

reach. In this way light, and its interplay with surface, influences our perception of these structures which are apprehended by the eye, hand and mind, simultaneously. Further, this act of beholding is inseparable from the 'light' space in which it is performed.

Essentially, my research sets out to present the cut of human dissection, which is the temporal and spatial act of anatomical study, as being poetically ordered, and determined by light. Here, light appears referentially and in resonance with Martin Heidegger's philosophy of phenomenology, it unfolds with use, for in the enactment of anatomical knowledge light and anatomy appear to us as being meaningful, relationally. The key concept that I put forward is that light-directing technologies create, and delineate, distinct task envelopes of light that are individual to each instrument, which define a perceptible limit to both the observer's action and understanding of anatomy by determining *what* they see and by instigating *how* they see it. As a result, each variant of light reveals, configures and reconfigures anatomy, influencing not only how anatomy is visualized but also how it is recorded in images. In this way, the *cut* of human dissection is conceptualized as a performative act, not only of observation but also visualization, which occurs at the threshold of the real and the ideal, simultaneously creating an idealized body of anatomical knowledge through the systematic dissection of the physical body.

Importantly, the study of anatomy is increasingly undertaken with the aim of reverse engineering the body, as we desire anatomical knowledge not only to construct bodies but also to fabricate blueprints for further possible ways of being in, and with, the world, as well as with others. Indeed, the anatomy of the human body now seemingly can expand to incorporate environments, entities and ideas, made possible

through an understanding of anatomy not viewed as 'static' ideal forms, but rather visualized as a networked system of 'becoming', which is always presumed to be 'becoming-with-others'. Yet the principles of engineering underlie our contemporary study of anatomy, and the construction of good anatomy will involve the logic of good design. However this reasoning raises questions about the political and socioeconomic concerns that set the parameters of good design, which in turn exposes the sense of care and responsibility (or lack thereof) that we have towards 'others.' Placing importance on the hands-on use of biotechnologies in their laboratory-based arts practice, bio-artists offer up contestable realities, 'thoughtful absurdities', which challenge the methodology of science and put forward ethical and social concerns.[2] In practice my work takes a different approach, as my interest lies not with laboratory-based art as such, but rather with the construction of anatomical images, though that is not to say that I forgo the concerns articulated by bio-artists. I consider anatomy a construct that is defined by images. In my research images appear not as a record, or an *a priori* to action, but rather are themselves the meaningful act of anatomy. I relate this idea to the changing status of the image in the twenty-first century, as what constitutes an image, let alone reality, appears in flux; as too our understanding of being human with our identity seemingly dispersed through a network of anatomical images.

In using contemporary media, mediation is not discrete but instead fluid and dynamic, as images transfer through various media with ease. For example, reconstructed CT scans of the human body can be used to produce volumetric images of anatomy that when exported to rapid prototyping machines can materialize as real

[2] Oron Catts, "Bulletproof Skin vs. Utility Proof Art or When a Symbolic Gesture is Seen as Real Action," *Bulletproof Skin: Exploring Boundaries by Piercing Barriers,* ed. G.J. van Trier and Jalila Essaïdi (Eindhoven: Jalila Essaïdi, 2012), 31.

world objects, even as living organs. Consequently, the question of where and how to locate images is becoming harder to define, and increasingly enabled by the Internet, images appear to gain a certain degree of autonomy. The fact that we no longer look at images, but rather interact with visuals, affects our perception of the virtual anatomical bodies that currently circulate in our visual and media culture. Influenced by the changing status of images, we tend to simultaneously engage with anatomical images as 'others' as well as extensions of ourselves. Marshall McLuhan's theories on new media offer a viable approach to uncovering our investment in the 'anatomical gaze'. In McLuhanian terminology, these images are an 'other' that fascinates, however they exist not as an extension of a sense, in the usual understanding of the term, but rather as an extension of our sense of identity which has been disconnected from the body and transposed into images, ultimately forming a *closed system* between viewer, and visualization. I relate this idea back to my prior assertion that since the Renaissance we have been in a process of 'becoming' image; a process that has unfolded for over four hundred years, in which bodies are being displaced by simulacra.

Is a way of 'seeing' becoming a way of 'being', whereby images no longer depict reality but can be thought of as actively determining reality? Following this idea further, are the various new modes in which we engage with anatomical images of the body effectively redefining what it means to be human? In an era when virtual anatomies circulate on the Internet and bioengineered human organs are being printed from volumetric images, my intention is to promote a critical reflection on the study of anatomy and the various processes used for anatomical imaging; but also to provide insight into our investment in the 'anatomical gaze,' which ultimately embraces technoscientific imaginary and sees us 'advancing' in accordance with our imaging technology.

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APPENDIX A

Research Publications: 2008-2012

Solo Exhibitions

2012	**Fehily Contemporary, Melbourne** – *The Optics of Anatomy and Light*
2009	**Shifted Gallery, Melbourne** - *Solid States/Liquid Objects* a (joint exhibition with Joanna Zylinska, Goldsmiths, University of London)
2008	**Guildford Lane Gallery, Melbourne** - *Oblique: Images from Stelarc's Extra Ear surgery*

Group Exhibitions

2012	**GV Art gallery, London –** *Graphite*
2012	**Ian Potter Museum, Melbourne University** - *A Body of Knowledge – The Anatomy Lesson*
2012	**Wellcome Trust, London -** *Brains: The Mind as Matter*
2012	**GV Art gallery, London –** *Polymath*
2011	**GV Art Gallery, London** - *Art and Science: Merging Art and Science to Make a Revolutionary New Art Form* (curated by Robert Devcic and Professor Arthur I. Miller)
2011	**Science Gallery, Trinity College, Dublin** - *Human +: The Future Of Our Species* (in collaboration with The Long Room Hub and the School Of Medicine, Trinity College Dublin, and supported by the Wellcome Trust)
2011	**University of Otago, New Zealand** - *A Medical Perspective,* (hosted by the Dunedin School of Art at the Otago Polytechnic and the Dunedin School of Medicine)
2010	**Australian Experimental Art Foundation** - *Duetto*
2010	**Palazzo Vaj, Monash University Prato Centre** - *Between Bodies*
2008	**Pilchuck Glass School Gallery, Seattle** - *Artists in Residence/Staff Exhibition*
2008	**Shifted Gallery, Melbourne** - *Convergence*

Conferences/Presentations

2012	**Ian Potter Museum, Melbourne University** - *A Body of Knowledge - The Anatomy Lesson,* artist's floor talk
2012	**Wellcome Trust**, **London** - *Brains: The Mind as Matter,* invited guest speaker for the *Perspective* gallery talks series
2011	**Whitechapel Gallery, London** - *Performing Medicine: Screening The Body* invited panel speaker. Mediator: Dr Roberta McGrath; invited speakers, Christina Lammer, Dr Richard Wingate, Nina Sellars
2011	**GV Art Gallery, London** - *Art and Science: Merging Art and Science to Make a Revolutionary New Art Form*, invited panel speaker. Mediator: Professor Arthur I. Miller; invited speakers Stelarc, Oron Catts, Nina Sellars
2011	**University of Otago, Dunedin** *Art and Medicine*, symposium (hosted by the Dunedin School of Art at the Otago Polytechnic and the Dunedin School of Medicine), presenting - *Lumen: Bodies Constructed From Light*
2011	**Monash University, Melbourne** *Solid States/Liquid Objects: Discourses of Mediation***,** one-day international symposium; symposium convener and speaker, presenting - *Almost Seeing: the Anatomical Body Between Light and Shadow*
2011	**Swinburne University, Melbourne** Respondent to Darren Tofts paper, *you can tie me up if you wish, but there is nothing more useless than an organ*
2008	**Coventry University, Coventry** *Photographic Mediations* symposium, invited speaker presenting - *Recording the Anatomical*
2008	**Science Gallery, Trinity College, Dublin** *Lightwave Festival,* invited speaker presenting - *Anatomy and Light*
2008	**Bellevue Arts Centre, Seattle** *In Translation* lecture series, invited speaker presenting - *Anatomy and Pathology in Glass*
2008	**Pilchuck Glass School, Seattle** Artist's talk
2008	**Pilchuck Glass School, Seattle** Demonstration class: Life Drawing/Anatomy for Artists

Symposium Convener

Monash University; International symposium: *Solid States/Liquid Objects: Discourses of Mediation.* Speakers: Professor Gary Hall (Coventry University); Dr Joanna Zylinska (Goldsmiths, University of London); Dr Matthew Sellars (Australian National University); Professor Darren Tofts (Swinburne University); Stelarc (Brunel University); Kit Wise (Monash University); Dr Melissa Miles (Monash University); Nina Sellars (Monash University)

Publications (as author)

2010	**Culture Machine**, vol. 11. *Creative Media*. 'Anatomy of Optics and Light' www.culturemachine.net

Media and Reviews

2012	**ABC Radio National** The Body Sphere - *Anatomical* (artist interview with Amanda Smith)- 23 September
2012	**MIT Press** - *Life After New Media* Sarah Kember and Joanna Zylinska. (Cambridge, MA: MIT Press, 2012), 86-95
2012	**Sunday Times, UK** - *Soul Searching* by Bryan Appleyard - 18 March
2012	**USA Today** - *Brains: London exhibit looks inside skull* - 29 March
2012	**BBC News** - *Brain exhibition explores thinking about grey matter* - 27 March
2012	**Wellcome Trust** exhibition catalogue - *Brains: The Mind as Matter* pp 158 – 159
2011	**New Scientist** [online article] - *Culture Lab: Escape Artists: Breaking Out of the Lab* by Tiffany O'Callaghan
2011	**Wired magazine** [online article] - *3D-Printed Brain Scan Just One Exhibit At London 'Bio-art' Show* by Olivia Solon
2011	**Guardian newspaper** [online article] - *HUMAN + Explores The Technologically Enhanced Future Of Our Species* by Michael John Gorman
2011	**Nature** - *Art: Body work* by Anthony King, Volume 473, p 451, 26 May
2011	**Science Gallery, Trinity College, Dublin** exhibition catalogue - *Human +: The Future Of Our Species* (in collaboration with The Long Room Hub and the School Of Medicine, Trinity College Dublin, and supported by the Wellcome Trust) p 30-31
2011	**Science Gallery', Trinity College, Dublin** Exhibition website - *Human+: The Future of the Species* (in collaboration with The Long Room Hub and the School Of Medicine, Trinity College Dublin, and supported by the Wellcome Trust)
2011	**GV Art gallery, London** online catalogue - *Art and Science: Merging Art and Science to Make a Revolutionary New Art Form.* pp 27 – 31
2010	**Thames and Hudson -** *Art + Science Now: How scientific research and technological innovation are becoming key to 21st-century aesthetics*, Stephen Wilson (London: Thames and Hudson), 78

2010	**Ashgate publishing** - *Art Practice in a Digital Culture*, eds. Hazel Gardiner & Charlie Gere (Surrey: Ashgate), 113 and plate 6.3
2010	**Australian Experimental Art Foundation** - *Duetto* exhibition catalogue p. 40
2009	**Exhibition catalogue essay** - *Solid States/Liquid Objects* by Dr Melissa Miles. Exhibition: Solid States/Liquid Objects. Joint exhibition with Joanna Zylinska
2009	**Litteraria Pragensia publishing** - *Pornotopias: Image, Desire, Apocalypse,* eds. Andrew Mitchel, Jane Lewty & Louis Armand (Prague: Litteraria Pragensia) Book chapter 'Interiors' by Darren Tofts
2008	**Australian Centre of Photography** Photofile: Journal of Photography, Issue 85 *Oblique Strategies: Nina Sellars* article by Ashley Crawford pp. 20-25
2008	**Exhibition catalogue essay** - *The Cut of the Artist: Sellars' Anatomy Lesson* by Dr Joanna Zylinska. Exhibition (solo): Oblique: images from Stelarc's Extra Ear surgery
2008	**Art and Australia** - *Current: Contemporary Art from Australia and New Zealand* edited by Art and Australia, pp.302-303

Collections

2008	**Pilchuck Glass School**, Seattle

Awards & Residencies

2011	**Monash University Postgraduate Research Travel Grant** to undertake research at the Wellcome Trust library, London, and to participate in the panel debate *Art & Science: Merging Art and Science to Make a Revolutionary New Art Form* at GV Art gallery, London
2010	**Australian National University** Artist in Residence, Solid-State Spectroscopy Laboratory, Research School of Physical Sciences and Engineering
2009	**Monash University Travel Sponsorship** to travel to Italy as Arts Tutor for *anARTomy 09* funded by Department of Anatomy and Developmental Biology
2008	**Pilchuck Glass School, Seattle** Artist in Residence
2008	**Monash University** Australian Postgraduate Award, Faculty of Architecture, Art & Design

Teaching: related to PhD research

2010

Associate Lecturer (5 week fixed term contract)
Faculty of Art & Design, Monash University

Sessional Advisor:
Department of Anatomy & Developmental Biology

Unit Coordinator: *undergraduate unit 'Anatomical Drawing' (Prato, Italy)*
Co-organizer: *undergraduate unit 'anARTomy 2010' (Prato, Italy)*

The anARTomy program aims to explore the interrelationship between art and anatomy by investigating their shared history. The students research collections held in various Art and Anatomy museums throughout Florence, Bologna, Padua, Arezzo, Siena, Rome and Venice as well as participate in practical drawing classes and attend art history and anatomy lectures. The unit is a collaboration between the Faculty of Art & Design and the Department of Anatomy & Developmental Biology, Monash University and is led by Adina Kleiner (anatomist), Bernard Hoffert (art historian) and Nina Sellars (artist).

DUTIES IN PRATO

• *Preparing, coordinating and presenting undergraduate lectures, at the Monash University Prato Centre in Italy, for students from medicine and art. The lectures focus on the history of anatomical illustration, the depiction of anatomy in art (historical and contemporary), perspective (techniques and history) and Renaissance art*

• *Conducting practical classes in figurative and anatomical drawing, as well as linear perspective*

• *Advisor for medical students for SPC (Special Project Case) essays and presentations conducted as part of the anARTomy program, Prato, Italy*

• *Assessing and grading student's work for the 'Anatomical Drawing' unit*

• *Curating exhibition of 'Anatomical Drawing' students work, Monash University Prato Centre*

2009 - 2010

Sessional Lecturer: Physiotherapy (Drawing, Art History & Anatomical Illustration)
Department of Anatomy & Developmental Biology, Monash University

Preparing and presenting a series of practical drawing lectures for Physiotherapy students as part of Anatomy classes conducted by Adina Kleiner (anatomy lecturer), Department of Anatomy & Developmental Biology. The lectures focus on the history of anatomy/illustration/art, physiology of visual perception, drawing techniques & life drawing

2009

Arts Tutor: anARTomy 2009, (Prato, Italy*)*
Department of Anatomy & Developmental Biology, Monash University

To accompany medical students along with Adina Kleiner, Lecturer in Anatomy, to Monash

Prato as arts tutor for 'anARTomy 2009'. An initiative of Adina Kleiner the anARTomy program aims to explore the interrelationship between art and anatomy; students research collections held in various Art and Anatomy museums throughout Florence, Bologna, Padua, Arezzo, Siena, Rome and Venice

2008 - 2010

Sessional Lecturer: Anatomical Drawing
Faculty of Art and Design, Monash University

Preparing, presenting and assessing an undergraduate degree course, which focuses on drawing the anatomy of the human body, with instruction in anatomy/physiology, life drawing, physiology of visual perception and drawing techniques. Classes are held at the Faculty of Art and Design, Caulfield campus, and Monash Medical School, Clayton campus. The lectures are presented in collaboration with Ms Adina Kleiner (anatomist)

APPENDIX B

Symposium Pamphlet

SYMPOSIUM SCHEDULE

Co-chair: Prof. Gary Hall, Nina Sellars and Dr. Joanna Zylinska

SESSION 1

10.00 – 10.10	*Introduction*
10.10 – 10.40	Keynote: Stelarc – 'The Cadaver, The Comatose and the Chimera'
10.40 – 11.00	Nina Sellars – 'Almost Seeing: the Anatomical Body Between Light and Shadow'
11.00 – 11.20	Dr Melissa Miles – 'Light, Presence and the Camera: On the Matter and Mutability of Photography'
11.20 – 11.35	*Questions*
11.35 – 12.10	**Break**

SESSION 2

12.10 – 12.15	*Introduction*
12.15 – 12.45	Keynote: Dr. Joanna Zylinska – 'Digital Flow: Photography on the Verge of a Nervous Breakdown'
12.45 – 1.05	Kit Wise – 'Digital Media, Art and the Overexposed City'
1.05 – 1.20	*Questions*
1.20– 2.40	**Break for Lunch**

SESSION 3

2.40 – 2.45	*Introduction*
2.45 – 3.15	Keynote: Prof. Gary Hall – 'Free, Libre, Liquid Media'
3.15 – 3.35	Dr Matthew Sellars – 'Capturing the Quantum Image'
3.35 – 3.55	Assoc. Prof. Darren Tofts – 'Beyond Technological Smartness: the Rise of the p-Zombie'
3.55 – 4.10	*Questions*
4.10 – 4.15	*Conclusion and invitation to exhibition opening*
6.00 – 8.00	**'Solid States/Liquid Objects' – exhibition opening, Shifted Gallery, Richmond**

BIOGRAPHIES

Stelarc has performed with a *Third Hand*, a *Virtual Body* and an *Exoskeleton* 6-legged walking robot. He is surgically constructing and stem cell growing an *Ear On Arm* which will be internet enabled. In 1997 he was appointed Honorary Professor of Art and Robotics at Carnegie Mellon University. In 2000 he was awarded an Honorary Degree of Laws by Monash University. He is currently Chair in Performance Art, School of Arts, Brunel University, London. He is also Senior Research Fellow at the MARCS Lab, University of Western Sydney. Stelarc's artwork is represented by the Scott Livesy Galleries in Melbourne. www.stelarc.va.com.au Second Life site- http://tr.im/jFGN

Dr Joanna Zylinska is a Reader in New Media and Communications at Goldsmiths, University of London. She is the author of three books: *Bioethics in the Age of New Media* (MIT Press, 2009), *The Ethics of Cultural Studies* (Continuum, 2005) and *On Spiders, Cyborgs and Being Scared: the Feminine and the Sublime* (Manchester University Press, 2001). She is also the editor of *The Cyborg Experiments: the Extensions of the Body in the Media Age* (Continuum, 2002) and co-editor of *Imaginary Neighbors: Mediating Polish-Jewish Relations after the Holocaust* (University of Nebraska Press, 2007). Zylinska combines her philosophical writings with photographic art practice. www.joannazylinska.net

Prof. Gary Hall is Professor of Media and Performing Arts at Coventry University , UK. He is author of *Culture in Bits* (2002) and *Digitize This Book! The Politics of New Media, or Why We Need Open Access Now* (2008). He is also founding co-editor of the open access journal *Culture Machine* (http://www.culturemachine.net) and co-founder of the *Open Humanities Press* (http://www.openhumanitiespress.org). His work has appeared in numerous journals, including *Angelaki, Cultural Politics, Cultural Studies, The Review of Education, Pedagogy and Cultural Studies*, and *The Oxford Literary Review*. www.garyhall.info

Dr Matthew Sellars is a senior research fellow in the Laser Physics Centre, Research School of Physical Sciences and Engineering, Australian National University. His research interests centre on quantum measurement and quantum information processing using optically active ions in crystals. He has published in numerous journals including *Physical Review Letters* and *Journal of the Optical Society of America*. His work on stopping light for over a second was voted by the Chinese Academy of Science as one of the top 10 international scientific achievements in 2005.

Assoc. Prof. Darren Tofts is Associate Professor of Media and Communications, Swinburne University of Technology. His publications include *Memory Trade: A Prehistory of Cyberculture* (1997), *Prefiguring Cyberculture: An Intellectual History* (2003) and *Interzone: Media Arts in Australia (2005)*

Nina Sellars is an artist and PhD student in Drawing at the Faculty of Art & Design at Monash University, where she also lectures in Anatomical Drawing for both the Medical and Art Faculties. She has trained and worked as a Prosector (dissector of cadavers for medical display) and often works collaboratively with scientists and artists on cross-disciplinary projects. Her artwork utilizes drawing, photography and installation, and has been exhibited nationally and internationally. In 2008 Sellars was an invited speaker at the Science Gallery, Trinity College, Dublin, Coventry University, UK and the Bellevue Arts Centre, USA. www.ninasellars.com

Kit Wise is an artist, art writer and curator, and has published over 50 book chapters, articles, reviews and catalogue essays since 2003 including texts for Australian and international art journals such as *Artlink, unMagazine* and *Frieze*. A graduate from Oxford University and Royal College of Arts, with an MFA in Sculpture, Wise has travelled and researched extensively overseas assisted by a Wingate Rome Scholarship in Fine Art, a Boise Travel Scholarship, administered by the Slade School of Fine Art, and Australia Council grants. He is currently Acting Head, and a Senior Lecturer in Fine Art, in the Faculty of Art & Design, Monash University as well as the Bachelor of Fine Arts Honours Course Coordinator.

Dr Melissa Miles is based at the Department of Theory of Art & Design, Faculty of Art & Design at Monash University. Her research on photography, light and visuality has been published in numerous journals including *The Journal of Visual Culture*, *Word and Image* and *Southern Review*, and forthcoming papers will appear in *Photographies* and the *Australian and New Zealand Journal of Art*. Melissa's essays on diverse aspects of contemporary art also appear regularly in the Australian arts press. Her book, *The Burning Mirror: Photography in an Ambivalent Light*, was published by Australian Scholarly Press in 2008.

SOLID STATES/LIQUID OBJECTS
DISCOURSES OF MEDIATION

The symposium will bring together artists, scientists and media theorists providing insight into how information is deployed, mediated and embodied within various disciplines and fields of enquiry.

MONASH University
Art & Design

KEYNOTE ABSTRACTS

The Cadaver, the Comatose and the Chimera
Stelarc

Flesh is circulating. Faces are detached and stitched onto other bodies, becoming third faces. Cadaver limbs are animated by other brains. Organs are extracted from one body and implanted into another. The blood flowing in my body today might be circulating in your body tomorrow. Ova are fertilized with sperm that were once frozen. Cryogenically preserved bodies await reanimation at some imagined future. Stem cells replicated in-vitro are reinjected and repair the body in-vivo. Prosthetic parts augment damaged and diseased bodies. Paralyzed bodies are machine actuated. Dead bodies can be preserved forever with plastination whilst comatose bodies can be sustained indefinitely on life-support systems. Chimeric entities can be now engineered in the lab. The dead, the undead, the not yet born and the partially living now exist simultaneously. Organs might be grown and might be 3D printed. Organs will be in excess. Organs will be awaiting bodies. Organs without bodies.

Digital Flow: Photography on the Verge of a Nervous Breakdown
Joanna Zylinska

Digital technology has played a significant role in the transformation of commercial and art photography: witness the convergence of different media resulting in mobile phones doubling as still and video cameras; or the proliferation of photo sharing websites such as Flickr, where amateur photographers can post their portfolios next to those of seasoned professionals. The context for this paper is provided by this transformation of the photographic medium and practice in the digital age. However, its aim is to explore deeper anxieties over the challenge to our established notions of art, culture and the media that digitisation has posed. It is also to query some of the ways of protecting these established notions and values via multiple strategies of remembrance, archiving and data storage. Although I will look at the issue of digitisation through the lens of photographic arts – Gerhard Richter's Atlas, Walid Raad's The Atlas Group Archive, Tacita Dean's Floh – my concerns in this paper are socio-cultural and political as much as they are aesthetic.

Free, Libre, Liquid Media
Gary Hall

This talk will present a series of performative media projects or 'media gifts'. Operating at the intersections of art, media and philosophy, these projects are gifts in that they are part of the 'academic gift economy' which circulates work for free rather than as market commodities. They are performative in that they are instances of media that endeavour to produce the effects they name or things of which they speak. The particular 'media gift' my talk will focus on is Liquid Books (http://liquidbooks.pbwiki.com/FrontPage). This consists of a series of digital 'books' that are available in an 'open access' format, which means that they are free for anyone to read online, on a worldwide basis. However, they are also based on the principles of 'open editing'and 'free content'. In other words, these books are 'liquid' in the sense that users can continually rewrite, remix and reinvent them. As a result the Liquid Books project raises some challenging questions for our ideas of the author, editor, artist, designer, publisher and 'the work'

ABSTRACTS

Capturing the Quantum Image
Matthew Sellars

Quantum mechanics holds that there is a fundamental limitation in the process of recording an image. Images are created by measuring aspects of the light, recording the resulting information and then displaying it in a way that can be interpreted by an observer. The uncertainty principle states that we cannot measure simultaneously all aspects of the light with infinite precision. The object and the observer cannot be separated, with the very act of observing any one characteristic of the light unavoidably altering the others. In this paper I discuss my research team's work on "stopping light", a new recording process that sidesteps the uncertainty principle by postponing the measurement of the light until the final viewing of the image. The concept is to map the light onto the quantum states of a crystal, effectively stopping the light. To view the image we reverse the time evolution of the crystal's quantum states.

Beyond Technological Smartness: the Rise of the p-Zombie
Darren Tofts

What happens when mediated agents obtain agency and operate beyond our control? From the myth of Prometheus to the "mind children" of Hans Moravec, the idea of artificial agents has both beleaguered and fascinated the human imagination. This paper will explore a micro-history of this fascination and its potential realization in the contemporary philosophical concept of the *p-zombie*, the "philosophical zombie" of cognitive science, developed as an acid test for distinguishing between a human and its artificial replicant. The paper will ground this idea of agency beyond human control in terms of the most recent series of generative computer animations by the media artist Murray McKeich. The title of this series is called, appropriately, p-zombie.

Almost Seeing: the Anatomical Body Between Light and Shadow
Nina Sellars

How does light affect what we see and experience in relation to the anatomical body, and how are these experiences articulated through image? With the magnification of sight and intensification of light, made possible through various technological advancements, it has allowed us to view what had previously lain invisible in the anatomical body. But just as importantly, if not more so, they have also provided us new ways to conceptualise these recently discovered structures, both intellectually and ideologically. This paper focuses on the role that light plays in the translation of flesh into image, presenting light as an instigator rather than a passive illuminator of anatomical knowledge, and thus also a transmitter of ideology with regard to the body, identity and subjectivity. The paper will discuss my recent installation *'Anatomy of Optics and Light'* (2009) using the artwork as a lens through which to explore and evaluate these ideas.

ABSTRACTS

Digital Media, Art and the Overexposed City
Kit Wise

Popular culture is strewn with visions of the urban spaces of the future. How do artists of our time navigate this territory? This paper addresses Paul Virilio's notion of the 'overexposed city' through contemporary Australian art practice, in order to investigate the current cultural imagining of the 'future spaces' of the city. In one sense updating the cliché that a painting offers a window on the world, this paper substitutes recent art works by contemporary Australian artists for Virilio's 'door without a city'. In attempting to discern the status of urban architecture in relation to the exponential development of technology, Virilio identifies 'a transmutation of representation' that he discusses in terms of film: here, more than anywhere, advanced technologies have converged to create a synthetic space-time'. The contemporary Australian art works serve to chart this filmic mediation or 'transmutation' from a geographical to a temporal representation of space as motion, where 'the living and the living dead merge to the point of delirium'.

Light, Presence and the Camera: On the Matter and Mutability of Photography
Dr Melissa Miles

Light has long served as a key myth of presence in photography. As an invisible, external agent, light yields ontological ground to objects, and forges an apparently direct link between those objects and the photographic emulsion. Foreclosed in these photological schemes are the fugitive, mutable and differential qualities of light. By drawing on Derrida's notion of the heliotropic character of metaphor and the recent pinhole photographs of the Japanese photographer, Tokihiro Sato, this paper will rethink notions of light and presence in an attempt to open up the practice and theory of photography to more dynamic modes of understanding.

Solid States/Liquid Objects: Discourses of Mediation
Symposium Venue
Lecture Theatre G1.04, Art and Design Building
Monash University
900 Dandenong Rd Caulfield East

Date & Time
Wednesday 19 August 2009, 10 – 4.15

The event is open and free for all
All enquiries please contact event organiser Nina Sellars
Nina.Sellars@artdes.monash.edu.au
Symposium schedule, abstracts and bios available online:
http://ninasellars.com/symposium/

The symposium will be held in conjunction with the exhibition SOLID STATES/ LIQUID OBJECTS, which will be held at the Shifted Gallery, Level 1, 15 Albert Street, Richmond. All attendees at the symposium are warmly invited to come to the exhibition opening on the evening of the symposium (19 August, 6-8pm)

THE ANATOMY OF OPTICS AND LIGHT

Nina Sellars

I

What role does light play in the translation of flesh into image? Through a reflection on my art practice, this article positions light as an instigator rather than passive illuminator of knowledge. With the advent of new technologies which are able to emanate, record and capture light, our perception of the anatomical body alters and a new body is imagined. This phenomenon leads me to investigate not only how light affects what we see and experience in relation to the anatomical body, but also how these perceptions and experiences are articulated through images and engaged with outside of the medical context. I propose to examine these questions by exploring the relationship between the anatomist, the artist and the public audience in their shared observations of the anatomical body. Enacted within a notional space of an anatomy theatre – a space whose design and philosophy go back to the Renaissance – the questions and relations are addressed through a series of mediations and relocations of the anatomy theatre that I perform through my art practice.

This paper takes as its focal point my recent artwork, *Anatomy of Optics and Light* (2009),[1] where the theatre is translated from its medical incarnation into an art gallery installation. Readers can also visit the interactive screen space online), which is to serve as more than mere documentation of the earlier work. Instead, it becomes yet another act of translation, with the theatrical space of the gallery being transposed into the virtual realm.

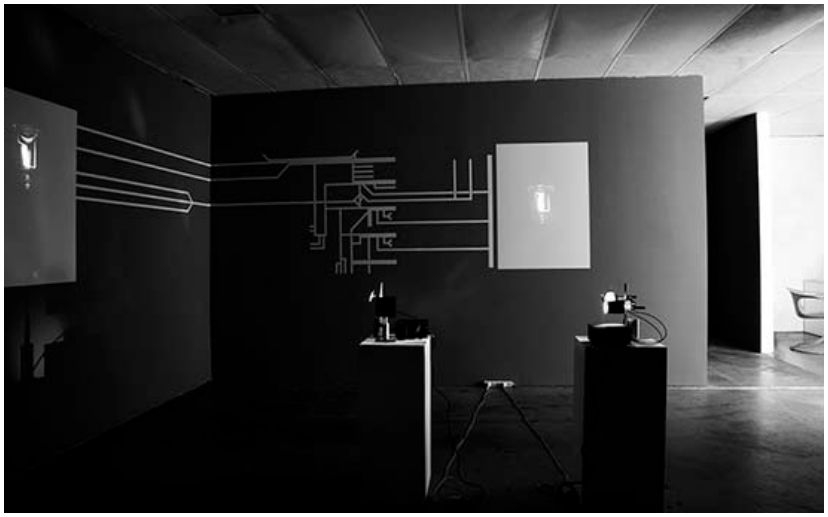


Fig. 1, Nina Sellars, *Anatomy of Optics and Light*, 2009. *View the installation by clicking on the image above, or by cutting and pasting the following link into your Internet browser: http://www.ninasellars.com/anatomy-of-light. You need to have QuickTime installed on your computer to view it correctly.*

This project has been devised as an investigation of the optical and technological dispelling of darkness in relation to bodily interiority. This process involves questioning the related representations and imaginings of the anatomical body which have been created by the interplay of technology and phenomenological experience. With the magnification of sight and the intensification of light, both enabled through various technological advancements, the viewer has been allowed to see what had previously lain invisible in the anatomical body. But just as importantly, if not more so, he or she will have been introduced to some new possible ways of thinking about human corporeality. As an artist who has experience of working within a medical context, I want to look at the production and representation of bodies in the realms of science and popular culture. We have to bear in mind here that, even in its scientific representation, the body remains embedded in culture and also that anatomising the body has always been a public – and not just scientific – concern.

II

The *Anatomy of Optics and Light* installation engages with multi-scale representations and imaginings of the body. It incorporates a diagram of a nervous system, which is visualised as a hybridisation of human tissue and light, and which exists as part of the technological environment. Magnified and extended across the gallery walls, it

escapes the usual diagrammatic confines of a page or screen and even eludes the artistic capture of framing. Instead, it gains its physical dimensions through the very act of installation. What is enacted here is not a body *within* a space; rather, a space is being defined *by* a body. In other words, viewers are presented with a spacious soma which invites a total sensory engagement with the abstracted corporeal structure. In a traditional anatomical theatre onlookers would gather in encircling stalls above a central stage where an anatomist would stand, opening a cadaver for display. However, in *Anatomy of Optics and Light* this schema is reversed. It is now the anatomical body intended for display that encircles the room, with the body that was to be viewed replaced by a viewing body. Viewers are thus not immersed in a representation of a visceral dissection room, nor are they invited to inspect a figurative wet body. Instead, they are surrounded by a diagram, with the discernable fleshy 'stuff' receding from sight and supplanted by a nervous system that has been translated into the diagrammatic language of electric circuit board design. It depicts the motor nerves that enable breathing and the movement of the arms, legs and head, showing the four main nerve plexuses – sacral, lumbar, brachial and cervical – that run from the spinal cord into the neck and limbs. Certain sections of the nervous system have been extended or stretched, but the linear order and connectivity within the individual plexuses have been maintained: the plexuses are stitched together to make a visually integrated whole, but not a whole coherent body. The term *diagrammatic language* signals that an abstract approach is being used here, which is produced through conceptualisation rather than an attempt to represent. The diagrams reveal a desire to understand and extrapolate ideas from appearances. *Appearing* and *thinking* are therefore not opposed to each other; rather, the former is the initial stage of the latter, with phenomenological engagement serving as an *a priori* to both.

The installation contains five devices, which I call *inverse camera obscuras*. They had been specially made for the exhibition. Each identical device is built from lathed brass. It houses a small light bulb and supports a ground glass lens with an adjustable diaphragm aperture. The usual working mechanism technique of the *camera obscura*, i.e. that of portraying an external scene onto an interior wall, has been inverted here, with an object contained within a small internal space being imaged and projected out. It is an interior that has been ousted for observation. The lens magnifies and projects the light emanating from a small bulb contained within the construction, so a 1-centimetre tall light bulb forms a 1-metre tall image on the

opposite gallery wall. The light here not only transmits the image but also becomes the image. The bulbs cannot be viewed or accessed directly; they are accessible to the viewer only as real time images (see fig. 2).

Fig. 2, Nina Sellars, *Anatomy of Optics and Light*, 2009, detail

Dust and small imperfections in the glass are magnified along with the glowing filaments, all in sharp focus, and offered up for close inspection, making visible what would have otherwise remained hidden. The multiple *inverse camera obscura* images link and illuminate the diagrammatic lines, but they also act to displace the central focus of the installation. The idea behind this set-up was to increase the impression of the installation forming a body/light environment, where one element does not dominate or act independently from the other. In other words, what we are presented with is a system or nexus of body and light. The body presented here is not only to be seen but also to be experienced via a process of all-sensory *listening*. It is a dispersed, abstracted body that exists, and surrounds the viewer, in the half-light of the gallery space. The externalised nervous system seemingly embraces the viewer both visually and aurally, with the power amps that provide the electricity to the *camera obscuras* creating an audible hum that permeates the room.

The combination of such simple technologies is aimed at exploring questions regarding how light affects what we see and experience in relation to the anatomical body and the ways in which these perceptions and experiences are articulated through images. These are questions that can be asked of the anatomical body's relation to light from the time of its inception as a science in the sixteenth century to its contemporary medical context. The proliferation of various anatomical images, both historical and modern, in medical science defines different approaches to the human body. These approaches are all a combination, in varying degrees, of theory, observation, culture and technology. We can compare, for example, a woodcut print from the first illustrated anatomy book *Commentaria* (1521) by Jacopo Berengarius da Carpi, figure 2, with a contemporary PET (i.e., positron emission tomography) scan, figure 3.[2]

Fig.2, *Commentaria*

Fig. 3, PET scan

Both images record light, which emanates out of an anatomical body, but they were made over four hundred years apart. PET scans are a record of a chemical reaction, brought about by an injection of radioactive materials into the body, which produces gamma rays that are emitted out from the body and then digitally imaged. The Berengarius woodcut also depicts light emanating out from the body, but here light symbolises 'philosophical and religious knowledge of the interior of the whole, or scripturally complete, individual' (Sawaday, 1995: 118), which is a reflection of the sacred beliefs of the era. Both images are laden with complex meanings and encoded with information. They may seem equally indecipherable and inaccessible to a lay person as they rely on being able to understand the context in which they were made and their intended use. It is also important to remember that anatomical images are never truly objective; they are created in the context of their time and are therefore subject to the technologies and beliefs of that time.

Anatomy of Optics and Light incorporates the use of contemporary technologies not only in the making of the *inverse camera obscuras* but also in the creation of the drawn images. There is a certain clinical precision to the schematic lines of the diagrams adhered onto the gallery wall, with the computer-generated graphics converted into laser-cut vinyl. The aim here was to uncouple the *line* from the *mark* of the artist and to emphasise instead the *cut* of technology. It is a visual analogy that refers to medical scans, with their precision, abstractness and absence of any *first-hand* mediatory mark of a human observer. As a comparison, in the Renaissance the process of manual dissection – guided by an observing, corporeal eye – was mirrored in the hand of the artist. The draw of the artist's blade equated the draw of the engraver's scribe, with both exploring and exposing the interior of the body. *Anatomy of Optics and Light* is purposefully devoid of the emotive direct interplay of the artist's body with a medium and is accompanied by the absence of an instantly recognisable image of the anatomical. Neither the corporeal body nor the mark of the maker are apparent in the installation. Instead, both have been visibly mediated by technology. The diagrams and the large rectangular sections that act as the *camera obscura* projection screens, as well as the exhibition wall text, were all produced by using the same method. The micro thin pearlescent-white vinyl, peeled from adhesive backing sheets in 4-metre long sections and pressed onto the dark walls of the gallery, creates a continuity in the work that links text, line and screen. At the end of the exhibition, when the power was turned off, the images and light patterns instantly disappeared. The elastic-like vinyl was then pulled and separated from the walls. It was in that moment that the diagrams appeared at their most corporeal, even fleshy, taking the form of sticky, knotted and visceral lines gathered on the gallery floor.

The installation was subsequently subject to another act of translation in the process of preparing this online article. It has been translated into compressed digital information to allow it to operate as an interactive panorama for the purposes of its publication in *Culture Machine*. This kind of visualisation offers an additional way of exploring and engaging with the space and takes the investigation of the body from the visceral 'cut and slice' to a virtual 'click and drag'. The eye of the viewer has been extended out from the body into the virtual room. Most importantly, it has become an eye that, to its greatest advantage, has been separated from a vestibular system. It is therefore not inhibited by dizziness or disorientation.

Speed and *spin* can thus be used as tools of investigation as it is now the room itself that is turning with the draw of a hand and not the viewer. The displacement of the audience and the dispersion of the body are also more apparent through the mediation of the Internet, where the viewer plays audience participant and is offered a certain anonymity and accessibility. The space is always available to the viewer to be entered, downloaded, transferred, sent, relocated, expanded, flattened and repositioned at will. It has been disconnected from its real world position and the volition of its maker.

III

One of the driving forces behind this project was a desire to explore how light illuminates, irradiates and exposes structures of an anatomical body to the receptive, ambivalent eye. Light alters our phenomenological engagement with the anatomical body and conditions our understanding of anatomical images. Engaging with images of the anatomical body created by penetrative light has become more than just an act of looking with the eye. It is now also an experience of listening *with the body*, in both senses of the term. In the *Anatomy of Optics and Light* installation the diagram, and the installation as a whole, are used as visual analogies for medical imaging technologies that in themselves can be elaborate to the point of distraction. The operational complexities of the equipment and the medium specificity of the images can promote a sense of wonder with 'scientific fact', which in turn can deflect attention away from the questions that I want to raise regarding ideological and phenomenological concerns. Therefore, the aim of the installation is to explore not so much the structures and technical processes involved in bodily imaging, but rather the network of relations and discourses around the anatomical body, both in culture and science, that have been initiated by these technologies. It is assumed that some preconceived ideas regarding what *anatomy* and *light* are – developed from their prior phenomenological experience of being embodied and embedded in the world – will be brought by the viewer into the art gallery as well as to the reading of this article. The project aims to raise questions about how far we can abstract an image of an anatomical structure before anxieties arise. How can we connect with a body that is not available to us as an easily defined and accessible object? We have to bear in mind that the anatomical body is always a construct, while anatomical images are abstractions of a certain *idea* of what a body is. The study of anatomy is therefore

also a study of contemporary ways of thinking, seeing and managing knowledge and information.

To proceed with this argument, we should perhaps clarify what anatomy *is*. The etymology of the term 'anatomy' can be traced back to the Greek *ana-*, meaning 'up', and *temnein*, meaning 'to cut'. In the medical sciences the term anatomy refers to the structures of the body, its organs and the systems. It is different from physiology, which describes the body's functions, and encompasses the movement and animation of those structures. Conceptualised in this way, the anatomical body can be understood as a still body, a non-moving body, and this remains equally true regardless of whether the body being considered is living or deceased. The anatomical body's condition of stillness relates directly to its intended use. It is a body to be investigated and recorded, whether by using modern medical imaging to capture images of the internal structures of the living body, or through the manual dissection and documentation of the deceased body. Anatomy can then be thought of not only as structures of the body but also as a method of questioning, an approach to the body that denotes, and was created by, scientific enquiry. However, by placing focus on the translation that happens when the *manual cut* of dissection – one which is guided by a corporeal eye – is replaced by the *virtual cut* of technology that is produced through the invisible penetration of light used in modern medical imaging, it becomes clear that this very method of questioning, that is to say *anatomy as a methodology*, has changed. With the cut, the spectacle and its visual realisation are now being performed as one instantaneous act. There is a sense of speed and immediacy that enters the discourse surrounding anatomy, but there is also an entirely different set of phenomenological engagements that are brought into play when light, from the extremes of the electromagnetic spectrum, is used as a medium to view and image the interior of a living body. In this discussion, I want to engage with the traditional meanings behind anatomy, with a view to redirecting them towards a more animated definition, one that will allow for a *quickening*[3] of the anatomical body through its active relationship with light.

When compared to the apparent stillness of the anatomical body, light can be described as an active, dynamic force – not only in a physical but also in an epistemological sense. Light itself is an unstable concept. It is difficult to define as it traverses various areas of knowledge in which it functions as both metaphor and physical agent. The philosopher Jacques Derrida refers to metaphors of light

as forming the basis of all philosophy when he states that 'the entire history of our philosophy is a photology' (1978: 27). Media theorist Marshall McLuhan conceptualises [electric] light as a pervasive medium that alters our sensory engagement with the world: for him light exists as 'pure information' (1964: 57). Identifying what light means in the context of my art practice has been an ongoing and context-dependent process. My study of light originally began in the realm of physics. As the area of knowledge that had constructed the anatomical body, science appeared a logical departure point for me, providing a methodology that placed light as part of a measurable, physical world. This is where I thought light would appear the clearest, the most stable and easiest to grasp. That departure point soon became a point of disappearance: the place of the last sighting of an elusive force. As 'light both reveals matter and ultimately retreats to a realm where it remains inaccessible to sight and to reason' (Miles, 2008: 37), light in itself cannot be seen and is accessible only through a combination of discourse, representation and affect.

In common usage, light is normally classed as a visible sub-section of the electromagnetic spectrum, but in the context of this article, and my wider art practice, I refer to light as comprising the entire spectrum, including its invisible parts.[4] (This definition was not arrived at arbitrarily: it was made in consultation with a quantum physicist.)[5] My intention is to remain faithful to the discipline of physics while suspending its historical classifications that divide the spectrum into separate sections. As different technologies were invented, their capabilities for measuring separate areas of the spectrum were recorded as new sections of the spectrum. The artificial boundaries document not so much the qualities of light, but rather the qualities and history of our measuring devices. This is reflected in a statement by the quantum physicist Werner Heisenberg: 'since the measuring device has been constructed by the observer… we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning' (1958: 25). This revised approach to understanding what counts as light allows me to traverse the entire spectrum in my discussion of light and associated technologies used in the exploration and imaging of the body, i.e. X-rays, computed tomography scans (CT), magnetic resonance imaging (MRI) and positron emission tomography scans (PET).

Commenting on visualisations of the body in medicine, Catherine Waldby highlights 'the issue of medicine's medium specificity, the

extent to which its knowledge of bodies, and its abilities to work them, is conditioned by the medium of objectification, rather than through some direct encounter with the full presence of flesh' (2000: 7). Continuing with this line of enquiry, the anatomical body can also be seen as a spectrum that is divided by artificial boundaries and categories, and thus itself forms a record of the qualities and histories of our measuring devices. These dividing categories and units – such as, for example, cells, document both the quality of magnification at the time and the history of microscopy. But what happens when penetrative light is used as a method of questioning the fleshy body and how is this process of mediation perceived and recorded onto the anatomical body? These questions are not aimed at exploring the technical aspects of making and recording medical images by means of penetrative light. Rather, the focus here is on how this visual penetration through light influences our phenomenological engagement with the anatomical body and how we see ourselves after being exposed to the anatomical interior.

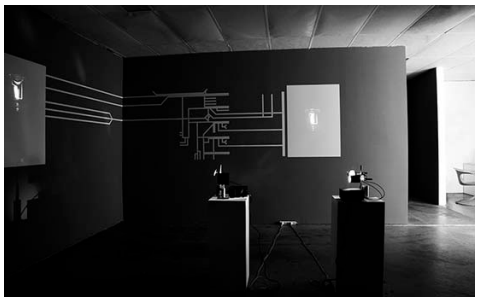
Arguably, light that penetrates the body also animates the body. I stated earlier on in my definition of anatomy that, as our ability to visually access the living body developed with the introduction of modern medical imaging, *anatomy as a methodology* itself changed. A sense of speed and an 'ocular' immediacy entered the discourse surrounding anatomy. When light from the extremes of the electromagnetic spectrum is used to image the interior of the living body, it culminates in the *virtual* cut, the spectacle and the visual realisation being performed in one instantaneous act. In the radiography room, which is an anatomy theatre of sorts, the relations and positions of the traditional protagonists are altered. The observed body is no longer necessarily a dead body, i.e. the ultimate still body, but it has become a *patient* body, still, ill and waiting. Witness the transformation of the role of anatomical images that has taken place in the process - from those of the Renaissance period, professing the illumination of God's perfect design to those of the contemporary medical scan, exposing the pathologies of the individual. The *patient* body of modern radiography is sensorially unaware of the light that is unveiling its interior, as its effect cannot be directly seen or felt. Yet, because of the light's intensity and potential harmfulness, the spectators have now become removed from direct viewing. With the audience dispersed and the anatomist displaced, the *patient* body must remain alone. This alienation of observation is nothing new, as the anatomical body has always been positioned as a liminal, but unlike the Renaissance cadaver, the radiographer's *patient* is alive and conscious.

We should ask here whether the interior of the living body is ever really unveiled to us, or whether what we see is only a mutually constructed compromise, where 'a body is brought into line with the potentialities of the technology and vice versa' (Pasveer, 2006: 44). A planar cross-sectional scan of the body appears as an abstract image. It seems dislocated not only from a fleshy and thus representational body, but also when viewed outside of the medical context, from the body of knowledge which is required for its understanding. What is being seen and not seen by an untrained eye when it views this unfamiliar representation of the body? The answers to these questions lie, in part, with the latent animation that is embedded in scans, which evokes a living body that is visualized as part of a diagnosis. In other words, to decode a scan one must understand the initial process of its encoding. The latter is not exclusively based on technological operations but is rather combined with an accumulation of information and understanding gained from the auscultation, palpation and percussion of a living body, i.e., the diagnostic *listening to the patient*'s body. Therefore, to encode and decode meanings in medical images involves not only total sensory engagement with a living anatomical body but also a need for these observations to be combined with theoretical medical knowledge. To an untrained eye, a seemingly abstract medical scan only announces the presence of a body, with the scan accepted in its role as a signifier of the body, which has been mediated by technology.

The abstraction of the body in medical imaging is further accelerated through its magnification, while minute forms become intangible and lie outside our reach. The sense of sight can no longer be verified by the touch of the hand, as a result of which the bodily microcosms being produced are accessible only by way of analogy. Magnification also dissolves discernable boundaries, or it multiplies them exponentially, depending on one's focus. Viewing an organ such as a heart at a cellular level negates, in that particular moment, the ability of being able to see it as a whole, let alone being able to perceive it as part of a system. On the other hand, such micro-perception can add millions of newly constructed boundaries such as divisions between individual cells. The limits of individual structures where an organ begins and ends become less clear and less relevant if questions about function, relations and communication are raised. How our body interacts in the world, where it begins and ends and even where *thinking* takes place becomes less discernable as the boundaries of the body contract and expand depending on social, cultural and technological influences

and perceptions. In this sense, the study of anatomy of optics and light is also, inevitably, a study of our ontology and epistemology – it is a study of who we are and how we construct knowledge.

To access the interactive panorama from the *Anatomy of Optics and Light* installation, please click on one of the images below or scan the QR code:



Notes

[1] *Anatomy of Optics and Light* was shown at Shifted Gallery in Melbourne, Australia, as part of a joint exhibition with Joanna Zylinska, titled *Solid States/Liquid Objects* and was accompanied by an exhibition catalogue essay written by Dr Melissa Miles. The exhibition was held in conjunction with the international symposium *Solid States/Liquid Objects: Discourses of Mediation*, which was hosted by the Faculty of Art & Design, Monash University, Melbourne. Dr Matthew Sellars, senior research fellow at the Laser Physics Centre, Research School of Physical Science and Engineering, Australian National University, assisted with the technical realisation of this project.

[2] Figure 2 and figure 3 are QR (Quick Response) codes. QR codes are matrix codes that function as physical hyperlinks, i.e. they normally appear as 'real' images that, when scanned by using the appropriate technology and software, provide access to the Internet and form a direct link to a selected online site. The QR codes contained in this paper have been given two functions. When an online reader accesses the article, the QR codes operate simply as clickable hyperlink images that will connect the reader directly to the website links. Alternatively, if the text is read from a printed hardcopy, the reader can use a mobile phone, uploaded with the scanner software, to scan the QR codes in order to gain access to the Internet and thus the links. Free QR scanner software (suitable for

most phones) and additional information about QR codes are available from <http://reader.kaywa.com>. Please note: QR codes cannot be scanned directly from a screen.

[3] quicken, *v.*[1] – To give or restore life to; to make alive; to vivify or revive; to animate. *The Oxford English Dictionary*. 2nd ed. 1989. OED Online. Oxford University Press. Sept. 2009. <http://dictionary.oed.com/cgi/entry/50194991>.

[4] The electromagnetic spectrum is continuous. 'An electromagnetic wave (light) consists of time-varying electric and magnetic fields that propagate at a speed of c (3.00×10^8 m/s) in a vacuum. The different types of electromagnetic radiation (such as UV, radio waves, and visible light) differ in frequency and wavelength' (Wilson, 2007: 679).

[5] Dr Matthew Sellars is a senior research fellow in the Laser Physics Centre, Research School of Physical Sciences and Engineering, Australian National University. His research interests centre on quantum measurement and quantum information processing using optically active ions in crystals. He has published in numerous journals, including *Physical Review Letters* and *Journal of the Optical Society of America*. His work on 'stopping light' for over a second was voted by the Chinese Academy of Science as one of the top ten international scientific achievements in 2005.

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