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Artist as Rhetor:

Strategies for the Visual Communication of Artistic & Scientific Concepts

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Karen Ann Austin

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Abstract

The notion that art, like science, contributes to scholarly discourse remains a contentious issue in academic debate. However an increased interest in the visual image within intellectual inquiry and a shift in the scholarly position concerning the image as a valid form of inquiry has provided an avenue in which to argue that art is a legitimate form of knowledge. This argument is premised on the notion that images are significant to both artistic and scientific discourse in that both disciplines have long utilised the image as a means to construct meaning and communicate concepts. Consequently the key insights derived from this study's research findings are understood through a framework of visual rhetoric.

This study, through a constructivist grounded theory approach, presents a substantive theory of the visual image in academic discourse and in doing so advances the understanding that art is an authoritative way of knowing. In this way this study identifies the image, which is the product of an image-making process, as knowledge artefact whereby knowledge exists through a plurality of practices involving both verbal and visual forms of representation. For this study the image-maker is considered significant to the production, representation and dissemination of knowledge. This is because as rhetor the image-maker, whether artisan or artist, utilises the image to bring forth new findings and thus new knowledge.

Certification of Thesis

This thesis is entirely the work of Karen Ann Austin except where otherwise acknowledged. The work is original and has not previously been submitted for any other award, except where acknowledged.

Student and supervisors signatures of endorsement are held at USQ

Acknowledgements

For my husband Ian . . .

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1.1: The Focus of the Study

This thesis examines the portrayal of the visual images within scholarly inquiry, and in doing so advances the notion that art, like science, as an authoritative way of knowing is significant to the wider knowledge economy. The increased attention paid to the visual in academic discourse is reflective of a growing shift in the scholarly position regarding the value of the image as a valid area of inquiry. This attention is both timely and significant because scholars are beginning to challenge long established ideas concerning the role of the visual in academic research, as well as traditional concepts of knowledge itself. Such contemplation is particularly discernible in the visual cultures of science, whereby a rise in interest in the visual has resulted in a re-evaluation of the relationship between art and science and a reconsideration of the role of the image in academic argument.

The notion of the visual image as a form of epistemology is a contested concept in academic debate. This is because traditionally linguistic modes of epistemology have prevailed. However for scholars the image is increasingly perceived as a legitimate form of knowledge. Sunil Manghani, for example, suggests that the world is not just known through the written word but is also known through visual images that have the capacity to reflect as well as establish ways of knowing. [1] For Manghani, a challenge to the established dominance of the verbal is not a strategy to disregard the word; rather it is an attempt to examine how we understand things differently through our engagement with the visual. [2] The consideration that there are different ways of understanding and creating knowledge is the central concept of this thesis. These differences concern the distinct modes of representation in addition to the epistemological status applied to particular disciplines. Science and scientific thinking, for example, hold a privileged position in Western culture whereas art's

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[1] S. Manghani, 'Image Theory', in M. Kelly (ed.), Encyclopedia of Aesthetics (2nd edn.), Oxford University Press, 2014, pp.422-426

[2] S. Manghani, *Image Studies: Theory and Practice,* Routledge, New York, 2013, p.xxii

claim to knowledge continues to attract scepticism within critical debate.[3] This is despite the notion that the arts in Western society 'have been variously constituted as disciplines of knowledge and practice since the fifteenth century, and for many centuries have demonstrated their capacities to advance our knowledge and understanding through conceptual discoveries'.[4] For this thesis the visual image is not only a site of commonality between art and science, but the image also serves as an avenue to demonstrate that one can know through art as well as through science.

It is within this context that this study will argue that art, like science, contributes to the knowledge debate. This argument is premised on the concept that both areas of inquiry communicate concepts visually, in that artists and scientists employ images as a means by which to construct argument and create meaning. Accordingly, these separate forms of inquiry are linked through the art of rhetoric. Rhetoric is described by Mark Backman as a dynamic art that focuses on the strategic nature of communication. [5] Backman also points out that this ancient art is enjoying renewed popularity in Western culture.[6] The notion that rhetoric is the common thread that runs through disciplines was understood in antiquity. Roman educators, for example, did not consider rhetoric as a discipline unto itself, rather rhetoric was an essential element in all areas of education. [7] More recent thinkers also recognise the significance of this ubiquitous nature of rhetoric. For instance, Richard McKeon characterised rhetoric as a universal and architectonic art' because it 'organises and gives structure to other disciplines'. [8] The pervasiveness of rhetoric also involves the notion of knowledge itself. This is a significant issue for this study because as Heather Graves argues, rhetoric assists in the presentation of new insights as well as

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[3] Angela Vettese and Henk Borgdorff argue that art research is not as highly valued within traditional intellectual circles. Vettese, in *Art as a Thinking Process: Visual Forms of Knowledge Production*, points to the deeply entrenched gap between the academies and the universities; 'it seems as though visual arts instruction is confined to places for educating *homo faber* rather than *homo sapiens*, according to the tacit premise of a distance between making and thinking'. p.6
Writing in the *Conflict of the Facilities* Borgdorff reveals that in some institutions 'art' remains a 'lessor' discipline in the academic world, 'artistic research is not regarded here as real research, or is seen as a lesser form of it'. p.66
[4] R. Stewart, 'Practice vs Praxis: Constructing Models for Practitioner-Based Research', *TEXT*, Vol.5, No.2, 2001, [web page] available from http://www.textjournal.com.au/oct01/stewart.htm (accessed 09/05/2012) web page
[5] M. Backman, 'Introduction: Richard McKeon and the Renaissance of Rhetoric', in R. McKeon, *Rhetoric: Essays in Invention and Discovery*, Ox Bow Press, Woodbridge, 1987, p.vii
[6] M. Backman, 'Introduction: Richard McKeon and the Renaissance of Rhetoric', in R. McKeon, *Rhetoric: Essays in Invention and Discovery*, Ox Bow Press, Woodbridge, 1987, p.vii
[7] A. Bourelle, 'Lessons from Quintilian: Writing and Rhetoric across the Curriculum for the Modern University', *Currents in Teaching and Learning*, Vol.1, No.2, 2009, pp.28-36, available from
http://www.worcester.edu/Currents/Archives/Volume_1_Number_2/CurrentsV1N2BourelleP28.pdf (accessed 06/1/2016) p.28
[8] R. McKeon, cited in J. A. Herrick, *The History and Theory of Rhetoric* (2nd edn.), Allyn & Bacon, Boston, 2001, p.2

contributing to the generation of human knowledge.[9] Drawing on these accounts and given the centrality of the image to this study visual rhetoric is deemed the most appropriate approach in which to address the complexities of this thesis which focuses on the visual communication of artistic and scientific concepts.

1.1.1 The Context of the Inquiry

This study situates the artist as rhetor, where, as an image-maker the artist is concerned with the process of visually shaping knowledge in order to communicate artistic and scientific concepts. Rhetoric is traditionally associated with the Aristotelian concept of persuasive discourse through constructed argument. Thus, rhetoric has been valued as a form of communication since ancient times when it was primarily a verbal art. However contemporary rhetoric has broadened in scope to include visual forms of communication such as images. For this study, visual rhetoric is broadly concerned with how and why images create meaning, in particular, how culture and meaning is reflected, communicated and transformed by images. [10] Visual rhetoric is a process by which certain visual strategies are employed so as to elicit a desired effect. It is also a process of understanding how meaning is created and communicated. Therefore, visual rhetoric applies to both the processes of image construction and image reception whereby engagement with the image occurs through interpretations that are primarily culturally based. [11] Because of the perceived pre-eminence of the visual in contemporary society scholars are re-examining rhetorical theory in order to explore the various strategies employed by image-makers to construct and present meaning.

Since ancient times visual images have been associated with 'science' through various contexts. These images range from paleolithic parietal depictions to the oft-cited 'anatomy lessons' that portray human dissection, to images that are inspired by the theories and discoveries of physics and more recently, human genetics. Yet, there

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[9] H. Graves, 'Rhetoric, Knowledge, and "The Brute Facts of Nature" Science Research', in S. H. McLeod (ed.), *Perspectives on Writing*, Parlor Press, Anderson, 2011, p.180

[10] M. Helmers & C. A. Hill, 'Introduction', in C. A. Hill & M. Helmers (eds.), *Defining Visual Rhetorics*, Lawrence Erlbaum Associates, London, 2004, Taylor & Francis e-Library, 2008, pp.1-23

[11] C. A. Hill, ''The Psychology of Rhetorical Images', in C. A. Hill & M. Helmers (eds.), *Defining Visual Rhetorics*, Lawrence Erlbaum Associates, London, 2004, Taylor & Francis e-Library, 2008, p.26

has been a dearth of scholarly debate concerning these works as a sphere of inquiry until recent times. As a consequence, the concept of the image as a site of inquiry for both art and science has been little understood. This lack of understanding has served to engender the critical debate focusing on images in addition to attracting the interest of a wide range of scholars from a variety of perspectives. [12] Consequently, a variety of positions concerning the image exists across a range of disciplines that include art, science, history and philosophy. However the complex issue of what the image is and its relationship with epistemology remains unresolved. This is primarily due to the long standing cultural and historical attitudes that regard images, and art in general, with scepticism despite the role attributed to images in the epistemology of science. Hence the complex relationships involving art and science, epistemology and the image remain an area of uncertainty in intellectual discourse. Such uncertainty is the focus of John Krois' 2001 essay *What are images and what are they for?* where the philosopher writes, even though 'the image has become a de facto link between art theory and the philosophy of science' and 'even if we recognise images are a part of science's toolkit and at the same time a vehicle for art' the relationship between these types of images is problematic. [13] This study takes as a point of departure Krois' argument in emphasising the difficulty in establishing philosophical or theoretical links between the images of art and those of science as well as the paucity of attention previously paid to images *per se*. This study also takes into account the growing body of academic literature specific to image studies that transcends disciplinary boundaries to include a wide range of intellectual positions as well as those positions that are specific to art and science.

1.1.2 Background of the Study

The study of the visual in relation to both art and science has gained currency as an area of inquiry in recent academic discourse. Integral to the dialogue between and within the disciplines of art and the disciplines of science is visual art's contribution to the knowledge debate. This increase in scholarly interest has revealed three

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[12] J. Elkins, 'Introduction', in J. Elkins & M. Naef (eds.), *What is an Image?,* The Pennsylvania State University Press, Pennsylvania, 2011, pp.1-12

[13] J. M. Krois, 'What are Images and what are they for?', Symposium presentation, *Art as Science and Science as Art*, 14 September 2001, Berlin, available from http://wissenschaft-als-kunst.de/multimedia/KroisEn.pdf (accessed 06/02/2014) p.2

distinct but interconnected areas of critical inquiry that are integral to this thesis; these areas involve art and science, the visual image and the image-maker.

1.1.2 (i) Art & Science: Different ways of knowing

Art and science have been discrete fields of knowledge as well as fertile areas of discussion and debate since antiquity when scholars distinguished practice from theory. In contemporary thought these separate fields of knowledge are frequently linked through what is referred to as a 'relationship' or an 'association'. This contrasts with the medieval system of learning in which art and science co-existed within single academic discipline until the eighteenth century when the 'fine arts' separated from craft and science. [14] Although many theories exist concerning this so-called 'separation' of art from science, René Descartes' 1637 text the *Discourse on Method and Meditations on First Philosophy* is credited with precipitating the fissure between art and science in the seventeenth century. [15] This publication has been identified as a key text of the Scientific Revolution when a new approach to knowledge was s ought as a response to new discoveries. During the eighteenth century Immanuel Kant sought to distinguish art from science in order to present a clear and precise concept of art. Kant's 'revision or "correction"' served to define the proper limits of each area of inquiry as well as functioning to preserve the arts and humanities from scientific encroachment. [16] This incursion of the sciences remains a concern in the Arts primarily because scientists such as Arthur I Miller and Edward O. Wilson advocate either reunification of these disciplines or merging the arts and sciences to form a new discipline. However Siân Ede, Arts Director of the Gulbenkian Foundation, makes the point that art and science are disparate ways of knowing by arguing that 'these are two quite different forms of knowledge, not reconcilable, but mutually curious to each other and as individuals we can accommodate both simultaneously'. [17] This study maintains this notion of

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[14] L- O. Åhlberg, 'The Invention of Modern Aesthetics: From Leibniz to Kant', *Historicni seminar 4*, 2003, pp.133-153, available from http://hs.zrc-sazu.si/Portals/0/sp/hs4/13-HS_4_web_Ahlberg.pdf (accessed 27/07/2013) p.135

[15] M. McDougall, B. Bevan & R. Semper, 'Art as a Way of Knowing', Conference Report, 3-4 March 2011, Exploratorium, San Francisco, available from http://cils.exploratorium.edu/pdfs/Art%20as%20a%20Way%20of%20Knowing_report.pdf (acceded 04/10/2012), p.12
   R. Debatty, C. Evans, P. Garcia, A. Grover, & Thumb Projects, New Art/Science Affinities, Miller Gallery at Carnegie Mellon University & CMU Studio for Creative Inquiry, Pittsburgh, 2011, e-book, p.170

[16] S. Shaviro, *Without Criteria: Kant, Whitehead, Deleuze, and Aesthetics*, The MIT Press, Cambridge, 2009, p.15

[17] S. Ede, *Art and Science,* I.B. Tauris & Co Ltd, London, 2005, p.180

separateness while examining the confluences between art and science that are manifest in visual imagery.

According to neuroscientist Giovanni Frazzetto art and science have occupied conflicting positions throughout modernity with each identifying as the reverse of the other. [18] This dichotomy is observed in the opposing attributes that have been traditionally ascribed to each pursuit. Science for example 'corresponds to progress, methodical rationality, austerity and objectivism' whereas 'art is recognized as mysterious creativity, ambiguity and joyful idiosyncrasy.'[19] Paradoxically, this perception of art and science as occupying conflicting areas of inquiry also comes with the recognition that their shared histories contribute to the complexity of how an association between these two areas is defined within both an historical and contemporary context. This is because the definitions and labels encompassing the terms 'art' and 'science' has changed in context and over time and a lack of awareness of the historical traces of the terms frequently results in terminological confusion and ambiguity.[20] Such vagueness poses problems in two areas, firstly in distinguishing one intellectual activity from the other particularly within a historical framework, and secondly in identifying any associations between two different fields of inquiry.

The most conspicuous example of a dichotomous relationship between art and science concerns the oft-cited *The Two Cultures*. *The Two Cultures* is the title of the polarising 1959 Rede Lecture by British novelist and scientist of C. P. Snow. Snow's argument was that not only did two distinct cultures exist in intellectual life, but that there was little communication or understanding between them. [21] The focus of the influential lecture was not just that a lack of communication existed but there was a perception of actual conflict between the sciences and the humanities which Snow identified as the 'two cultures'. This binary approach to what is often viewed as a

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[18] G. Frazzetto, 'Different and yet alike', *European Molecular Biology Organisation Science and Society*, Vol 5, No.3, 2004, pp.233-235 available from https://www.embl.de/aboutus/science_society/discussion/discussion_2004/ref17jun04.pdf (accessed 16/10/2012) p.233
[19] G. Frazzetto, p.233
[20] B. Frischer, 'Art and Science in the Age of Digital Reproduction: From Mimetic Representation to Interactive Virtual Reality', *Virtual Archaeology Review*, Vol.2, No.4, 2011, pp.19-32, available from http://varjournal.es/doc/varj02_004_06.pdf (accessed 27/11/2013) p.21
[21] C. P. Snow, *The Two Cultures and The Scientific Revolution: The Rede Lecture*, Cambridge University Press, New York, 1961, p.2

problematic relationship of the 'arts and sciences' is a recurring theme within academic discourse that has long been a subject of seasoned debates. For example, this topic was in part responsible for highly contentious Huxley-Arnold debate of the eighteen eighties and the more recent and variously labelled 'culture wars/science wars' of the nineteen eighties.

A historical account of the relationship between art and science also reveals an association of interwoven concepts, structures, values, and cultural influences in addition to the mutual exchange of ideas and philosophies rather than relationships comprising of antagonism and competition. This permeability of the boundaries between the arts and sciences is evidenced by the work of contemporary artists as well as through a rich history of imagery and related literature by philosophers, art historians and theorists as well as the philosophers and historians of science. Art's dialogue with science has shifted from presenting science's achievements, such as the development of lenses and the popularisation of the telescope as captured in Jan Brueghel the Elder and Peter Paul Rubens' 1617 collaborative work *The Allegory of Sight* (Fig. 1), to questioning the impact of science on society and nature.

Figure 1

The impact of radioactivity on local flora and fauna for example, are found in the works of Swiss artist Cornelia Hesse-Honegger (Fig. 2). Also gaining significance as a subject of research within the visual arts is the relationship between humankind, culture, and nature. This type of research is realised in the work of Dutch artist herman de vries. Martin Kemp writes that de vries challenges the relationship between science and art, in that it is through his works that the artist 'invites us to sense anew, so that we can sense affinities across boundaries.' [22]

Figure 2

These affinities between art and science are apparent in works such as the 2013 *wintergräser* (Fig. 3) which resembles the taxonomic displays in a natural history museum.
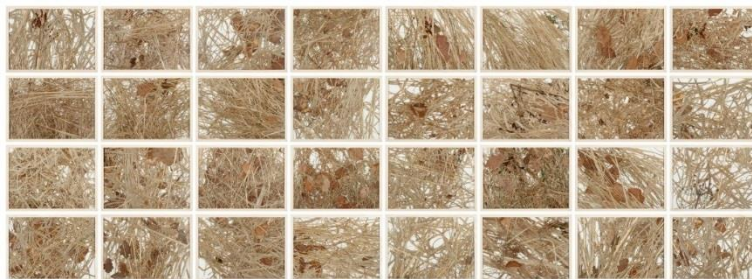
Figure 3

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[22] M. Kemp, *Visualizations: the nature book of art and science*, Oxford University Press, Oxford, 2000, pp.156-157
Contrary to convention herman de vries stylises his name in lower case on his artwork "to avoid hierarchy"

1.1.2 (ii) The visual images

Frequently described as a ubiquitous phenomenon, the image occupies a significant place in societies where meaning is often produced and packaged through visual language. Thus, in contemporary culture, the image is increasingly employed as a form of communication as well as an instrument for the production and dissemination of knowledge. Traditionally this has long been the role of verbal or literature based forms of communication because the image is customarily perceived as a lessor form of knowledge. Such long held philosophical assumptions on which epistemology is grounded indicate a logocentric and empiricist bias. [23] However, in recent times there has been a challenge to the concept of the image as an inferior gnosis. This means that, although scholarly research traditionally concerns text-based data, there is a growing appreciation of the relationship between visual representation and knowledge. This appreciation is not limited to an art-based inquiry; it is also significant for the study of the visuality of scientific knowledge. The usefulness of the image to scientific research is highlighted by Michael Lynch and Steve Woolgar who suggest that the increasing tendency to transfer correspondence theories of representation from a propositional to a pictorial base indicates a shift in scientific thought whereby scholars are beginning to consider the image as an appropriate means to represent theoretical concepts. [24] Some scholars argue that any acknowledgement of visual forms of knowledge also involves a recognition of the existence of the fluid boundaries between word and image. W. J. T. Mitchell for instance suggests that distinguishing between the linguistic and the visual is problematic because there remains 'a sense that texts and images are indissolubly connected, yet radically different'. [25] The notion of fluid boundaries and paradoxical relationships between word and image has a long existence in communication systems. For example, the correlation between visual and verbal imagery has been an important component of persuasion since classical times when the early rhetoricians

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[23] J. Drucker, 'Graphesis: Visual knowledge production and representation', *Poetess Archive Journal,* Vol.2, No.1, 2010, pp.1-50, available from http://www.johannadrucker.com/pdf/graphesis_2011.pdf (accessed 05/10/2013)

[24] M. Lynch & S. Woolgar, 'Introduction: Sociological orientations to representational practice in science', in M. Lynch & S. Woolgar (eds.), *Representation in Scientific Practice*, MIT Press, Cambridge, 1988, p.viii

[25] W. J. T. Mitchell, in A. McNamara, 'Andrew McNamara, Words and Pictures in the Age of the Image: An Interview with W. J. T. Mitchell', *Eyeline*, No.30, Autumn-Winter, 1996, pp.16-21, available from http://eprints.qut.edu.au/4620/1/4620.pdf (accessed 08/07/2014) p.1

recognised the potential of the 'image' to move an audience. [26] Thus, for this study an examination of images and the debates surrounding them extends further than the ancient word-image dichotomy or mere disciplinary alignment to involve the relationship of the visual to different structures of knowledge.

Research has shown that artists have long employed science in various ways to inform their practice while art has been engaged as one of a number of means to facilitate scientific discourse. Rather than be considered new or novel phenomena these practices have a long lineage. A notion that is advanced by Siân Ede who suggests that it would be difficult to find examples since the modern period 'of occasions when artists have not in some way become involved with science.' [27] This involvement is evidenced in the works of art that portray scientific themes and concepts in a variety of context, in addition to the growing body of scholarly literature that indicates the existence of a well-established, meaningful and productive association between art and science. Such an association is noted in the images of Renaissance artists including Leonardo da Vinci who applied Filippo Brunelleschi's mathematical system of linear perspective in his works so as to persuade the viewer of three-dimensional space and volume. [28] The link between art and science is also demonstrated in the work of Eighteenth-century English painter Joseph Wright of Derby who sought to engage a lay audience with experimental science. Wright was acquainted with many of the scientific thinkers and innovators of his time, and the aim of the 1768 painting *An Experiment on a Bird in an Air Pump* was to persuade the viewer that rather than an illusionistic trick, experimental science was an authentic inquiry that demonstrated mortality and inevitable pathology. [29] According to these accounts, images have served to illustrate art's response to science as well as illustrating the role that art plays in the development and understanding of that science. Consequently, the questions that are significant for science resonate with corresponding concerns in art. These concerns are manifest in

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[26] K. LaGrandeur, 'Digital Images and Classical Persuasion', in E. Hocks & M. R. Kendrick (eds.), *Eloquent Images: Word and Image in the Age of New Media*, MIT Press, Cambridge, 2003, p.119

[27] S. Ede, 'Bizarre Consequences: Introduction and Background', in S. Ede (ed.), *Strange and Charmed: Science and the Contemporary Visual Arts*, Calouste Gulbenkian Foundation, London 2000, pp.17-18

[28] N. Mulholland, 'Representation and the Idea of Realism', in M. Rampley (ed.), *Exploring Visual Culture*, Edinburgh University Press, Edinburgh, 2005, p.120

[29] B. M. Stafford, *Artful Science: Enlightenment Entertainment and the Eclipse of Visual Education*, The MIT Press, Cambridge, 1999, p.102

images that, as this thesis proposes, serve to demonstrate that although it is a concept that is customarily assigned to science, art itself, and visual art in particular, represents both a form of research and therefore knowledge.

Scholars acknowledge that science has produced an abundance of imagery which is depicted in diverse ways and in a variety of contexts. Such representations exist in complex mathematical notations, in anatomical and botanical illustrations, in classical painting and literature, and in contemporary art and popular culture. In recent times these depictions have grown in significance for scholars of art and of science who are seeking references to knowledge and meaning within visual representation. As visual images these representations exist in a wide range of media and in contrast to earlier times they are widely accessible, either through traditional sites such as libraries and institutions of learning, or more generally through digital technology and web-based systems. Such images are also housed in galleries and museums where they frequently feature in art collections or thematic exhibitions. This study asks, what is the link between the images displayed in a museum of art and those images that are located in a science museum? Specifically, is there a relationship between the images created in a studio and the images produced in a laboratory, or do these visual images as modes of representation and sites of inquiry exist independent of each other? To address these questions this thesis examines the works produced within the context of scientific inquiry and the images created within the cannon of Western art. In positioning these images within the wider academic debate this study sought to demonstrate that the visual image represents a common ground of inquiry in both art and science.

1.1.2 (iii) The image-makers

The creators of the images and the cultures in which they practice constitutes a critical area of inquiry for this study. Of particular significance are the artists and artisans who have engaged with the fields of scientific and technological research. Recent research points to a link between the skills and knowledge of artisans and the establishment of science as we know it today. For Pamela Smith skilled artisanal practices were essential to the advancement of scientific knowledge because such

skills functioned to document, preserve and present scientific research. [30] However, despite the notion that artisans and artists were active participants in the production of knowledge, as image-makers they were deemed to be in the service of science. This long held notion is in contrast to contemporary artistic practices whereby image-makers engage with science primarily to make art.

Although there are various ways for art to consider science, Stephen Wilson notes that contemporary artists generally engage with science through three approaches:

> *One response positions artists as consumers of the new tools, using them to create new images, sounds, video, and events; another response sees artists emphasizing the critical functions of art to comment on the developments from the distance; a final approach urges artists to enter into the heart of research as core participants, developing their own research agendas and undertaking their own investigations.[31]*

In this way science is utilised for art's benefit and the resulting insights provided through an engagement with science will be a significant contribution to both academic and cultural discourse. This is because an artist's research focus is beyond the utilitarian goals that dominate science, and because through their work artists are questioning conceptual frameworks, deconstructing language and overcoming barriers between research and cultural structures. [32] Through their engagement with science artist are also reflecting society's consciousness of the possibilities and the consequences of science.

1.2: The Statement of the Argument of the Study

This study argues that if images, as an area of commonality between art and science, are significant to the documentation and representation of scientific knowledge, as will be argued, then by definition they are also significant to art's way of knowing,

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[30] P. H. Smith, 'Artists as scientists: nature and realism in early modern Europe', *Endeavour,* Vol.24, No.1, 2000, pp.13-21, available from http://ac.els-cdn.com.ezproxy.usq.edu.au/S0160932799012594/1-s2.0-S0160932799012594-main.pdf?_tid=02c82a4e-4c7a-11e5-bfc3-00000aacb360&acdnat=1440652442_8764ea6836902464f29a615b0125a7bf (accessed 21/08/2014) 2006, p.95

[31] S. Wilson, 'Potential Contributions of Bioartists to Research', Paper, San Francisco State University, 2007, pp.1-16, available from https://itp.nyu.edu/classes/germline-spring2013/files/2013/01/PotentialBioartistResearch.pdf (accessed 19/01/2015) p.1

[32] S. Wilson, 2007, pp.3-5

thereby demonstrating that both art and science are legitimate fields of academic inquiry.

This study is proposing that because images are a form of intellectual inquiry across disciplines, as well as crucial to artistic and scientific discourse, they are significant to art's claim as a knowledge discipline.

1.3: The Statement of the Purpose of the Study

The purpose of this study is to contribute to the wider academic debate by demonstrating that art should be positioned, alongside science, as a legitimate way of knowing.

This aim will be realised through the generation of a substantive theory that accounts for the role of the visual image in academic inquiry through an examination of the images produced in the pursuit of scientific knowledge together with those images created through artistic inquiry

1.4: The Questions Guiding the Study

This study seeks to demonstrate that art, like science, has a legitimate claim to knowledge. This claim will be addressed through the following frames of reference.

- How are the complexities that the image poses to the traditional concept of knowledge described within the different ways of knowing? That is, does the notion of multiple ways of knowing, including the visual communication of concepts, have validity across disciplines?
- Has the intellectual scrutiny of images, as carriers of information and sites of knowledge production, privileged only one tradition of knowledge, such as science, or have strategies been employed in order to integrate ideas about art and knowledge into academic discourse?
- Is there a specific framework in which the image might be perceived as a manifestation of the maturation of the complex and dynamic relationship between art and science, or does an engagement with the visual involve

appropriated concepts and methods rather than a form of organised collaboration?

1.5: The Rationale of the Study

Despite a long tradition, the use of visual images in academic research remains a contentious issue. Yet, the notion that images in some way provide a framework for art to argue the legitimacy of its knowledge is the raison d'être for this study.[33] This notion had its genesis in early anatomical illustrations, such as the drawings of Leonardo da Vinci and the woodcuts that constitute Andreas Vesalius' illustrated anatomical atlas *De humani corporis fabrica*. Leonardo's drawings, which form part of the Royal Collection at Winsor Castle, were clearly intended to record and demonstrate the artist's anatomical research. [34] However, rather than feature in a museum of science, these drawings are exhibited in art museums such as New York's Metropolitan Museum of Art, where they were described by curators as Leonardo's 'contribution to art and science'. [35] Similarly, Vesalius' anatomical illustrations were initially published for intellectual contemplation. And, while these plates are notable for their anatomical accuracy and detail they also have significant artistic merit. [36] A contextual analysis of these images indicates that a link exists not only between art and science, or between an image and the visual documentation and presentation of early scientific research, but between all of these 'concepts'. Such a connection functions to provide a tacit link between making and thinking which has long been considered a barrier to recognising art as an intellectual pursuit. This link between making and thinking was alluded to in antiquity, even though the philosophers had clearly distinguished between theoretical and practical knowledge. However, Aristotle had determined that because the practice of art involved

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[33] The 'use' of images refers to the practice of producing an image, which includes the relationship between specific ways of knowing [practice] and knowledge forms [theory]

[34] M. Kemp, 2000, p.20

[35] C. Pedretti, 'Introduction', in P. Cone (ed.), *Leonardo da Vinci: Anatomical Drawings from the Royal Library*, Windsor Castle: Exhibition Catalogue, January 20- 15 April, 1984, The Metropolitan Museum of Art, New York, pp.8-9, available from http://www.metmuseum.org/research/metpublications/Leonardo_da_Vinci_Anatomical_Drawings_from_the_Royal_Library_Windsor_Castle (accessed 27/09/2013) p.8

[36] D. Laurenza, *Art and Anatomy in Renaissance Italy: Images from a Scientific Revolution*, trans. F. Dabell, The Metropolitan Museum of Art, New York, 2012, p.23

De humani corporis fabrica has been described by Christie's as 'probably the most beautiful medical text ever published'

theoretical understanding, art might therefore be regarded as a thinking process. [37] From this account, an artist is considered to be a participant in the process of knowledge production. Even though this study involves complex relationships across diverse ways of knowing, Aristotle's argument concerning the significance of theory to the practice of art as well as the potentialities of the image functions to provide the framework in which for the questions that guide this study will be addressed.

The resurgence in interest in the visual cultures of science has resulted in a reconsideration of the relationship between art and science as well as a re-examination of the significance of the image as an area of inquiry for both disciplines. Such interest has revealed that this is a diverse field of inquiry that involves a wide range of images in a variety of contexts; it is also an area of study that is fragmented across disciplines. A recent scrutiny of the images that focuses on scientific topics, for example, has attracted the scholars of science and image studies as well as visual art theorists. Consequently works of art, such as the aforementioned *The Allegory of Sight*, provide an invaluable avenue for research for both artists and scientists. However, some authors claim that a scholarly focus on the image, rather than the context in which the image is produced, has resulted in an incomplete account of the image, particularly in reference to the art-science debate. Art theorist Caroline Jones and historian of science Peter Galison suggest that a focus on 'art' and 'science' as discrete products ignores the commonalities in the practices that note in addition to being created by image-makers who identified as 'artists', the 'purpose of anatomical images during the period from the Renaissance to the nineteenth century had as much to do with what we would call aesthetics and theological understanding as with the narrower intentions of medical illustration as now understood'. [38] In this instance, the context of an image's creation is significant to understanding images because images were constructed to conform to both the anatomist's vision and pictorial conventions and as they applied at a particular time. Gillian Rose informs us that visual imagery is always constructed through various

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[37] R. Parry, 'Episteme and Techne', *The Stanford Encyclopedia of Philosophy*, Fall 2008 Edition, E. N. Zalta (ed.), [web page] available from http://plato.stanford.edu/entries/episteme-techne/ (accessed 10/06/2014) web page

[38] M. Kemp & M. Wallace, *Spectacular Bodies: The Art and Science of the Human Body from Leonardo to Now*, University of California Press, Berkeley, 2000, p.11

practices, technologies and knowledges, and furthermore, the context of its production and viewing will influence interpretation and the meaning that can be learned from an image. [39] Consequently, any message or argument transmitted through a visual image is dependent upon the image-maker and the context of its production as well as the context of viewing.produced them, furthermore 'art' and 'science' are 'regimens of knowledge, embedded in, but also constitutive of, the broader cultures they inhabit.' [40] Consequently, an increase in scrutiny by scholars in both the 'objects' of art and science and the 'practices' that produced them has resulted in an increase in the understanding of the historical contexts that have made them meaningful. However in some cases, images are not only meaningful to both disciplines but are also difficult to categorise. This is because the contexts of their production is different from the context in which contemporary imagery has been produced. The previously mentioned anatomical imagery are a case in point. Martin Kemp and Marina Wallace

1.6: The Significance of the Study

The significance of this study lies in its potential to contribute to the contemporary knowledge debate through an engagement with visual images. Consistent with this view, images provide an avenue to challenge the traditional view of knowledge whereby knowledge is defined as justified true belief. Even though the notion that images have a role in the knowledge debate has recently attracted scholarly attention, Lorraine Daston has argued that the visual image has long been significant to the epistemology of art and of science. [41] Therefore, rather than ask what *should* be the role of the visual in academic inquiry, scholars might ask how image-makers, and in particular artists, *do* contribute to contemporary academic research?

This study is concerned with art's role as a contributor to scholarly discourse. This concern has arisen because with the exception of dialogue among the scholars of the

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[39] G. Rose, *Visual methodologies: An Introduction to the Interpretation of Visual Materials*, Sage Publications, London, 2001 p.32

[40] C. A. Jones & P. Galison, p.2

[41] L. Daston, 'The Common Languages of Art and Science', *Research Project: Ideals and Practices of Rationality,* Max Planck Institute for the History of Science [web page] available from https://www.mpiwg-berlin.mpg.de/en/research/projects/commScienceArt (accessed 06/04/2015) web page

arts, we are unaccustomed to locating art among the disciplines of knowledge. Even though, as Elliot Eisner has argued 'the arts have long been associated with ways of describing, interpreting and appraising the world.' [42] Eisner states further that the forms through which the arts have represented and shaped experiences have not been sufficient of inquiry because of the limited and limiting conception of knowledge. [43] This means that, in contrast to the sciences, the arts are not measurable against established criterion. Rather, the field of art has, according to Simon Sheikh, become 'a field of possibilities, of exchange and comparative analysis', moreover, art has 'become a field for alternatives, proposals and models, and can, crucially, act as a cross field, an intermediary between different fields, modes of perception and thinking, as well as between very different positions and subjectivities'. [44] However, despite the intermingled histories of the two disciplines, art, in contrast to science, appears to be isolated with regard to the knowledge economy. The 'knowledge economy' refers to the use of knowledge as an exchange commodity. Coined by management consultant Peter Drucker, the term was used to describe a concept whereby 'the knowledge industries', specifically ideas and information, rather than goods and services are the key economic resource. [45] This study proposes that the idea that knowledge is a crucial asset to the economy and thus to society has wide implications for the status of the different ways of knowing.

According to philosopher Anjan Chakravartty, the sciences are in the knowledge production business, that is, 'scientific work produces theories, models, predictions, and explanations which are offered, *prima facie*, as candidates for knowledge.'[46] However, the notion of 'art and knowledge production' remains an unresolved issue, even though the definition of knowledge itself continues to be challenged. Questions such as: What is it that we know? Who authorizes what knowledge is? What are the uses of knowledge and how can it be manipulated? What (if anything), and how, can

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[42] E. W. Eisner, *The Enlightened Eye: Qualitative Inquiry and the Enhancement of Educational Practice* (2nd edn.), Toronto, New York, 1998, p.2
[43] E. W. Eisner, p.2
[44] S. Sheikh, 'Objects of study or commodification of knowledge? Remarks on artistic research', *Art and Research: A Journal of Ideas, Contexts and Methods,* Vol.2, No.2, 2009, pp.1-8, available from http://www.artandresearch.org.uk/v2n2/pdfs/sheikh.pdf (accessed 30/08/2011)p.5
[45] P. F. Drucker, *The Age of Discontinuity: Guidelines to our Changing Society*, Heinemann, London, 1970, p.247
[46] A. Chakravartty, 'Truth and the Sciences', in M. Glanzberg, (ed.) *The Oxford Handbook of Truth,* Oxford University Press, (forthcoming) pp.1-26, available from http://www3.nd.edu/~achakra1/downloads/glanzberg_handbook.pdf (accessed 07/03/2015) p.2

we learn from art? stress the necessity of re-examining traditional assumptions about knowledge.[47] Beliefs concerning knowledge and issues relating to art's position within the knowledge economy have attracted critical debate from within art discourse. Art historian and theorist Sarat Maharaj, for example, focuses on art as knowledge production. For Maharaj the notion of visual art as knowledge production concerns issues such as 'what sort of knowledge' as well as 'what it is that makes this knowledge different' specifically, its 'otherness'. [48] Maharaj goes on to suggest that this 'otherness', in relation to art and knowledge production, primarily concerns the 'grey-matter environs' rather than just the technological development that is currently prominent in the knowledge economy. [49]

Of significance to innovation and research in the arts and sciences and therefore the knowledge economy, is the integration of knowledge from a wide range of sources. From this account, the benefits of multiple perspectives not only have the potential to increase understanding across disciplines, but such diverse viewpoints also aid in addressing complex concrete cultural problems. According to research scholar Gabriele Bammer, 'the real world does not always present its problems and opportunities conveniently aligned with traditional academic disciplines so mechanisms are needed to facilitate interactions and collaborations between researchers working in widely different fields.' [50] Such strategies involve a range of knowledge claims and perspectives from relevant disciplines in order to improve understanding of certain issues because disciplines are limited in what they can achieve singularly. Accordingly, the employment of multiple disciplines in a research project aims to improve the understanding of unknown or incomplete knowledge thereby increasing its potential for success.[51] In this way an interdisciplinary inquiry, such as this study, would build on the strengths of the disciplines through diverse creative combinations of disciplinary knowledge.

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[47] M. Hlavajova, J. Winder & B. Choi, 'Introduction', in M. Hlavajova, J. Winder, & B. Choi (eds.) *On Knowledge Production: A Critical Reader in Contemporary Art*, BAK & Revolver, Utrecht, 2008, p.7

[48] S. Maharaj, 'Know-how and No-How: stopgap notes on "method" in visual art as knowledge production', *Art & Research*, Vol.2, No.21, 2009, pp.1-11, available from http://www.artandresearch.org.uk/v2n2/pdfs/maharaj.pdf (accessed 12/02/2013) p.2

[49] S. Maharaj, p.2

[50] G. Bammer, 'Strengthening Interdisciplinary Research: What it is, what it does, how it does it and how it is supported', *The Australian Council of Learned Academies*, 2012, pp.1-30, available from http://i2s.anu.edu.au/sites/default/files/alcoa-report/bammer_2012.pdf (accessed 07/05/2013) p.1

[51] G. Bammer, p.7

The concept of multiple perspectives gained from a variety of disciplines, whereby the participants share diverse knowledge and skills, is a recurring theme within 'art-science' research. According to Jill Scott, this framework provides the opportunity for artists and scientists to compare ways of thinking and know-how transfer, as well as question the relationship between the skills, methods and processes of art and design and of science. [52] These methods also have the capacity to create different processes of inquiry and new ways of knowing. That is, the knowledge and connections diverse participants bring to a situation provide the ingredients for exchange of knowledge, creative recombination of knowledge and for posing new questions that may lead to the creation of new knowledge. [53] However, rather than seek connections between disciplines through the concept of shared knowledge, the notions of non-compartmentalised knowledge have gained relevance in contemporary society. Stephen Wilson alludes to this concept when he suggests that the partitioning of curiosity, inquiry and knowledge into specialised compartments is a recipe for cultural stagnation.[54] As an example Wilson offers the point that 'biology does not belong only to the biologists', rather questions about life transcend academic categories. [55] For Wilson the partitioning of knowledge concerns context-dependent knowledge. For this study, the flow of knowledge between and among disciplines contributes to a recontextualization of the concept of 'borderless knowledge'. [56] This thesis expands the notion that knowledge is borderless by demonstrating that knowledge and ideas flow across disciplinary boundaries. Such a transfer results in the proliferation and intensification of both the individual disciplinary recipients of this knowledge and the relationship between them, thereby providing the opportunity for knowledge production and preventing the possibility of knowledge stasis.

Because this study is an examination of the significance of the visual to the art-science relationship the consideration of 'borderless knowledge', with regard to this

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[52] J. Scott, 2006, p.6

[53] A. Wilkes, A., 'Plurality in research for development', Beyond Diversity Re-situating Pluralism, 2012,[web page], available FROM http://beyonddiversity.dnr.cornell.edu/node/15 (accessed 27/02/2015) web page

[54] S. Wilson, *Art + Science Now: How scientific research and technological innovation are becoming key to 21st-century aesthetics*, Thames & Hudson, London, 2012, p.6

[55] S. Wilson, 2012, p.6

[56] Although borderless knowledge originally refers to the production of knowledge across national borders for this study 'Borderless knowledge' refers to knowledge production is not exclusive to a particular discipline or field of inquiry

relationship, provides an opportunity to examine the image from a similar perspective. That is, like knowledge, images disregard disciplinary boundaries, and, while the notion of the image as an 'open concept' is beyond the scope of this study, research has shown that the visual as a mode of representation and communication has the capacity to connect a diverse range of scholars as well as provide tangible links between different fields of inquiry. In recognizing the breadth of the topic of the visual, Grant Malcolm states that it is extremely fruitful one for dialogue across disciplines. [57] This realisation is important because it coincides with an increase in the range and scope of visual representation and interpretation in critical debate.

1.7: The Approach to the Study

The aim of this literature-based research is to demonstrate that art, like science, is a legitimate way of knowing. This claim is based on the notion of plausible relationships among diverse and complex concepts. These concepts will be identified and constructed through an interpretative analysis of data. It is through these relationships that this study will establish that the image is not only significant to intellectual inquiry but is also an area of commonality between art and science. This study proposed that these ideas and relationships will be constructed from a vast body of research, therefore a research approach that focused on conceptual relationships was sought. Consequently this qualitative study will employ grounded theory methods in order to generate a substantive theory to account for the role of images in scholarly research. Grounded theory is deemed the most suitable because a grounded theory methodology 'is designed to guide researchers in producing theory that is conceptually dense – that is, with many conceptual relationships'. [58] Rather than one unified tightly defined methodology, contemporary grounded theory consists of competing interpretations and various classifications. For this project a constructivist approach to grounded theory is considered to be the most appropriate strategy to address the research questions. This is because such an approach assumes that reality is multiple, processual, and constructed, that research is interactive, and

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[57] G. Malcolm, 'Editor's preface', in G. Malcolm, (ed.) *Multidisciplinary Approaches to Visual Representations and Interpretations*, Elsevier, Amsterdam, 2004, p.vii
[58] A. Strauss & J. Corbin, 'Grounded theory methodology: an overview', in N. K. Denzin & Y. S. Lincoln (eds.), Handbook of Qualitative Research, Sage, Thousand Oaks, 1994, p.278

that data is the product of research not simply the observed objects of it. [59] This contrasts with traditional grounded theory methods which assumes the existence of a single reality and value free data observed by a passive researcher. Thus, constructivist grounded theory maintains the rigour of traditional grounded theory, whilst fostering reflexivity and relativity in research practice.[60] This interpretative study is guided by a constructivist framework which is underpinned by ontological realism and epistemological subjectivism. In contrast to an objective reality, this study assumes the world consists of multiple constructed realities that are influenced by context. [61] Furthermore, constructivism emphasises the subjective interrelationship between the researcher and the researched and the construction of meaning. Therefore in keeping with this study's theoretical framework, which emphasises knowledge construction rather than knowledge discovery, a constructivist grounded theory approach will provide the most appropriate ontological and epistemological fit for this thesis.

Because the claims on which this study is based concern previous studies a literature-based thesis is the most appropriate model to address the research question. This is in contrast to studies whereby empirical evidence is documented and presented. That is, rather than produce new data; this study's attempt to seek connections between specialised bodies of knowledge is based on existing information. This approach involves critical analysis and engagement with non-elicited data, which includes visual images and theoretical literature, whereby the argument and key concepts will be constructed around secondary sources. This is in contrast to the practice-led or practiced-based research models that inform contemporary visual art research in the studio. These models are seeking to establish a link between theory and practice and therefore involve the practitioner researching through action and reflecting in and on that action. That is, action research seeks to form a bridge between practitioner understanding and the generation of theoretical knowledge to inform action rather

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[59] K. Charmaz, 'Constructionism and the Grounded Theory Method', in J. A. Holstein & J. F. Gubrium, (eds.), *Handbook of Constructionist Research*, The Guilford Press, New York, 2008, p.402

[60] K. Charmaz, 2008, pp.403-404

[61] J. Mills, A. Bonner & K. Francis, 'The Development of Constructivist Grounded Theory', *International Journal of Qualitative Methods,* Vol.5, No.1, 2006, pp.21-10 available from https://www.ualberta.ca/~iiqm/backissues/5_1/PDF/MILLS.PDF (accessed 26/03/2014) p.2

than establish connections between bodies of knowledge. [62] Consequently, this study will utilise the grounded theory method of concurrent data collection and analysis in order to elicit meaning and understanding of the research topic

1.8: The Terms Specific to the Argument

Because this study draws on a diverse range of literature across multiple disciplines, the labelling of concepts and the specific use of terminology extends beyond convention and morphological structure to include an acknowledgement and understanding of how the terms themselves, as well as their usage have changed over time. Research has revealed that a multitude of expressions are used interchangeably as descriptive tools. This emphasises the importance of providing an explanation of specific terminology or labels within the context of this thesis. Consequently, certain terms and concepts that have their origins in antiquity and are examined extensively throughout this thesis require some form of initial scholarly defence.

This thesis adopts the terms 'art' and 'science' to refer to those activities that have been categorised either through convention or by association as belonging specifically to either mode of inquiry even though meanings and practices have changed over time and through context, and even though authors such as Simon Werrett have deemed inadequate the assumption there are just two simple practices that we call 'art' and 'science'. [63] The need to historicize these terms is also widely acknowledged. Werrett, for instance, claims that it is meaningless to speak of art and science as existing as we currently think of them, because they were understood as craft and knowledge until well after the Renaissance. [64] Nonetheless, as descriptors the terms are considered useful starting points. According to Martin Kemp this is because the meanings assigned to both 'art' and 'science', with all their associations and exclusions, cannot be applied safely to earlier periods, however as convenient shorthands these are meaningful terms which do correspond to pursuits in the past,

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[62] B. Somekh, 'Action Research', in L. M. Given (ed.), *The SAGE Encyclopedia of Qualitative Research Methods: Volumes 1 & 2*, Sage Publication, Los Angles, 2008, pp.4-6
[63] S. Werrett, 'Art and Science: Historical Perspectives', Presentation Paper, *Science Studies Network Colloquium*, 21 April, pp.1-5, 2008, available from http://courses.washington.edu/uwsts/docs/SSNet-Werrett-Art-&-Science.pdf (accessed 03/05/2014) p.2
[64] S. Werrett, p.3

even though those pursuits have developed over time. [65] Science, for example, emerged from 'natural philosophy', a venture devoted primarily to learning; to a profession that is consistent with research and discovery. Historians of science have adopted 'natural philosophy' as an umbrella term to describe the study of nature and the physical universe. Ann Blair notes that the concept and the term were replaced in the early nineteenth century by the emergence and professionalization of specialised scientific disciplines. [66] These specialities range from biology and zoology to chemistry and physics in addition to many sub-disciplines, thus contemporary science encompasses many new and emerging fields. This evolution is described by Lynn Gamwell as the transformation from a pursuit of the learned elite gentlemen for whom science was ultimately a speculative, philosophical activity, to an activity that focused on the tasks of observing, recording and synthesising data in laboratory settings. [67] Rather than compare ancient and current concepts of 'science', this study adopts Charlotte Robidoux's description whereby 'science' is 'well-corroborated and generally-accepted knowledge acquired through the process of carrying out investigations and presenting findings, which are then verified; this broad definition could serve ancients and moderns equally well'. [68] Thus, despite its terminological and contextual development, science remains 'the study of the natural world', which now refers to any element in the physical universe whether or not it is constructed by humans.

Like the 'sciences', the 'arts' generally refers to a broad category of concepts and practices that serves to distinguish one form of knowledge, in this case art, from other knowledge forms such as science. For Edward O. Wilson 'the arts' involve more than the creative arts, such as literature, visual arts, drama, music and dance. Writing in the 1999 work *Consilience: The Unity of Knowledge* Wilson notes that 'the arts':

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[65] K. Kemp, 2000, p.5

[66] A. Blair, 'Natural Philosophy', *The Cambridge History of Science Volume 3: Early Modern Science,* Cambridge Histories Online 2008, pp.363-406, available from http://universitypublishingonline.org.ezproxy.usq.edu.au/cambridge/histories/popups/pdf_viewer.jsf?cid=CBO9781139054010A024&ref=true&pubCode=CUP&urlPrefix=cambridge&productCode=CHO (accessed 09/02/2014) p.365

[67] L. Gamwell, *Exploring the Invisible: Art, Science, and the Spiritual*, Princeton University Press, Princeton, 2002, p.51

[68] C. A. Robidoux, Human Genome Project Discoveries: Dialectics and Rhetoric in the Science of Gene, PhD Thesis, The Catholic University of America, Washington, D. C., 2008, available from https://docex.usq.edu.au/zportal/zengine?VDXaction=GetAttachment&illno=460111&objectno=42487&objectseq=1&is_popup_window=true (accessed 15/09/2015) p.13

> *are sometimes taken to mean all the humanities, which include not*
> *only the creative arts but also, following the recommendations of*
> *the 1979-80 Commission on the Humanities, the core subjects of*
> *history, philosophy, languages, and comparative literature, plus*
> *jurisprudence, the comparative study of religions, and "those*
> *aspects of the social sciences which have humanistic content and*
> *employ humanistic methods. Nevertheless, the arts in the primary*
> *and intuitively creative sense, ars gratia artis, remain the definition*
> *most widely and usefully employed.* [69]

Within the framework of this thesis 'art' and 'science' are umbrella terms used to categorise complex and diverse activities that are continuously being redefined and re-evaluated. However, through contemporary understanding such activities, particularly those 'pursuits in the past', have been identified as belonging to either art or science. In concurring with Wilson, this study notes that 'art' refers broadly to creative pursuits, however throughout this thesis term specifically refers to visual art.

Although technology and medicine are different fields of endeavour with distinctive philosophical, historical, and cultural concepts these separate fields are considered within the ambit of science. This is because medicine and technology are associated with the scientific method which describes the process by which scientists explore questions, test hypotheses and make rational conclusions; it is based on evidence that is observable and measurable. [70] Rather than differentiate between these two areas, this study will refer both to medicine and technology as 'science'.

Technology in particular is frequently conflated with science, and it is widely recognised that the relationship of science to technology is complex. However, for scholars such as Stephen Wilson the differences are relatively uncomplicated. Wilson suggests the differences between science and technology concern intention, whereby technologists focus on utilitarian goals while scientists search for something more abstract: knowledge, in this way technology is seen as 'knowing how,' while science

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[69] E. O, Wilson, *Consilience: The Unity of Knowledge*, Vintage Books, New York, 1999, p.229

[70] A. J., Nichols & A. H. Stephens, 'The Scientific Method and the Creative Process: Implications for the K-6 Classroom', *Journal for Learning through the Arts'*, Vol.9, No.1, 2013, pp.1-12, available from https://escholarship.org/uc/item/0z72t75q (accessed 24/01/2015) p.3

is seen as 'knowing why'. [71] Furthermore, the history of technology is essentially the history of invention and for much of its history 'understanding why' was irrelevant to technologists. [72] During the nineteenth century the term 'technology' acquired limited usage as a way to refer to the application of science (knowledge) which concerned the making and use of artefacts, in contrast, contemporary scholars note that formal knowledge is inextricably linked with the development of both science and technology. [73] The scholars of technology stress the importance of distinguishing between science and technology. This is because technology has its own knowledge and structures regardless of this strong association with the application of science to the solution of technical problems. [74] Irrespective of differences, a multitude of scholarly publications and academic institutions continue to consolidate science and technology. Schools of Science and Technology, for example, frequently refer to a multidisciplinarity that encompasses a variety of science-based areas. This study adopts the term 'science' to refer to both science and technology.

There is a substantial body of literature to suggest that science and medicine possess interwoven histories and concepts. Historians however have traditionally considered that the boundaries between medicine and science could be clearly defined, and it is a distinction that continues to be conventionally maintained. [75] In antiquity medicine was referred to as an art and the medieval practitioners of medicine were primarily scholars of philosophy. According to Roger French, physicians in ancient Greece referred to the practice of medicine as simply 'the art', and in an effort to distinguish between 'moral philosophy' and 'natural philosophy', students of the medical arts during the late Middle Ages studied 'philosophy'.[76] After this time natural philosophy transitioned from theoretical to practical knowledge. As a consequence, attention was given to both experience and reason and medicine finally absorbed these new doctrines. [77] As noted, 'prior to the nineteenth century the practice of

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[71] S. Wilson, *Information Arts: Intersections of Art, Science, and Technology,* The MIT Press, Cambridge, 2002, pp.13-14
[72] S. Wilson, 2002, pp.13-14
[73] D. R. Herschbach, 'Technology as Knowledge: Implications for Instruction', Journal of Technology Education, Vol.1, No.1, 1995, pp.31-42 available from http://files.eric.ed.gov/fulltext/EJ513065.pdf (accessed 25/02/2014) p.31-33
[74] D. R. Herschbach, p.31-33
[75] Science and Technology in the European Periphery, 'Science X Medicine', Science and Technology in the European Periphery, [web page] available from http://bdrupal.hicido.uv.es/?q=node/773 (accessed 14/06/2013) web page
[76] R. French, *Medicine before Science: The Business of Medicine from the Middle Ages to the Enlightenment*, Cambridge University Press, New York, 2003, pp.74-78
[77] R. French, p.223

medicine in the Western world was as much an art as a science. But according to William Bynum "modern medicine" as practiced today is built upon foundations that were firmly established between 1800 and the beginning of World War 1'.[78] Such foundations include laboratory science, which is widely recognised for its scientification of medicine. For this study references to medicine are considered within a scientific context.

The term 'image' is used in a variety of contexts. For Susan Buck-Morss language is replete with images; and it is through symbol, allegory and metaphor that imagery plays a dominant role in literature; whereas James Elkins lists the image in the glossary entry in the *Domain of Images* as 'a general non descriptive term for patterns on surfaces, taken in by the eye. . . ' [79] 'Image' is employed throughout this thesis to refer to images that are visibly perceptible, that is, images that have been created in visible form, rather than perceived images, or those images that exist in the 'mind's eye'. These images are not only understood as two-dimensional works but also include the works that involve a three-dimensional space. When referring to an 'image' this study does not differentiate between a captured image and a created image, unlike Buck-Morss who argues that a 'taken' image is different to a 'created' artwork. According to Buck-Morss a work of art represents, in contrast, an image is evidence. [80] For this study, an 'image' refers to both the realistic or illusionistic representations of science as well as the symbolic or allegorical images that determine how science is portrayed in art.

Given the centrality of the image to this thesis a term was sought by which to collectively refer to the producers of the images examined in this project. Such practitioners include artists and artisans in addition to the visual documenters of scientific activity which includes contemporary illustrators of science. The term 'image-maker 'rather than 'originator of image' was adopted because this term not only refers to the actual practice of making, but functions to circumvents the strict

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[78] W. F., Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, Cambridge University Press, Cambridge, 1994, Back Cover
[79] S. Buck-Morss, 'Visual Studies and Global Imagination', *Papers of Surrealism,* No.2, 2004, pp.1-29, available from http://www.surrealismcentre.ac.uk/papersofsurrealism/journal2/acrobat_files/buck_morss_article.pdf (accessed 05/06/2013) p.6
J. Elkins, 1999, p.256
[80] S. Buck-Morss, 2004, p.9

criteria applied to imagery that is categorised as either 'scientific' or 'artistic'. When referring to 'all images' as distinct from specific types of images Bert Hall utilised the term 'image maker' as the 'one' who fulfils the expectations of the subject, and such expectations include the establishment of representational conventions required for effective communication. [81] Hall acknowledged that even though diagrams or illustrations and naturalistic art could be differentiated through theoretical argument there were certain features that were constituent of all images. [82] These commonalities primarily involve a practitioner who is both skilful and knowledgeable. Thus, an 'image maker' would function to produce 'all images', whereas an artist would create works of art and an illustrator , or an artisan in the case of early science, is required to render a scientific image. In keeping with Hall's view, the term 'image-maker' has been applied when referring to the producers of images in general, that is, the image-maker is the collective description applied to those practitioners who produce ambiguous visual representations.

'Visual image' and 'visual representation' are terms that are frequently used interchangeably in academic discourse. However, visual representation refers to the mode by which concepts are visually presented, and include the images that are the focus of this thesis. Even though the term 'representation' has invited a range of meanings and interpretations since antiquity, Geoffrey Yeo has suggested that at a general level there is a consensus among scholars that 'representations are things that stand for something else, and are usually assumed to have some kind of correspondence to the things they represent'. [83] An image, for example, might be the material representation of an artist's concepts. This notion of substitution has long been problematic for scholars. Plato, for example, considered some forms of a representation to be detrimental to society. This is because representations create worlds of illusion leading one away from the 'real things'. [84] Even though

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[81] B. S. Hall, 'The Didactic and the Elegant: Some Thoughts in Scientific and Technological Illustrations in the Middle Ages and Renaissance' in B. S. Baigrie, (ed.) *Picturing Knowledge: Historical and Philosophical Problems Concerning the Use of Art in Science*, University of Toronto Press, Toronto, 1996, p.10

[82] B. S. Hall, 'p.10

[83] G. Yeo, 'Concepts of Record (1): Evidence, Information, and Persistent Representations', *The American Archivist*, Vol.70, 2007, pp.315–343, available from http://americanarchivist.org/doi/pdf/10.17723/aarc.70.2.u327764v1036756q (accessed 12/11/2015) p.334

[84] M. Vukcevich, 'Representation', The University of Chicago: Theories of Media, 2002, Web Page, available from http://csmt.uchicago.edu/glossary2004/representation.htm (accessed 16/10/2014)

representation has a long and problematic association with philosophy it remains a foundational concept in the philosophy of the arts. A point argued by W. J. T. Mitchell who notes that that unlike Plato's hostility toward representation Aristotle has favourably defined all arts, including visual art, as modes of representation. [85] Representation widely refers to the production of meaning through the use of language. Elliot Eisner has argued that representation is what is needed if the products of our imagination are to make a contribution to culture, therefore it is through representation that the idea or image is preserved in durable form, this means that representation 'stabilizes the idea or image in a material and makes possible a dialogue with it.'. [86] Historically, debates concerning representation have focused on the theories of mimesis and convention. Mimesis is understood as some notion of mimicry whereby something represents something else if the former mimics the latter in some relevant way, in contrast, convention functions by way of voluntary and arbitrary stipulation. [87] Consequently, representation through convention occurs through generally understood symbols that refer to concepts or objects, and mimetic representation is primarily concerned with imitation or reflection.

1.9: The Outline of the Study

This thesis is presented in seven interrelated chapters which are further divided into thematic sections. This introductory chapter provides a space in which to present a synopsis of the study, that is, it provides the focus, context and background of the study as well as elaborating on the terms specific to this thesis. Chapter One also outlines the aims and objectives underscoring the research in addition to revealing the relevance and rationale for conducting this research.

Chapter Two, the methodology, discusses the approach taken to conduct this study. This contributes to the aim of the study by revealing the methods used for investigating the research question. Such a discussion concerns a rationalisation of

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[85] W. J. T. Mitchell, 'Representation', in F. Lentricchia & T. McLaughlin (eds.), *Critical Terms for Literary Study* (2nd edn.), University of Chicago Press, Chicago, 1995, p.15
[86] E. W. Eisner, *The Arts and the Creation of Mind*, Yale University Press, New Haven, 2002, pp.5-6
For Elliot Eisner, imagination is a form of thinking that engenders images of the possible, which are seen in the mind's eye
[87] R. Frigg & M. C. Hunter, 'Introduction', in R. Frigg & M. C. Hunter (eds.), *Beyond Mimesis and Convention: Representation in Art and Science*, Volume 262 Boston Studies in the Philosophy of Science, Springer, 2010, p.xv

the research design in addition to an account of the theoretical frameworks which support this thesis. It also establishes grounded theory as the most appropriate approach for this qualitative literature-based thesis.

Chapter Three concerns a critical review of the literature relevant to this study. This review analyses the multidisciplinary perspectives, theories and arguments that have shaped debate concerning the visual representations within wider art-science discourse. To understand the complexity and diversity of the extant literature informing the research, this review of the literature is organised thematically whereby the key ideas are further divided into several sub-themes that function to categorise the research that was fragmented across several areas of inquiry. This system serves to establish relationships between existing knowledge as well as identify areas where there was a knowledge deficit.

Chapter Four presents the conceptual framework of the study. It provides a systematic structure of the key concepts on which this study is based as well as the proposed relationships between them. In contrast to the literature review, which presents a critical review of the literature informing this study, the aim of the conceptual framework is to examine the broad concepts which frame the study and from which the research questions have arisen. Consequently this chapter will provide clarity and focus for chapters five and six by establishing how linkages occur between art and science, the image, and how the image can know.

Chapter Five examines the image as a means of communication and representation whereby the visual, as a system of meaning making, functions differently in art than it does in science. By conceptualising the image-maker as rhetor this chapter argues that visual rhetoric, the process of visually shaping knowledge as a means to construct and transmit meaning, is deeply entrenched in art and in science. By focusing on the human body Chapter Six extends on the concepts established in chapter five by advancing the idea that images as rhetorical sites are a common ground of inquiry between art and science. Chapter seven revisits the research aims and objectives outlined in chapter one. The focus of this chapter are the key insights derived from the research findings, as well as an evaluation of the grounded theory approach.

Chapter 1: Introduction

CHAPTER 2: METHODOLOGY

2.1: Introduction

The purpose of this chapter is to present the rationale and methodological structure of this study as a systematic process that functions to address the research questions. The aim of research is to seek new knowledge and advance understanding of the topic of that research; it also aims to expand knowledge of the research process itself.[88]

Therefore, this chapter functions to outline and explain the approaches taken to address the research questions that guide this study. This study seeks to demonstrate that art, like science, has a legitimate claim to knowledge through three interrelated frames of reference, which constitute the following research questions.

- How are the complexities that the image poses to the traditional concept of knowledge described within the different ways of knowing? That is, does the notion of multiple ways of knowing, including the visual communication of concepts, have validity across disciplines?
- Has the intellectual scrutiny of images, as carriers of information and sites of knowledge production, privileged only one tradition of knowledge such as science, or have strategies been employed in order to integrate ideas about art and knowledge into academic discourse?
- Is there a specific framework in which the image might be perceived as a manifestation of the maturation of the complex and dynamic relationship between art and science, or does an engagement with the visual involve appropriated concepts and methods rather than a form of organised collaboration?

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[88] Z. O'Leary, *The Essential Guide to Doing Research*, Sage Publications, London, 2004, p.15

Because this process involved complex concepts across diverse fields of inquiry, the focus of the research involves understanding relationships between concepts rather than through measurement against a 'standard' criteria. Consequently, a constructivist-interpretative framework has been adopted to underpin this qualitative literature-based research project. This is because interpretative research and constructivist ways of knowing allows for new possibilities to be constructed from the data.[89] In this way meaning is constructed through interpretation of, and interaction with the social world.

Due to the complexity of the research questions guiding this study a constructivist grounded theory approach was deemed the most appropriate method in which to conduct this study. [90] The appropriateness of this approach is in accord with the work of Michael Jones and Irit Alony who note that an approach is useful because of its capacity to interpret complex phenomena, its accommodation of social issues, its appropriateness for socially constructed experiences, its absence from the constraints of a priori knowledge and the method's ability to fit with different types of researchers. [91] More often associated with substantive theory than formal theory, grounded theory offers a detailed, rigorous and systematic method of research that also permits flexibility and creativity. Substantive theory refers to a theoretical interpretation or an explanation of a delimited problem in a particular area. [92] Whereas formal theory concerns more extensive research and is developed for a formal or conceptual area of inquiry. [93] This thesis is concerned with building substantive theory which will serve as a guiding framework for understanding the significance of art to the knowledge debate. For the purposes of this study, the term 'theory' refers to substantive theory, rather than formal theory. Situating the researcher within the research is consistent with a constructivist grounded theory

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[89] P. C. Taylor, 'Constructivism and Interpretive Research', Presentation Paper, Science Education Centre, National Taiwan Normal University, Taipei, 7 May 1996, available from https://pendidikansains.wordpress.com/2008/04/18/constructivism-and-interpretive-research/ (accessed 22/04/2015) web page

[90] The selection of which method depends on the research questions being asked. Questions flow from the research problem, in this case The Statement of Argument and the Statement of Purpose

[91] M. Jones & I. Alony, 'Guiding the Use of Grounded Theory in Doctoral Studies – An Example from the Australian Film Industry', *International Journal of Doctoral Studies*, Vol.6, 2011, pp.97-114, available from http://ijds.org/Volume6/IJDSv6p095-114Jones322.pdf (accessed 16/12/2013) pp.2-3

[92] A. Bryant & K. Charmaz, 'Discursive Glossary of Terms', in A. Bryant & K. Charmaz (eds.), *The Sage Handbook of Grounded Theory*, Sage Publications, London, 2007, p.610

[93] B. G. Glaser & A. L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Aldine, New York, 1967, p.32

approach, whereby the researcher is part of the research process rather than an objective observer and such the researcher's world view must be acknowledged by the researcher and by their reader as an inevitable part of the outcome of the research.[94] In seeking a methodological 'fit' between grounded theory and the researcher's role as the co-constructer of meaning, this researcher has adopted a relativist ontological position and a subjectivist epistemological perspective. The appropriateness of a grounded theory approach is also due to the iterative nature of the grounded theory method, which is not only accommodative of library-based data collection methods but this method also provides a transparent means by which to analyse a wide range of documents. This chapter will firstly outline the framework for the research which involves the research strategy and the method used to conduct this study. This is followed by the grounded theory research process. This section concerns the processes involved in grounded theory research as well as the research approach adopted by this grounded theory study. This chapter concludes with a discussion concerning the theoretical frameworks that served to underpin this research.

2.2: Framework for the Research

A framework for research is described by Sitwala Imenda as a structure that provides 'guidance for the researcher as study questions are fine-tuned, methods for measuring variables are selected and analyses are planned.' [95] Furthermore, once data are collected and analysed this framework later functions to explain the findings of the research and whether discrepancies exist. [96] Therefore should such discrepancies be found, questions are asked whether or not the framework can be used to explain such discrepancies.

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[94] J. Mills, et al, p.2
[95] P. Leihr & M. J. Smith, in S. Imenda, 'Is There a Conceptual Difference between Theoretical and Conceptual Frameworks?', *Journal of Social Sciences*, Vol.38, No.2, 2014, p.188, available from http://www.krepublishers.com/02-Journals/JSS/JSS-38-0-000-14-Web/JSS-38-2-000-14-Abst-PDF/JSS-38-2-185-14-1396-Imenda-S-P/JSS-38-2-185-14-1396-Imenda-S-P-Tx%5B9%5D.pmd.pdf (accessed 23/11/2014) p.188
[96] P. Leihr & M. J. Smith, p.188

2.2.1 Research Strategy

2.2.1 (i) A qualitative research approach

This literature-based thesis involved an interpretative approach whereby meaning is constructed from a variety of documents in order to make sense of the long and complicated relationships that encompassed art, science the visual image and knowledge. Because this study concerns the investigation of diverse relationships that are difficult to measure quantitatively, and because exploration of complex phenomena from multiple perspectives is required to address the research questions, a qualitative approach offered the most appropriate form of inquiry.[97] This is because a qualitative inquiry not only provides the opportunity for flexible modes of research which focused on interpretation, meaning and context, but qualitative research is also 'an exciting interdisciplinary landscape comprising diverse perspectives and practices for generating knowledge'. [98] Consequently, a constructivist-interpretative framework served to inform the methodology and provide context for this study.

2.2.1 (ii) A constructivist-interpretive framework

The 'constructivist-interpretive' paradigm initially grew out of the philosophy of Edmund Husserl's phenomenology and Wilhelm Dilthey's and other German philosophers' study of interpretive understanding called *hermeneutics*. [99] From this perspective, the existence of an objective reality is rejected in favour of the notion of multiple realities that are socially constructed.[100] Consequently, the concept of the active researcher is pivotal to the research process. This is consistent with the work of Egon Guba and Yvonna Lincoln who suggest epistemologically, constructivism is subjectivist and transitional; meaning that the 'investigator and the object of investigation are assumed to be interactively linked so that the "findings" are *literally created* as the investigation proceeds'. [101] To this extent, a constructivist-interpretive framework emphasises knowledge-construction rather than knowledge-discovery.

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[97] For this study phenomena refers to the object of study.
[98] S. N Hesse-Biber & P. L. Leavy, *The Practice of Qualitative Research* (2nd edn.), Sage, Loa Angeles, 2011, p.4
[99] R. T. Eichelberger, in D. M. Mertens, *Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods* (3rd edn), Sage, Los Angeles, 2010, p.16
[100] J. Mills, et al, 2006, p.2
[101] E. Guba & Y. S. Lincoln, 'Competing paradigms in qualitative research', in N. K. Denzin & Y. S. Lincoln, (eds.), *Handbook of qualitative research*, SAGE, Thousand Oaks, 1994, p.111

2.2.2 Research Method

2.2.2 (i) Grounded theory

A grounded theory approach was considered the most appropriate fit for this study because this approach is suitable for investigating complex multifaceted phenomena, and because grounded theory's iterative approach to research is accommodative of document-only research, and finally because grounded theory requires an active engagement between the researcher and the data. [102] This study's rigorous involvement with complex and unfamiliar fields of inquiry to this researcher, such as the history and philosophy of science in addition to some fields of science itself, required an approach that enables a conceptual understanding to develop from an engagement with the data. For this study, grounded theory was specifically useful because it provided rigorous insights into areas that were relatively unknown to this researcher, since it is not only a detailed rigorous and systematic method of analysis, it also reserves the need for the researcher to conceive a preliminary hypothesis. [103] Thereby permitting greater freedom to explore the issues related to research area.

The second reason for selecting grounded theory concerned the grounded theory research process itself, particularly the practice of simultaneous data collection and data analysis. As a method that is primarily analytic, grounded theory was an ideal fit because this is a literature-based thesis which relies on document analysis to realise the research aims, which are to address the research question in addition to advancing an understanding of grounded theory in the discipline of art. The iterative nature of data collection and data analysis mirrors the methods of library-based research, which is described by Andrew Abbott as a process that is non-sequential, non-standardised, parallel and artisanal. [104] Thirdly, this approach is an appropriate fit because grounded theory is an interpretative method rather than positivist or logico-deductive. This means that the researcher is an active element of the research instead of being separate from it. Roy Suddaby attributes successful grounded theory

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[102] M. Jones & I. Alony, 2011, p.1
[103] M. Jones & I. Alony, 2011, p.1
[104] A. Abbott, 'The Traditional Future: A Computational Theory of Library Research', *College and Research Libraries*, Vol.69, No.6, 2008, pp.524-545, available from http://home.uchicago.edu/~aabbott/Papers/crlpub.pdf (accessed 25/06/2013), pp.532-536

research to the creativity of the interpretative process. [105] A concept that is noted by grounded theory theorists such as Juliet Corbin and Anselm Strauss, who write that researchers following the grounded theory procedures without imagination or insight into what the data are reflecting fail in in their quest, because they produce an unimaginative analysis that may be adequately grounded in the data but insufficiently grounded for the researchers purpose. [106] Thus creativity, or the interplay between researcher and data, is a key component to grounded theory.

2.2.2 (ii) An overview of grounded theory

The 'Grounded Theory Method' comprises a systematic, inductive and comparative approach for conducting an inquiry for the purpose of constructing theory. [107] The goal of a grounded theory method is to generate theory from the data. This is in contrast to those methods that either utilise inductive methods to merely generate themes from the data or employ deductive methods to test existing theories.

Grounded theory was first articulated in 1967 by sociologists Barney Glaser and Anselm Strauss in their seminal work *The Discovery of Grounded Theory*. [108] According to Carla Willig, this method was designed to open a space for the development of new contextualised theories by allowing researchers to move from data to theory so that new theories could emerge. [109] Grounded theory has since evolve and changed to include different interpretations depending on the researcher's ontological and epistemological orientation. However, even though there are several points of departure from the original concept, grounded theorists remain committed to a set of common characteristics.[110] These characteristics form the basis of the principles of grounded theory outlined by Carla Willig whereby:

> *Grounded theory involves the progressive identification and*

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[105] R. Suddaby, 'From the editors: What grounded theory is not', *Academy of Management Journal*, Vol.49, No.4, 2006, pp.633–642, available from http://www.idi.ntnu.no/grupper/su/publ/ese/suddaby-groundedtheory-ednote06.pdf (accessed 08/02/2014) p.638

[106] J. Corbin & A. Strauss, 'Grounded theory research: Procedures, canons and evaluative criteria', *Qualitative Sociology*, Vol.13, No.1, 1990, pp.3–21, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=5a2a64e7-ac84-44c4-84b3-a0e7d0e3437f%40sessionmgr111&hid=115 (accessed 27/04/2015) p.19

[107] A. Bryant & K. Charmaz, 'Introduction: Grounded Theory Research: Methods and Practices', in A. Bryant & K. Charmaz (eds.), *The Sage Handbook of Grounded Theory*, SAGE Publications, London, 2007, p.1

[108] B. G. Glaser & A. L. Strauss, 1967

[109] C. Willig, *Introducing Qualitative Research In Psychology* (3rd edn.), Open University Press, Maidenhead, 2013, p.70

[110] J. Mills, et al, p.3

> *integration of meaning from data. It is both the process of category*
> *identification and integration (as method) and its product (as*
> *theory). Grounded theory as method provides us with the*
> *guidelines on how to identify categories, how to make links*
> *between categories and how to establish relationships between*
> *them. Grounded theory as theory is the end-product of this process;*
> *it provides us with an explanatory framework with which to*
> *understand the phenomenon under investigation. To identify, refine*
> *and integrate categories, and ultimately to develop theory,*
> *grounded theory researchers use a number of strategies, including*
> *constant comparative analysis, theoretical sampling and*
> *theoretical coding.* [111]

The three main versions of grounded theory that dominate the current field of qualitative inquiry include the 'classical' or Glaserian version, Strauss' and Corbin's more structured approach and Charmaz' constructivist version. [112] These versions represent the different perspectives that have resulted from ongoing methodological development. Carla Willig points to the three major issues relating to the evolution of the different approaches to grounded theory. These issues concern the role of induction in grounded theory, discovery versus construction, and a focus on social processes versus individual experience. [113] These competing interpretations enable researchers with diverse theoretical perspectives to pursue various forms of inquiry through grounded theory methods.

2.2.2 (iii) Constructivist grounded theory as the method of Inquiry

Constructivist grounded theory is the most appropriate grounded theory method of inquiry because this study is underpinned by a constructivist theoretical framework which is not embedded in a materialistic ontological view, but instead, subscribes to multiple constructed realities. Within this framework 'knowledge is relativistic (that is, knowledge and realities are time, space and context dependent), inquiry should be

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[111] C. Willig, 2013, p.70
[112] C. Willig, 2013, p.76
[113] C. Willig, 2013, p.76

naturalistic, and that interpretivism (rather than scientific methods and empiricism) is the appropriate frame through which to bring to light and explore these realities'. [114] Consequently, the researcher is considered to be central to the research process. For this reason a researcher is accompanied by a constructivist worldview, therefore functioning as a co-constructor of the reality that is the research process. [115] This means that through interaction and therefore interpretation of the data, research becomes a process of co-construction. For this study, the adoption of constructivist grounded theory has provided the opportunity to maintain the rigour of the classical grounded theory approach whilst remaining open to the possibilities of multiple realities that might be constructed from the data. According to Kathy Charmaz this opportunity arises 'when social constructionists combine their attention to context, action, and interpretation with grounded theory analytic strategies, they can produce dense analyses with explanatory power, as well as conceptual understanding'. [116] The debates surrounding traditional and the constructivist approaches reflect differences in practice and theoretical orientation. Traditionalists, according to Charmaz, adopt a limited form of grounded theory which emphasises generality instead of relativity, and objectivity rather than reflexivity. [117] Traditional grounded theory states that theories emerge from the data. Constructivists however question this concept, posing instead that theories are constructed by the researcher interacting with the data. In this way decisions relating to the data, such as type, source, collection and analysis as well as the theoretical and methodological frameworks, shape the research process and the conclusions drawn. Thus, constructivism addresses how realities are made. Bryant and Charmaz concur on this point, stating that constructivism is a perspective that assumes that people, including researchers, construct the realities in which they participate. [118] The authors go on to explain:

> *Constructivist inquiry starts with the experience and asks how*

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[114] J. E. Bisman & C. Highfield, 'The Road Less Travelled: An Overview and Example of Constructivist Research in Accounting', *Australasian Accounting, Business and Finance Journal*, Vol.6, No.5, 2012, pp.3-22, available from http://ro.uow.edu.au/aabfj/vol6/iss5/2 (accessed 25/2/2015) p.6

[115] D. *Darlaston-Jones, 'Making connections: The relationship between epistemology and research methods', The Australian Community Psychologist, Vol.19, No.1, 2007, pp.19-27, available from* http://committeehub.groups.aps.stage.roadhouse.com.au/Assets/Files/Darlaston-Jones_19%281%29.pdf *(accessed 12/01/2014) p.25*

[116] K. Charmaz, 2008, p.399

[117] K. Charmaz, 2008, p.399

[118] A. Bryant & K. Charmaz, 2007, p.607

> *members construct it. To the best of their ability, constructivists*
> *enter the phenomenon, gain multiple views of it, and locate it in its*
> *web of connections and constraints. Constructivists acknowledge*
> *that their interpretation of the studied phenomenon is itself a*
> *construction.* [119]

According to Charmaz grounded theory strategies are 'strategies for creating and interrogating our data, not routes to knowing an objective reality.' [120] In contrast, objectivist methods seek to provide explanations and predications.

This study involved three expectations that are consistent with a constructivist approach. This study assumed firstly, that there are multiple realities that are constructed within certain conditions. This assumption is in keeping with an interpretative theory that calls for an imaginative understanding of the studied phenomenon, whereby knowledge and theories are situated and contextual. [121] The second assumption concerned the concept of reflexivity. Reflexivity is 'the researcher's scrutiny of his or her research experience, decisions, and interpretations in ways that bring the researcher into the process and allow readers to assess how and to what extent his or her interests, positions, and assumptions influenced the research.' [122] In this way, the practice of reflection involves the researcher continuously examining oneself as a researcher. For this study, reflection not only involved assumptions and preconceptions, but how these affected certain research decisions. For instance, Charmaz argues that a reflexive stance toward both the research process and research products considers how theories evolve by reflecting on earlier points of research. [123] Thirdly, a constructivist assumes that the research is a co-constructed activity between the researcher and the data. In this instance Charmaz claims that 'data are a *product* of the research process, not simply observed objects of it. Researchers are part of the research situation, and their positions, privileges, perspectives, and interactions affect it'. [124] This means that the researcher

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[119] A. Bryant & K. Charmaz, 2007, p.607

[120] K. Charmaz, 2008, p.401

[121] K. Charmaz, *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*, Sage Publications, Thousand Oaks, 2006, p.131

[122] A. Bryant & K. Charmaz, 2007, p.609

[123] K. Charmaz, 2006, p.131

[124] K. Charmaz, 2008, p.402

is an integral part of the research situation. These assumptions therefore provided the frame in which this constructivist grounded theory research project was be conducted.

2.2.2 (iv) Strengths and challenges of grounded theory

No one method is applicable across all research settings, as such; all research methods have inherent strengths and weaknesses or challenges. In addition to claims of epistemological simplicity, improvised methods of data collection and analysis, some commentary on grounded theory originates from within grounded theory itself. As previously noted, such disputes arise from ongoing methodological development. However, the multiple variations and interpretations of grounded theory and the diverse theoretical perspectives, particularly between classical grounded theory and the evolving grounded theories, contribute to the perception that grounded theory is limited in its application. This is despite claims regarding its widespread popularity as a research method.

The strength of the grounded theory method is, according to Michael Muller,

> *the ability to make sense of diverse phenomena, to construct an account of those phenomena that is strongly based in the data ("grounded" in the data), to develop that account through an iterative and principled series of challenges and modifications, and to communicate the end result to others in a way that is convincing and valuable to their own research and understanding.*[125]

For Gregory McKinney this means that grounded theory methods have not only earned their place as a standard method, but have also influenced researchers from varied disciplines. [126] McKinney's argues that grounded theory has considerable significance because this approach;

1. provides explicit, sequential guidelines for conducting qualitative research
2. offers specific strategies for handling the analytic phases of inquiry

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[125] M. Muller, 'Curiosity, Creativity, and Surprise as Analytic Tools: Grounded Theory Method', in J. S. Olson & W. A. Kellogg (eds.), *Ways of Knowing in HCI*, Springer, New York, 2014, p.25
[126] G. McKinney, 'Qualitative Research: Grounded Theory: What is it?', *Research Guides,* Temple University Libraries, available from http://guides.temple.edu/groundedtheory (accessed 11/06/2015) web page

3. streamlines and integrates data collection and analysis

4. advances conceptual analysis of qualitative data

5. legitimizes qualitative research as scientific inquiry

One challenge to grounded theory is the overly generic use of the term. Writing in 2006 Roy Suddaby listed six misconceptions of what grounded theory is not. [127] These include:

1. Grounded theory is not an excuse to ignore the literature

2. Grounded theory is not a presentation of raw data

3. Grounded theory is not theory testing, content analysis or word counts

4. Grounded theory is not simply routine application of formulaic technique to data

5. Grounded theory is not perfect

6. Grounded theory is not easy

For Suddaby, mislabelling a study, which results in the generic application of grounded theory to any form of qualitative research project, might be avoided by ensuring that the study includes a meticulous and transparent methodology. [128] Challenges to constructivist grounded theory also arise from claims of potential researcher bias, whereby bias is seen as a threat to the validity of a study. However, Barney Glaser suggests that 'bias is just another variable and a social product. If the researcher is exerting bias, then this is a part of the research, in which bias is a vital variable to weave into the constant comparative analysis'. [129] According to Michael Jones and Irit Alony the process of Grounded Theory functions by including an acknowledgement of the researchers' bias. [130] For example, this study concerns a constructivist-interpretative paradigm which adopts a relativist ontological position and a subjectivist epistemology. Such disclosure therefore serves to alert the reader of this researcher's orientation as well as this researcher's awareness of the potential for bias to exist.

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[127] R. Suddaby, pp.634-640
[128] R. Suddaby, p.640
[129] B. G. Glaser, 'Constructivist Grounded Theory?', *Forum: Qualitative Social Research*, Vol.3, No. 3, Art.12, 2002, available from http://www.qualitative-research.net/index.php/fqs/article/view/825/1792 (accessed 20/01/2013) web page
[130] M. Jones & I. Alony, 2011, p.7

2.3: The Grounded Theory Research Process

2.3.1: The Research Process

2.3.1 (i) Positioning the researcher

In constructivist grounded theory research the researcher's presence is not only integral to the research process but is also part of the research outcome. Consequently, the researcher's position must be explicitly acknowledged because it is the voice that shows and talks about the research area. [131] According to Melanie Birks and Jane Mills interrogating the researcher's 'philosophical position requires thinking about what you believe to be true about the nature of reality', and once this ontological position is determined, 'you need to examine how your beliefs about how researchers can legitimately gain knowledge about the world', which concerns epistemology, or the nature of justified knowledge. [132] In keeping with a constructivist-interpretive paradigm, this researcher has adopted a relativist ontological position that involves the notion of multiple and socially constructed realities, and a subjective epistemology. Within a constructivist grounded theory methodology this means that the researcher is a subjective active participant in data analysis rather than an objective instrument of data collection.

By acknowledging a subjective approach to research the researcher is also acknowledging that they cannot be isolated from the research. This is because a constructivist approach emphasizes the subjective interrelationship between the researcher and the researched, and the co-construction of meaning. [133] The process of making the researcher's influence on the research explicit, is generally referred to as reflexivity. A reflective stance, according to Kathy Charmaz, is an important aspect of research because it informs 'how the researcher conducts his or her research, relates to the research participants, and represents them in written reports'. [134] Reflexivity began with this researcher stating the philosophical position to research

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[131] R. Ramalho, P. Adams, P. Huggard & K. Hoare, 'Literature Review and Constructivist Grounded Theory Methodology', *Forum: Qualitative Social Research,* Vol.16, No.3, Art.19, 2015, available from http://www.qualitative-research.net/index.php/fqs/article/view/2313/3876 (accessed 12/1/2016) web page
[132] M. Birks & J. Mills, *Grounded Theory: A Practical Guide,* SAGE Publications, London, 2011, p.51
[133] J. Mills, et al 2006, p.2
[134] K. Charmaz, 2006, p.189

and proceeded throughout the research process, thus functioning to provide transparency to the subjective approach to research and therefore the insights gained from the research findings. For this study, the reflexive process is made visible through the process of memoing.

2.3.1 (ii) Data collection

This literature-based study is concerned with documents that existed prior to, and not because of the research. Consequently, such data is referred to as secondary data. This secondary data included historical records and contemporary studies that are documented in discipline specific journals and academic texts as well as event programmes, media documents including interviews and personal papers and diaries, in addition to a vast array of images created in the pursuit of artistic and scientific knowledge. Barney Glaser's argument that 'all is data' therefore provided a useful starting point in which to consider the range and complexity of the data that constituted the research for this study. [135] The relevant data was collected from pool of existing knowledge utilising library-based techniques that concerned the both the physical and virtual library.

Despite increasing interest in secondary data and the potential benefits to a study, such as the provision of theoretical and methodological insights, there remains scant information regarding the use of these documents in grounded theory methods. However, the utilisation of secondary data sources in grounded theory is encouraged by Barney Glaser and Anselm Strauss when they suggest that not only does the library contain materials that are as potentially valuable for generating theory as observations and interviews, but similar to other forms of research such as fieldwork, library-based research must be directed with intelligence and ingenuity if it is to be effective. [136] By emphasising the similarities between fieldwork and library-based research the scholars were advocating a shift in the attitude toward qualitative research materials such as secondary data. Whilst this study did not produce new

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[135] B. G. Glaser, *Doing Grounded Theory: Issues & Discussion*, Sociology Press, Mill Valley, 1998, p.8
[136] B. G. Glaser & A. L. Strauss, 1967, p.163

data, the use of documents enabled the construction of new concepts and ultimately theory.

2.3.1 (iii) Analysis of the data

According to Charmaz, grounded theory is primarily a method of analysis whereby each phase of the inquiry serves to raise the analytic level of the work. [137] In grounded theory data analysis commences and continues with data collection in order to allow data sampling. Data analysis begins with coding, which refers to the process by which data is conceptually categorised. Codes are identified by Birks and Mills as a 'form of shorthand that researchers repeatedly use to identify conceptual re-occurrences and similarities in the patterns of participant's experiences', whereas groups of codes representing a higher level concept form a category. [138] A concept is described as a descriptive or explanatory idea, its meaning embedded in the word, label or symbol.[139] Coding is the process of breaking down data into components and labelling those components. Furthermore, coding is integral to theory development, in that it is a process which concerns the conceptual abstraction of data and its reintegration as theory takes place. [140]

Data analysis also involves the notions of 'secondary data', 'secondary analyses', and 'reusing data from previous for a new purpose'. It is beyond the scope of this chapter to discuss the various definitional concerns relating to pre-existing data and secondary analysis, however, this study adopted the position of Martyn Hammersley who put forward the notion that:

> [I]t is possible, and desirable, to use material that other
> researchers have generated; and that the process of analysis here
> is no different in epistemic status from that in primary research,
> because the data are necessarily constituted, contextualised and

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[137] K. Charmaz, 'The Power and the Potential of Grounded Theory', *Medical Sociology Online,* Vol.6, No.3, 2012, pp.1-15, available from http://www.medicalsociologyonline.org/resources/Vol6Iss3/MSo-600x_The-Power-and-Potential-Grounded-Theory_Charmaz.pdf (accessed 27/01/2014) p.4
[138] M. Birks & J. Mills, p.93
[139] I. Holloway, *A-Z of qualitative research in healthcare* (2nd edn), Oxford, Blackwell, 2008, p.43
[140] K. Charmaz, 'Grounded theory: Objectivist and constructivist methods', in N. K. Denzin & Y. S. Lincoln (eds.), *Handbook of qualitative research* (2nd edn), SAGE, Thousand Oaks, 2000, p.515
J. A. Holton, 'The coding Process and its Challenges', *Grounded Theory Review*, Vol.9, No.1, 2010, available from http://groundedtheoryreview.com/2010/04/02/the-coding-process-and-its-challenges/ (accessed 21/01/2014) web page

> *recontextualised within any project. As a result, the problems of*
> *'fit' and 'context' are no more likely to arise in research using data*
> *from an earlier study than they are in one where 'new' data are*
> *produced [141]*

The potential of analysing data collected for other purposes is also recognised Barney Glaser who notes that this re-emerging method was appropriate for the investigation of theoretical and substantive problems, in part, because secondary analysis can lend new strength to a body of knowledge. [142]

2.3.2 The Research Approach

Grounded theory is described as a concurrent, iterative and non-linear form of inquiry, whereby data collection and data analysis continue simultaneously throughout the research process until theory development occurs. However, for the purposes of documentary convenience, a formulaic presentation was adopted for this study whereby each phase of the research is displayed as a sequential process. Thus, the approach to the research consisted of the several phases of analysis as well as the section that describes the sites where this analysis took place.

2.3.2 (i) Iterative analysis

Initial coding

Initial coding, also referred to as open coding, proceeds from data collection and is the first step of data analysis, whereby important words, or groups of words are identified then labelled accordingly. [143] These categories serve to facilitate comparison both between phenomena and among phenomena, such as differentiating between art and science or between the different artistic or scientific disciplines. Thus, the codes that were formulated during the initial coding process reflect the diversity and complexity of the study. For example, not only were the initial codes of 'visual representations', 'scientific knowledge' and 'art's way of knowing' derived

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[141] M. Hammersley, 'Can We Re-Use Qualitative Data Via Secondary Analysis? Notes on Some Terminological and Substantive Issues', in P. Atkinson & S. Delamont (eds.), *SAGE Qualitative Research Methods*, SAGE Publications, Thousand Oaks, 2010, p.4
[142] B. G. Glaser, 'Retreading Research Materials: The Use of Secondary Analysis by the Independent Researcher', *American Behavioural Science*, Vol.6, No.10, 1963, pp. 11-14, available from http://abs.sagepub.com.ezproxy.usq.edu.au/content/6/10/11.full.pdf+html (accessed 06/04/2015) p.11
[143] M. Birks & J. Mills, p.9

from a wide range of data gathered for the preliminary literature review, the formation of these codes also relied on this researcher's prior knowledge in visual art and science. These codes borrowed from sensitizing concepts such as the 'art-science relationship' and 'visual modes of medical representation', and reflected background assumptions based in disciplinary perspectives, which functioned to shape both the research topic and the conceptual emphasis. [144] The initial codes and categories functioned as points of departure for developing specific codes through studying the data and successive levels of analysis. [145] Because these initial codes were provisional, comparative and disciplinarily oriented, they functioned to provide a general survey of the research area and identify gaps in the research.

The initial coding process utilised inductive reasoning through a close reading of the data until concepts were identified and codes were assigned. For example, documents were critically read and analysed in order to establish disciplinary orientation as well as focus and context of the study, the data was then loosely collated to form categories based on similar phenomena. Data was coded along thematic and disciplinary lines and categories such as 'art', 'science', 'art and science', 'images', and 'general study resources' were quickly determined. This method continued throughout the duration of the study as the data was reviewed and codes redeveloped. However, these initial codes were more descriptive than interpretative, reflecting an early focus based on prior perspectives that were elaborated during the original project proposal.

Theoretical sampling

Theoretical sampling is described by Barney Glaser and Anselm Strauss as 'the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges'. [146] This process continues until no new codes are identified in the data, at which time coding is of a more advanced nature and the researcher seeks extant theory to add explanatory power to their

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[144] K. Charmaz, 2006, pp.16-17
[145] K. Charmaz, 2006, p.17
[146] B. G. Glaser & A. L. Strauss, 1967, p.45

integrative grounded theory. [147] In this study theoretical sampling involved sampling for the development of a theoretical category, whereby new concepts were selected based on information that had emerged from data already coded. For example, theoretical sampling shaped further data collection as concepts and codes were emerging from the 'general pool' of data relating to 'the image'. Rather than add to this pool, this study pursued the developing concepts related to historical debates concerning the image as well as the image-word dichotomy. Consequently, this process provided the means of ensuring that new data contributes to theory development and that the data worked with the concepts already compiled through a measure of fit and relevance. [148] During this phase relationships between data sets were identified and gaps in the existing data were revealed, therefore theoretical sampling provided the means by which to identify the areas in which there was a lack of data. Some scholars consider that part of the analytic process of research is realising that the data has 'gaps'. For Charmaz discovering gaps enables the researcher to conceptualise how and what is needed to fill these gaps, thus simultaneous data collection and analysis facilitates delving into the research problem as well as engage in developing categories. [149] Rather than the topic of the research, the most significant 'gap' identified by this researcher concerned the research process itself, specifically, there was a lack of published data relating to literature-based studies.

Constant comparative analysis

The method of advancing conceptual understanding through ongoing comparison of incident to incident, incident to codes, codes to codes, codes to categories, and categories to categories, is referred to as constant comparative analysis. [150] This iterative analytical approach involves a constant engagement with the data whereby the decisions to collect new data and recode extant data concerns theoretical sampling. These decisions are based on comparing existing codes and categories

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[147] K. Hoare, J. Mills & K. Francis, 'Dancing with data: an example of acquiring theoretical sensitivity in a grounded theory study', *International Journal of Nursing Practice*, Vol.18, No.3, 2012, pp.240-245, available from http://onlinelibrary.wiley.com.ezproxy.usq.edu.au/doi/10.1111/j.1440-172X.2012.02038.x/epdf (accessed 15/02/2014) p.244
[148] M. Jones. & I. Alony, 2011, p.12
[149] K. Charmaz, 2006, p.48
[150] M. Birks & J. Mills, p.11

with developing codes and categories so as to advance conceptual understanding of these emerging categories. This phase articulates and labels the continuing iterative process that extends from data collection and analysis, through theoretical sampling to the emergence of substantive theory. [151] On this point, a constructivist grounded theorist would insist that substantive theory is constructed from the data rather than emerge from it. The decisions that resulted from the ongoing interplay between data collection and data analysis involved both inductive and abductive modes of reasoning. Inductive reasoning is defined as a 'type of reasoning that begins with the study of a range of individual cases and extrapolates patterns from them to form a conceptual category'. [152] Whereas abduction is 'a type of reasoning that begins by examining data and after scrutiny of these data, entertains all possible explanations for the observed data, and then forms hypotheses to confirm or disconfirm until the researcher arrives at the most plausible interpretation of the observed data'. [153] Because this study involved a large amount of data through the aforementioned collection strategies, there was a heavy reliance on memos to maintain focus and make decisions. Thus, memos served as a site of analysis whereby data advanced from a descriptive, thematic analysis to the development of a theoretical picture.

Intermediate coding

Intermediate coding is the next major step in the analytical process. This is a more directed, selective, and conceptual form of coding that is guided by the decision-making during the initial coding. For Birks and Mills, intermediate coding closely resembles Glaser's 'selective coding', which concerns generating codes around core variables; and Charmaz' 'focused coding' in which existing codes direct analysis, in addition to Strauss' and Corbin's 'axial coding', which is the most developed form of intermediate coding. [154] The aim of this phase was to attain a higher level of conceptual analysis through ongoing comparative analysis and conceptualisation whereby connections among themes were identified. The notion of rhetoric, for example, is a recurring theme throughout each of the categories of art, science,

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[151] B. G. Glaser & A. L. Strauss, 1967, pp.105-6
[152] A. Bryant & K. Charmaz, 2007, p.607
[153] A. Bryant & K. Charmaz, 2007, p.603
[154] M. Birks & J. Mills, p.96

knowledge and the image. Consequently, the processes of theoretical sampling and selective coding identified rhetoric as a core category because rhetoric encapsulates and explains this grounded theory as a whole. [155] As a core category, rhetoric became understood within a framework of sub categories such as 'thinking and making' and 'strategies for communication' - the latter was conceptualised through codes such as 'visual literacy', 'rhetorical literacy and 'communicating visual knowledge'. This process of conceptualisation was achieved as the result of full theoretical saturation of both the core category and its subsidiary categories, sub-categories and their properties. [156] Hence, the newly constructed links between concepts, such as 'knowledge transmission' and 'visual images', as well as an established relationship between these individual concepts and the newly identified core category resulted in a reordering and eventual incorporation of the early established codes such as 'the presentation of knowledge' into new categories such as the aforementioned 'strategies for communication'.

Advanced coding and theoretical integration

According to Birks and Mills there are three factors necessary for the integration of grounded theory. [157] The first necessary factor concerns an identified core category. Without this 'hub' of the developing theory relationships between concepts within the theory are fragile and theoretical elaboration is diminished. [158] The development of the core category of rhetoric and saturation of other major categories that focused on visual forms of inquiry resulted in a provisional model in which to argue that art is a significant knowledge discipline. The second necessary factor involves the theoretical saturation of major categories. [159] The categories that constituted this study were theoretically saturated when it was noted that gathering fresh data no longer sparks new theoretical insights nor reveals new properties of these core theoretical categories. [160] As an abstract term theoretical saturation is determined by the researcher. Saturated categories such as 'the image' and 'visual rhetoric' are

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[155] M. Birks & J. Mills, p.12
[156] M. Birks & J. Mills, p.12
[157] M. Birks & J. Mills, p.115
[158] M. Birks & J. Mills, p.115
[159] M. Birks & J. Mills, p.115
[160] K. Charmaz, 2006, p.113

therefore theoretically abstract yet substantively grounded and as such function as the link between the data and the final theory. [161] The third necessary factor involves an accumulated bank of analytical memos. [162] The research process for this project was dependent on two types of memos, the research journal and the pre-submission drafts, as well as the concept maps that described the evolving structure of individual chapters. It was found that reviewing and sorting these memos facilitates the integration process through the identification of relationships and synthesising concepts. [163]

Even though the final phase of analysis before theoretical integration is described as advanced coding, Birks and Mills emphasise that this does not preclude returning to earlier phases analysis to ensure that the theory, which is linked through the core category, remains grounded. [164] Although many of the categories required ongoing reflection during the course of this research, abstracting ideas and constructing categories that encompassed the core category was particularity problematic. This meant returning to the data to clarify concepts and relationships that were the source of uncertainty and ambiguity. Karen Locke argues such uncertainty and ambiguity are part of an interpretative research process, in that 'data are a resource for possible connections and relationships that will help us to imagine the processes, structures, or characterizations that might be'. [165] This ambiguity becomes more pronounced as analysis moves toward theory, therefore it functions as an opportunity to maintain both focus and precision in the utilisation of grounded theory methods. [166]

For this study advanced coding was achieved through the utilisation of a storyline. Although this approach was utilised in various forms throughout different stages of the analysis, it was specifically useful during the final analytical stage of the research. A storyline is described as 'a strategy for facilitating integration, construction, formulation and presentation of research findings through the

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[161] M. Birks & J. Mills, p.115
[162] M. Birks & J. Mills, p.115
[163] A. L. Strauss & J. Corbin, *Basics of qualitative research: Grounded theory procedures and techniques*, Sage, London, 1998, p.148
[164] M. Birks & J. Mills, p.117
[165] K. Locke, 'Rational Control and Irrational Freeplay: Dual-thinking Modes as Necessary Tension in Grounded Theorizing', in A. Bryant & K. Charmaz *The Sage Handbook of Grounded Theory*, Sage Publications, London, 2007, p.575
[166] M. Birks & J. Mills, p.117

production of a coherent grounded theory.' [167] Storyline as a strategy was used both for developing and disseminating grounded theory, and for this study storyline also served to demonstrate the aims of a grounded theory research study. That is, grounded theory 'aims to produce a theory that serves to explain a phenomena in the context within which it exists' and because 'theoretical development occurs as an end result of specific data collection and analysis techniques. [168] With these aims in mind, theoretical integration was formulated with the assistance of memos and the aforementioned concept maps. These maps provided a schematic representation of the order and sequence of the categories that were continuously refined while firming the dimensions of the core category, and like the memos, assumed increasing significance to the developing a storyline. In producing a story line Birks and Mills stress that theory takes precedence, because the emphasis is on theory as a product of analysis. [169] Rather than a descriptive report, the final storyline served as a high level of conceptual abstraction whereby theoretical constructs, such as the relationship between categories, provide the framework of the study.

Theoretical coding, considered to be the final analytical process of grounded theory, is described as 'the use of advanced abstractions to provide a framework for enhancing the explanatory power of grounded theory'. [170] Because the theoretical codes constructed during the final analytical stages of the study help tell an analytical story that has coherence, they 'not only conceptualize how your substantive codes are related, but also move your analytic story in a theoretical direction'. [171] The conceptual map for example, illustrated the direction of anatomy from the concept of useful knowledge, through the notion of knowledge interpreted through the practice of dissection to the preservation of this knowledge in illustrated anatomy. The theoretical code that propelled this process concerned the interrelationship between borrowing knowledge, shaping knowledge and knowledge advancement. This part of the storyline conceptualised anatomy as field of knowledge that evolved through

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[167] M. Birks & J. Mills, p.115
[168] M. Birks, J. Mills, K. Francis & Y. Chapman, 'A thousand words paint a picture: The use of storyline in grounded theory research', *Journal of Research in Nursing*, Vol.14, No.5, 2009, 405–417, available from http://jrn.sagepub.com/content/14/5/405 (accessed 07/05/2015)
[169] M. Birks & J. Mills, p.119
[170] M. Birks & J. Mills, p.176
[171] K. Charmaz, 2006, p.63

various conceptual stages from the destruction of the physical body by science to its artistic preservation in anatomical images. Producing this grounded theory study as a storyline provided the format to explain the construction of substantive theory from the data.

Generating theory/theorising

The results of this research are explained through the aforementioned storyline which is a set of concepts that are linked to form a cohesive whole. This is in keeping with the definition of a theory provided by Birks and Mills, whereby theory is an 'explanatory scheme comprising a set of concepts related to each other through logical patterns of connectivity'. [172] The aim of this study is to address the research questions and present the 'findings' through consistent logical and sustained argument. In this way, the research document functioned to demonstrate an understanding of the topic as well as the research process itself. In keeping with the core category of rhetoric, the notion of theorising which emphasises understanding rather than explaining is deemed to be a suitable 'fit' when describing the process of this research. Theorising 'entails the practical activity of engaging the world and of constructing abstract understandings about and within it'. [173] For this grounded theory study theorising concerned guiding interpretive theoretical practice rather than providing a blueprint for theoretical products. [174] Consequently, interpretative theorising concerned the construction of meaning instead of the discovery of facts.

2.3.2 (ii) Sites of analysis and conceptualisation

Memos and maps

Memo writing is the key to this research process, because memos provide a written record of the interpretative and analytical processes that were required to address the research goals. These memos not only involve the majority of all writings including early categorising strategies, but they also function to ensure that the questions were fully understood and the findings meaningfully interpreted. Because documentary

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[172] M. Birks & J. Mills, p.119
[173] K. Charmaz, 2006, p.128
[174] K. Charmaz, 2006, p.129

analysis was the primary means by which this research project was approached, and because vast amounts of detailed information was involved in the coding processes, memoing provided the strategy by which to clarify complex data and identify gaps in the research. Consequently, this study relied extensively on memoing as a method to maintain focus and thus 'clarify areas of substantive richness'. [175] This study also relied on concept maps in which to represent meaningful relationships between concepts. Concept maps are described as a schematic devices for representing a set of concept meanings embedded in a framework of propositions. [176] For this study concept maps are the tools by which themes were organised and represented. As well as sites of conceptualisation, memos and maps also served as a site of reflection in that they involve both inductive and deductive logic. For example, memos and maps are inductive during the process of conceptualising the data and deductive when the researcher assesses how the conceptual labels, categories and subcategories link together. [177] Consequently, these devices function to represent the visible and therefore retrievable aspect of the grounded theory's iterative approach.

Memoing

This study maintained an ongoing relationship with the research through two separate forms of memoing which are essential in providing insights into data analysis and therefore theory development. The first memos concern the research journal; these memos were initially descriptive notations. The writings and re-writings of the pre-submission drafts, or rough drafts, serve as the second type of memoing, for the purposes of differentiation these dated and titled memos are referred to as draft memos. Memoing functions to reflect the researcher's internal dialogue, which is a process of both inductive and deductive logic. By way of explanation, memos are inductive during the process of conceptualising the data and

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[175] J. C. Hood, 'Orthodoxy vs. Power: The Defining Traits of Grounded Theory', in A. Bryant & K. Charmaz (eds.), *The Sage Handbook of Grounded Theory*, Sage Publications, London, 2007, p.161

[176] J. D. Novak & B. D. Gowin, *Learning How to Learn*, Cambridge University Press, Cambridge, 1984, p.15

[177] S. A. Hutchinson, cited in T. V. McCann & E. Clark, 'Grounded theory in nursing research: Part 1 – Methodology', *Nurse Researcher,* Vol.11, No. 2, 2003, pp.7-18, available from http://web.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=f5afbb82-1d6f-44b9-bf2e-974395aa9310%40sessionmgr198&vid=0&hid=107 (accessed 13/04/2015) p.15

deductive when the researcher assesses how the conceptual labels, categories and subcategories link together. [178]

Memo writing also concerns the literature review which in grounded theory remains a site of disputation. On this issue Ciarán Dunne points out that Glaser and Strauss advised against conducting a literature review during the early stage of the research process from a desire to allow categories to emerge naturally from the data during analysis. [179] This stance supposedly allowed the researcher to enter the field free of preconceived ideas. However, philosophers have long understood that it is not only impossible to know anything without referring to prior knowledge, but it is this prior knowledge that makes knowing possible. [180] The concept of the 'tablua rasa' in a grounded theory inquiry is a flawed and often misunderstood concept because researchers frequently possess some preconceived ideas relevant to the inquiry. The notion of disregarding prior knowledge however is based on a serious misreading of the seminal texts in grounded theory. [181] Rather than a complete avoidance of the existing literature, Ian Dey suggests Glaser and Strauss advise a wider engagement with ideas from diverse fields, thereby increasing the potential for theoretical stimulation. [182] As grounded theory evolved differing views concerning the role of literature in the research process were embraced.

In addition to the aforementioned classic Glaserian grounded theory, the model posed by Juliet Corbin and Anselm Strauss allowed for an early review of the relevant literature. [183] Whereas Kathy Charmaz argued a delayed but focused literature review helps to strengthen the argument and lend credibility to the study. [184] From this perspective memos have a significant role in the literature review. For

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[178] S. A. Hutchinson, p.15
[179] C. Dunne, 'The place of the literature review in grounded theory research', *International Journal of Social Research*, Vol.14, No.2, 2011, pp.111-124, available from http://staff.neu.edu.tr/~cise.cavusoglu/Documents/Advaced%20Research%20Methods/Qualitative/Dunne%20Place%20of%20Literature%20in%20Grounded%20theory.pdf (accessed 19/01/2014) pp.113-114
[180] University of Strathclyde, 'Sensing Categories', Unit Materials: MSc Applied Educational and Social Research, University of Strathclyde, available from http://www.strath.ac.uk/aer/materials/2designstrategiesineducationalresearch/unit3/sensitisingcategories/ (accessed 03/04/2015) web page
[181] R. Suddaby, p.634
[182] I. Dey, 'Grounding Categories', in A. Bryant & C. Charmaz (eds.), *The Sage Handbook of Grounded Theory*, SAGE Publications, Los Angeles, 2007, p.176
[183] J. Corbin & A. A. Strauss, *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (3rd edn.), SAGE Publications, Los Angeles, 2008, pp.36-39
[184] K. Charmaz, 2006, pp.165-166

Dunne it is implausible that memoing should not form an integral component of the literature review, 'whereby the researcher could reflect on the ideas to which s/he has been exposed while engaging with existing literature'.[185] Consequently, memoing represents the visible and therefore retrievable aspect of the grounded theory's iterative approach.

Maintaining a research journal provided the space to document thoughts as well as function as an audit trail. The audit trail is not only concerned with the overall progress of the project but it is 'helpful in tracking analytic processes'.[186] This journal is an important communication tool consisting of a series of informal analytic notes or memos that frequently provided links or notations to the draft memos. Therefore, there is a high degree of integration between the two types of memos, whereby the significance of the draft memos relates to ongoing analytical development documented in the research journal. This is in keeping with Kathy Charmaz who argues that writing drafts 'brings out implicit arguments, provide their context, make links with extant literatures, critically examine your categories, present your analysis, and provide data that support your analytic arguments.' [187] Although memos are 'the written records of the researcher's thinking, both conscious and preconscious realizations as the research and the researcher grow', they are, according to Barney Glaser normatively and automatically private. [188] Furthermore, because memos are a free association of ideas, Glaser argues that they are neither 'showable' not part of the final paper to be submitted. [189] This study adopts this notion and as such the aforementioned memos remain a site of discrete contemplation.

Sites of conceptualisation

The benefits of memoing extend further than the original intent of the research diary, which is to maintain a description of the vast amount of data required to address the

[185] C. Dunne, p.118
[186] S. Payne, 'Grounded Theory', in E. Lyons & A. Coyle (eds.), Analysing Qualitative Data in Psychology, London: SAGE Publications, London, 2007, p.81
[187] K. Charmaz, 2006, p.154
[188] B. G. Glaser, 'Introduction: Free Style Memoing', *Grounded Theory Review,* Vol.12, No.2, 2013, web page, available from http://connection.ebscohost.com/c/articles/102559438/introduction-free-style-memoing (accessed 12/1/2015) web page
[189] B. G. Glaser, 2013, web page
However such memos would be submitted upon request

research questions. For example, the memos had developed from the early journal entries, which were descriptive notes, to the notes that resembled a narrative form of conceptualised data. [190] Consequently, memos play a central role in theory development because through writing, both the form and the content of analytic work are rendered concrete.

Even though the memo entries were consistent for the duration of the project, the content and degree of conceptualisation within the memos tended to be variable. Variability is dependent on factors relating to a specific phase in the research process such as the availability and the complexity of the materials as well as the particular stage of data analysis. Later stages of theory development for example, changed the tone of memo writing, because at this stage 'there is an active interplay between memo writing, data analysis and data questioning.' whereby the researcher works proactively with the data to achieve steadily more analytic insights. [191] The journal also reveals intense memoing when the research questions require further refinement. It was found that analytic insights required for further development of the questions were heavily dependent on thinking about the data *and* the active process of writing. Juliet Corbin and Anselm Strauss suggest the act of writing sets in motion the process of analysis and if considered in this way memos are not just mere repositories of thought, they are 'working and living' documents. [192] Through the process of writing and re-writing memos that the developing insights and ideas were transformed into the substantive data that formed the basis of initial drafts for this paper. Memoing is described by Katy Charmaz as the pivotal intermediate step between data collection and writing drafts of papers. [193] Consequently, memos facilitate analytic insight and reflection.

Concept maps were also integral to this grounded theory study because these schematic devices provided the means by which to visualize the interrelationships between concepts such as 'art and science', and between 'knowledge and the image'

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[190] L. B. Lempert, 'Asking Questions of the Data: Memo Writing in the Grounded Theory Tradition', in A. Bryant & K. Charmaz K. (eds.), *The Sage Handbook of Grounded Theory*, Sage Publications, London, 2007, p.245
[191] S. Payne, p.81
[192] J. Corbin & A. Strauss, 2008, p.117
[193] K. Charmaz, 2006, p.72

and how these interrelationships fit within the overall idea of rhetoric. Charmaz suggests that devices such as maps and diagrams are used to both tease out relationships during the analytic process and demonstrate these relationships in visual form. [194] The structural format of each chapter, for instance, provided a means to visually present the categories and subcategories that provided the framework of the chapter. For example, establishing the image-maker as rhetor was presented as a linear process whereby relationships between making and thinking progressed through an understanding that image-making or the practice of shaping knowledge was primarily concerned with making, to an understanding that practical knowledge also concerned thinking or theoretical knowledge. Initially such maps served a descriptive purpose whereby patterns were recognised and themes were constructed. However in keeping with Strauss and Corbin, these maps, as a conditional/consequential matrix, provided a visual representation of the observed transactions and their interrelations and inter-relationships whereby the work advanced beyond description to analysis. [195]

For this study, the literature review is a site in which a concise critical analysis of the existing body of work is presented for the purposes of establishing a theoretical framework for the study. For Lora Bex Lempert this is a process that involves becoming familiar with, and reflecting on, the extant literature in order to acquire 'knowledge of the substantive area in sufficient depth to understand the parameters of the discourse and to enter into the current theoretical conversation.'[196] It is through the exercise of internal dialogue that memo writing aides in making the conceptual leap from the raw data to abstract theory that is required to present a critical review of the literature that was deemed relevant for this thesis. Thus, memoing involved constant writing throughout the research process thereby enabling the development of a framework through the ensuing analysis. Lempert explains that continuous memo writing, re-reading and re-writing, leads to progressively more abstract levels of theorising. [197] Memoing therefore reveals that the literature review is a

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[194] K. Charmaz, 2006, p.118
[195] A. L. Strauss & J. Corbin, cited in K. Charmaz, *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*, Sage Publications, Thousand Oaks, 2006, p.118
[196] L. B. Lempert, 2007, p.261
[197] L. B. Lempert, 2007, p.262

complicated process that involves analysis and interpretation of the selected literature, however, for the review to be comprehensive it must be subjected to the same analytic processes and stages as this grounded theory study itself.

2.4: Summary

The frameworks that underpin this research are consistent with the research aims and the overall research strategy including a grounded theory method of inquiry. A qualitative approach assumes an interpretative subjective framework with an emphasis on understanding and the significance of meaning and context. A constructivist approach to research aims to make the data meaningful through interpretative processes. Meaning for this study is realised by establishing connections in the data so as to increase the understanding of art's long association with science and how this association is reflected in the contemporary art-science debate. A constructivist grounded theory method ensures the centrality of the researcher to the process. Unlike traditional approaches to grounded theory which emphasise discovery, the role of the researcher in constructivist grounded theory is to build and transform knowledge through interpretation of the data.

Chapter 3: Literature Review

3.1: Situating the Research

The aim of this chapter is to provide, through selective reference to the extant literature, a clearer understanding of the arguments that focus on role of the visual image in academic discourse. A literature review is described as the systematic identification, location, and analysis of material related to the research problem, that is conducted in order to establish what is known about the topic as well as any gaps in the research. [198] This review will therefore function to situate the research topic within an existing body of knowledge. The concerns and debates surrounding the topic of research are expansive and long-established, and this this is evidenced by a plethora of literature available through a variety of sources and across several disciplines. Consequently, because of the diverse and complex nature of the topic it is beyond the scope of this work to present an extensive review of the literature. Instead, the following presents a focused review involving key ideas that draws on knowledge across several disciplines.

3.2: Literature Informing the Research

3.2.1 Artificial Structures and Overlapping Themes

Although this literature review is organised thematically the boundaries between the themes are not entirely distinct. This means that even though each theme is categorised according to a set of generalised concepts, this study acknowledges that no firm distinction between the categories exists. For this reason this chapter consists of an artificially organised set of overlapping categories that involve the five key areas that provide the structure for this literature review. These key areas concern Art

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[198] L. D. Bloomberg & M. Volpe, *Completing Your Qualitative Dissertation: A Road Map From Beginning to End*, Sage Publications, Thousand Oaks, 2012, p.47

and Science; The Image; The Image-makers; the Ways of Knowing; and The Art of Rhetoric.

3.2.2 Art and Science

In response to a perceived lack of research concerning the interrelationships between the arts and the sciences, David Topper and John Holloway produced a two part bibliographic list focusing on the topics of visual art, science and technology, and the peripheral themes relating to the topic. [199] Rather than provide a comprehensive list the aim of this bibliography is to provide a starting point for further study about these relationships. [200]

Art and science are described according to a myriad of concepts which range from generic broad descriptions to particular definitions accorded to a specific area of inquiry. However, the practice of describing art and science in terms of their differences is well established. Peter Galison and Caroline Jones, for example, describe art and science as binary opposites in their 1998 edited work *Picturing Science, Producing Art* in that:

> *Like all binaries, art and science needed to be yoked together (yet held apart) in order to accrue the strengths of their polar positions: soft versus hard, intuitive versus analytical, inductive versus deductive, visual versus logical, random versus systematic, autonomous versus collaborative, and, like all binaries, at some level, male versus female.[201]*

The relationship between art and science has been the focus of a series of popular and academic debates. Benjamin Cohen argues that the oft-cited 'two cultures debate' is but one such debate that focuses on the issues 'of authority (and thus credibility) and hegemony (and thus authority). [202] The central issue of the Huxley-

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[199] D. R. Topper & J. H. Holloway, 'Interrelationships between the Visual Arts, Science and Technology: A Bibliography', *Leonardo*, Vol.13, No.1, 1980, pp.29-33, available from
http://www.jstor.org.ezproxy.usq.edu.au/stable/pdfplus/1577916.pdf?acceptTC=true (accessed 19/11/2014) p.29
[200] D. R. Topper & J. H. Holloway, p.29
[201] C. A. Jones & P. Galison, p.2
[202] B. R. Cohen, 'On the Historical Relationship Between the Sciences and the Humanities: A Look at Popular Debates That Have Exemplified Cross-Disciplinary Tension', *Bulletin of Science, Technology & Society*, Vol.21, No.4, 2001, pp.283-295, available from
http://ezproxy.usq.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=5261143&site=ehost-live (accessed 10/04/2013), p.283

Arnold debate of the eighteen eighties, for instance, was one of cultural authority whereby a challenge to the traditional humanities-based education was initiated by new forms of knowledge based on the 'materially oriented natural sciences'. [203] Whereas the science education reformation (and neglect-of-science) debates in Britain in the 1920s, drew on the technological advantages of modern warfare demonstrated by a science-based German education. [204] The more recent science/culture wars of the nineteen eighties concerned a perceived breech in the divide that both separates the humanities and the sciences from other epistemological efforts and secures their own authority. [205] In contrast to the previous debates, in which the sciences and humanities each focused on the superiority of their forms of inquiry, the science/culture wars were about the legitimacy of interdisciplinarity research. Rather than an atmosphere of discord, Stephen Wilson situates art and science within a framework of cultural innovation whereby the 'arts and the sciences are two great engines of culture: sources of creativity, places of aspiration, and markers of aggregate identity'. [206] Consequently, issues of definition are culturally laden concepts that focus primarily on the historical development of both areas of inquiry.

Defining art remains problematic for scholars because theories or attempts to explain the nature and value of art have been debated since ancient times. However the work of philosophers, in particular Immanuel Kant, have continued to be influential in defining the concept of art. Las-Olof Åhlberg points to Kant's philosophy of aesthetics and the notion of aesthetic judgement as a hallmark in the development of aesthetic thought and analysis. [207] In the *Critique of Judgement* Kant describes art as a form of representation that is purposive in itself; something that presents to our faculties of 'imagination and understanding' an object that is without determinate end, that nevertheless cultivates our 'mental powers for sociable communication'. [208] Kant was concerned with the issues of aesthetic, sensuous perception and the judgments of taste. However in the search for knowledge, thinkers such as Hegel

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[203] B. R. Cohen, 2001, p.285
[204] B. R. Cohen, 2001, p.286
[205] B. R. Cohen, 2001, p.292
[206] S. Wilson, 2002, p.5
[207] L- O. Åhlberg, p.152
[208] I. Kant, *Critique of Judgement*, trans. W. S. Pluhar, Hackett Publishing Company, Indianapolis, 1987, p.173

emphasised the relationship between truth and beauty, whereby beauty is characterized as the sensuous presence of the Idea. [209]

Notions of art range through the philosophical, historical and the institutional, but, according to James Ladyman defining science is the most fundamental task of the philosophy of science. [210] Consequently, definitions of science are provided by institutions such as the *National Academy of Sciences* which defines science as 'the use of evidence to construct testable explanation and prediction of natural phenomena, as well as the knowledge generated through this process.'[211] Additionally, London's *Science Council* describes science as 'the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence'. [212] The methodological approach used by scientists to study the natural world is referred to as the scientific method. The scientific method is described by Christine McLelland, as 'a way of learning or a process of using comparative thinking. Things that are not testable or falsifiable in some scientific or mathematical way, now or in the future, are not considered science.' [213] Scientific method involves the theories of scientific procedure as well as theories about the justification of scientific claims. The scientific method is supposed to be the rational mode by which we gain objective knowledge of the world. To say that scientific knowledge is objective means that it is not the product of individual whim, and it deserves to be believed by everyone, regardless of their other beliefs and values. [214]

Science is also associated with progress, and questions concerning scientific progress and the rationality of scientific change were the focus of the 1965 Kuhn versus Popper debate, *Criticism and the Growth of Knowledge.* Thomas Kuhn's arguments were based on the claims he made in the 1962 work, *The Structure of Scientific Revolutions*. Such claims relate to the concepts of normal science,

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[209] A. Eliëns, et al, p.3

[210] J. Ladyman, *Understanding Philosophy of Science*, Routledge, London, 2002. p.4

[211] The National Academies, 'What is the definition of science?', Some Frequently Asked Questions, *The National Academies*, [web page] available from http://www.nationalacademies.org/newsroom/faq/index.htm (accessed 21/08/2013) web page

[212] The Science Council, 'Definition', *The Science Council*, [web page], 2014, available from http://www.sciencecouncil.org/definition (accessed 16/04/2014) web page

[213] C. V. McLelland, 'The Nature of Science and the Scientific Method', *The Geological Society of America,* 2006, pp.1-8, available from http://www.geosociety.org/educate/NatureScience.pdf (accessed 31/02/2015), p.1

[214] J. Ladyman, p.4

incommensurability, and paradigms. [215] Kuhn used the concept of paradigms and paradigm shifts to explain the manner in which science progresses. Whereas Karl Popper defended the views he proposed in his seminal work *The Logic of Scientific Discovery*, initially published in 1934 and republished in English in 1959. Popper proposed that scientific knowledge grows through the process of making hypotheses about the nature of problems and the falsification or testing of those hypotheses. [216] Popper's concept of falsification argues that theories are never proven, instead they resist refutation, whereas Kuhn proposed changes in science were due to revolutionary shifts from one paradigm to another.

3.2.3 The Image

The topic of the image is not only attracting a wide range of scholars from various forms of inquiry, it is also shaped through a variety of approaches. The challenges related to the study of images is highlighted by Dominic Lopes in the 1996 publication *Understanding Pictures* when the scholar wrote that 'diversity is the central fact with which a theory of figurative pictures must reckon'.[217] Along similar lines art historian James Elkins sought to demonstrate the value of exploring images beyond traditional boundaries to include the images of science, commerce, music and archaeology. [218] An interdisciplinary consideration of the image is provided in the 2006 edited publication *Images: A Reader* however the creation of a single 'interdiscipline' is not a consideration for the editors Sunil Manghani, Arthur Piper, and Jon Simons.[219] This is because, in so far as 'images are objects of study and enquiry in disciplines from art history to neuroscience, from political science to cultural studies, it cannot be assumed that the interdisciplinary terrain is already mapped out, ready for scholarly investigation'. [220]

Because 'image' is utilised in a number of discourses and in a variety of contexts the image has been critically scrutinised by a range of scholars. Sandra Weber for instance, depicts the image as a multilayered theoretical statement which functions to

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[215] T. S. Kuhn, *The Structure of Scientific Revolutions* (2nd ed.), University of Chicago Press, Chicago, 1970
[216] K. Popper, *The Logic of Scientific Discovery*, Routledge, London, 2005, p.1-5
[217] D. M. Lopes, *Understanding Pictures*, Oxford University Press, Oxford, 1996, preface
[218] J. Elkins, 1999, p.2
[219] S. Manghani, A. Piper. & J. Simons (eds.), *Images: A Reader*, Sage Publications, London, 2006
[220] S. Manghani, et al, 2006, p.1

'convey multiple messages, to pose questions, and to point to both abstract and concrete thoughts in so economical a fashion that makes image-based media highly appropriate for the communication of academic knowledge'.[221] In the 1972 publication *Ways of seeing* John Berger describes an image as 'a sight which has been recreated or reproduced. It has appearance, or a set of appearances, which have been detached from the place and time in which it first made its appearance and preserved – for a few moments or a few centuries'. [222] Like Walter Benjamin, Berger based his assumptions about images on the mechanical means of reproduction, specifically photography. Rather than a single description Julia Marshall argues that several definitions of the 'image' exist, and such definitions range from 'likenesses of perceived entities to internal visualizations in the mind such as apparitions and conceptions'. [223] According to Marshall:

> *These definitions include and delineate between perceived and mental images ( ) and exteriorized images, that have been created in visible, material form by an artist, designer, or scientist. Whether interior or exterior, images can be categorized into two general types: pictorial (natural, mimetic) images that represent or record perceptions (such as naturalistic drawings and photographs), and conceptual images that embody concepts.[224]*

Philosophers trace the origins of the study of the image to ancient times, but more recent accounts include the writings of French philosopher Jacques Rancière and John Kulvicki. Rancière's concept of the image moves beyond idea of the image as one that involves traditional media such as painting, to include cinema and audio visual installations. In the 2007 publication the *Future of the Image* Rancière argues that artistic images are '. . . operations. . . relations between a whole and parts; between a visibility and a power of signification and affect associated with it;

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[221] S. Weber, 'Using Visual Images in Research' excerpted from J. G. Knowles, & A. L. Cole (eds.), *Handbook of the Arts In Qualitative Research: Perspectives, Methodologies, Examples, and Issues,* Sage Press, London, 2008, p.3

[222] J. Berger, *Ways of Seeing*, British Broadcasting Corporation and Penguin Books, London, 1972, pp.9-10

[223] J. Marshall, 'Image as Insight: Visual Images in Practice-Based Research', *Studies in Art Education A Journal of Issues and Research*, Vol.49, No.1, 2007, pp.23-41, available from http://www.naeaworkspace.org/studies_single/Studies%2049%281%29_Fall2007_individual/A2_Studies%2049%281%29_Fall 2007-3.pdf (accessed 08/03/2013) p.28

[224] J. Marshall, 2007, p.28

between expectations and what happens to meet them.[225] Whereas John Kulvicki's account of the image concerns representation, that is, how pictures represent their subject.[226] Drawing on the work of Nelson Goodman, Kulvicki unpacked the necessary and sufficient conditions for a representational system to be pictorial. These conditions were identified as; relative repleteness, syntactic sensitivity, semantic richness, and transparency as the necessary and sufficient conditions for a representational system to be pictorial.[227] For Kulvicki, a representation is pictorial of diagrammatic by virtue of its relationship within a system of representation.[228]

Scholars are also seeking to locate the image within visual culture. Marita Sturken and Lisa Cartwright argue that in many ways culture is an increasingly visual one filled with images which 'are central to how we represent, make meaning, and communicate in the world around us'.[229] Moreover, visual culture encompasses many media forms ranging from fine art to popular film and television to advertising to visual data in fields such as the sciences, law, and medicine.[230] In the 2004 essay, *What is an image and what is image power?* Dirk van den Berg suggests that by positioning of the study of the image within either visual cultural studies or visual theory, art history would be transformed into an expanded history of images.[231] In this new mode of inter-disciplinarity, art historiography would involve both the 'theory of images' or *Bildwissenschaft* and 'history of images' or *Bildgeschichte*.[232] In this way, the 'interpretation of images that incorporates both theory and history in cultural analysis is essential for the success of art historiographical involvement in cultural studies.'[233] Along similar lines Oliver Grau also aims to position the image within *Bildwissenschaft*. Grau describes *Bildwissenschaft*, or 'image science', as a neglected story-line of art and media history in the discipline of art history.[234] Grau

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[225] J. Rancière, *The Future of the Image*, (trans.) Elliott, G., Verso, London, 2007, pp.3-7

[226] J. V. Kulvicki, *On Images: Their structure and content*, Oxford University Press Oxford, 2006, p.14

[227] J. V. Kulvicki, 2006, p.14

[228] J. V. Kulvicki, 2006, p.6

[229] M. Sturken & L. Cartwright, *Practices of Looking: An Introduction to Visual Culture*, Oxford University Press, New York, 2001, p.1

[230] M. Sturken & L. Cartwright, p.2

[231] D. van den Berg, 'What is an image and what is image power?', *Image & Narrative*, No.8, 2004, available from http://www.imageandnarrative.be/inarchive/issue08/dirkvandenbergh.htm (accessed 23/04/2013) web page

[232] D. van den Berg, web page

[233] D. van den Berg, , web page

[234] O. Grau, 'Art History as Image Science: Integrating Media Art into our Culture', Presentation Paper, *Refresh, First International Conference on the Histories of Media Art, Science and Technology*, 28 September – 1 October, 2005, pp.1-7, available from http://mail.virtualart.at/jspui/bitstream/10002/298/1/GrauImages.pdf (accessed 04/03/2013) p.5

suggests that the function of contemporary 'image science' is to investigate the aesthetic reception and response to images in all areas' and this new interdisciplinary subject shares 'the recent research areas of the historical study of image techniques, the history of the science of artistic visualization, art history of scientific images, and particularly the natural sciences-oriented occupation with images in science.' [235]

The relationship between image and word has shaped intellectual debate since Plato declared a mistrust of images. More recent discourse involves W.J.T. Mitchell's 'pictorial turn', which was coined in the 1984 work *Picture Theory* to describe a renewed interest in images and visual culture in general. [236] The term was adapted from Richard Rorty's 'linguistic turn' whereby the history of philosophy is characterised as a series of 'turns', that is, 'a new set of problems emerges and the old ones begin to fade away '.[237] For Mitchell, the pictorial turn concerns a 'widely shared notion that visual images have replaced words as the dominant mode of expression in our time'. [238] This turning away from a preoccupation with words in the humanities signalled an increased interest in the visual concepts of representation. In contrast, semiologist Roland Barthes disregards the notion of a society in which the visual was a significant means of communication. Writing in the seminal essay, *Rhetoric of the Image*, Barthes comments:

> *. . . at the level of mass communications, it appears that the linguistic message is indeed present in every image: as title, caption, accompanying press article, film dialogue, comic strip balloon. Which shows that it is not very accurate to talk of a civilization of the image - we are still, and more than ever, a civilization of writing, writing and speech continuing to be the full terms of the informational structure.* [239]

However Laurence Petit points to a growing dominance of the image in contemporary literature whereby 'hybrid texts' rely on both visual and verbal modes

[235] O. Grau, 2005, p.5

[236] W. J. T. Mitchell, *Picture Theory: Essays of Verbal and Visual Communication*, University of Chicago Press, Chicago, 1994, p.11

[237] W. J. T. Mitchell, *Picture Theory: Essays of Verbal and Visual Communication*, University of Chicago Press, Chicago, 1994, p.11

[238] W. J. T. Mitchell, *What Do Pictures Want? The Lives and Loves of Images*, University of Chicago Press, Chicago, 2005, p.1

[239] R. Barthes, *Image Music Text,* (trans.) Heath, S., Fontana Press, London, 1977, p.38

of representation. [240] This rising dominance of the visual over the verbal is treated with ambivalence by Gunther Kress and Theo van Leeuwen who argue that 'each have their potentialities and their limitations. A move from a central reliance on one mode to a central reliance on another will therefore inevitably have effects in both directions.' [241]

The image has a long association with art. Even though art history has become a highly contested discipline, particularly in relation to the emergent field of visual culture, it is the longest standing discipline concerned with the study of visual artefacts. [242] Images are the focus of Art Historian Keith Moxey's 2013 publication *Visual Time: The Image in History*. [243] In this text Moxey attempts to address the image in time as well as the time of the image through the notion of heterochrony, which poses that time is neither uniform nor linear but rather multivalent and discontinuous. [244] Moxley's second concern relates to the power of the image, irrespective of the moment of it creation, to affect the present. Such perspectives pose a challenge to thinking about the image and its history, that is, there needs to be an awareness to of the life of images beyond the moment of their creation. [245] Moxey, referred to as a pioneer of 'the new art history', rejects art history's interpretation of works of art based teleological categorization, stressing instead the notion of presentation whereby the work creates its own time.

The issue of aesthetic value as it relates to images is central to the work of Dominic Lopes who argues no theory can afford to ignore pictures' aesthetic potential. [246] Lopes' 2005 publication *Sight and Sensibility: Evaluating Pictures* was in part concerned with the aesthetic appraisal of pictures, viewed in relation to other evaluations of them. [247] These are not new concerns, because 'philosophers have long debated aesthetic value and evaluation on the one hand, and experiences of

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[240] L. Petit, 'On Pickles, Pictures and Words: Pick-torial Preservation and Verbal Self-Regulation in Salman Rushdie's Midnight Children', in M. Meyer, *Word and Image in Colonial and Postcolonial Literatures and Cultures*, Rodopi, Amsterdam, 2009, p.206
[241] G. Kress & T. van Leeuwen, *Reading Images: The Grammar of Visual Design* (2nd edn), Routledge Taylor & Francis Group, London, 2006, p.31
[242] S. Manghani, et al, 2006, p.53
[243] K. Moxey, *Visual Time: The Image in History*, Duke University Press, Durham, 2013
[244] K. Moxey, *Visual Time: The Image in History*, Duke University Press, Durham, 2013, p.1
[245] K. Moxey, p.8
[246] D. M. Lopes, *Understanding Pictures*, Oxford University Press, Oxford, 1996, p.6
[247] D. M. Lopes, *Sight and Sensibility: Evaluating Pictures,* Oxford University Press, Oxford, 2005, p.2

pictures and depicted scenes on the other'. [248] For Lopes aesthetic evaluation is not limited to traditional two dimensional images but also involves 'computer art' which suggests new approaches to familiar issues in the philosophy of art. Such approaches include the need to understand the role of technology as an art medium that defines an art form, which evokes the doctrine of medium specificity, the issue of the ontology of art and finally, theories of artmaking, performing, and spectating. [249]

The use of hybrid texts in science has attracted the interest of Punyashloke Mishra who remarked that diagrams 'accompanied by text, have been a common means of recording and conveying scientific and technical information since the fifteenth century.' [250] However, until recently this area was poorly researched because greater attention has been afforded to verbal propositions, arguments, references, analogies, metaphors, and 'ideas' as constituents of scientific reasoning and rhetoric. [251] The increase in interest in visual modes of representation of science has resulted in a contribution to the debate from a variety of scientific perspectives including the historical, the philosophical, and the sociological, as well as the purely scientific. Some scholars however are also seeking to demonstrate a theoretical account of visual images within a broader context of science. Luc Pauwels for instance notes the 'multifaceted issue of visualisation in science basically involves the complex processes through which scientists develop or produce (and communicate with) imagery, schemes, and graphical representations, or the like, using various means (ranging from a simple pencil on paper to advanced computers or optical devices).' [252] However, Michael Lynch suggests the increased attention paid to images is part of a more general interest in the detailed contents of scientific texts, discourses and practices, that is, '[f]or many social historians and sociologists of science, visual

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[248] D. M. Lopes, 2005, p.2
[249] D. M. Lopes, *A Philosophy of Computer Art*, Routledge, London, 2009, p.xiii
[250] P. Mishra, 'The Role of Abstraction in Scientific Illustration: Implications for pedagogy', *Journal of Visual Literacy*, Vol.19, No.2, 1999, pp.139-158, available from
http://web.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=8e859da4-7371-4499-ab9e-2a5a05602c6c%40sessionmgr4&vid=1&hid=28 (accessed 31/05/2013) p.140
[251] P. Mishra, p.140
[252] L. Pauwels, 'A Theoretical Framework for Assessing Visual Representational Practices in Knowledge Building and Science Communications', in L. Pauwels (ed.), *Visual Cultures of Science: Rethinking Representational Practices in Knowledge Building and Science Communication*, Dartmouth College Press, Hanover, 2006, p.1

images are less significant, in themselves, then are the practices that compose and establish the evidential significance of these images.' [253]

Writing in the 1998 publication *Representation in Scientific Practice* Michael Lynch and Steve Woolgar note that a particular interest in the communicative power of the pictorial has resulted in questioning the once privileged verbal statement or 'proposition'.[254] This means that in recent academic debate the traditional view of scientific representation as linguistic has shifted to include an understanding that scientific theory could also be represented by a collection of non-linguistic models such as images. For Roman Frigg and Matthew Hunter these models are theorised on the basis of mimesis or convention. [255] In other words, pictorial representation is a complex field of study that concerns both the mimetic, based on either similarity or isomorphism, and the conventionalist traditions of representation. [256] These traditions have been at various times perceived as not only different ways of representing scientific concepts but as opposing strategies of representation. Luc Pauwels for instance, points out that science is not about copying nature and culture but revealing it, as such, these representations should function to solve a problem such as a gap in knowledge or facilitation of knowledge transfer, rather than replicating reality. [257]

3.2.4 The Image-makers

Even though a broad range of interpretations exist for the terms 'artist', 'artisan' and 'craftsperson', they are frequently used interchangeably to refer to those practitioners who are involved in some form of 'skilled creative activity'. Although these 'skilled creative activities' have a common linage, differences that have developed between them have been determined in various ways. While artisan and craftsperson are traditionally associated with quality 'workmanship', the notion of the artist continues

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[253]M. Lynch, 'The Production of Scientific Images: Vision and Re-Vision in the History, Philosophy, and Sociology of Science', in L. Pauwels (ed), *Visual Cultures of Science: Rethinking Representational Practices in Knowledge Building and Science Communication*, Dartmouth College Press, Hanover, 2006, pp.26-40
[254] M. Lynch & S. Woolgar, p.vii
[255] R. Frigg & M. C. Hunter, p.xv
[256] R. Frigg & M. C. Hunter, p.xx
[257] L. Pauwels, 'Introduction: The Role of Visual Representation in the Production of Scientific Reality', in L. Pauwels (ed.), *Visual Cultures of Science: Rethinking Representational Practices in Knowledge Building and Science Communication*, Dartmouth College Press, Hanover, 2006, p.viii

to be contestable. For Mary Ann Stankiewicz historical educational markers serve as coordinates for the development of the visual arts. Such periods might include:

> *(1) a prehistory of informal means of art education up to the Renaissance in European-dominated nations, roughly ca. 100 BCE-ca. 1600, [. . .]; (2) artist education and liberal art education for elite amateurs in the context of national formation, ca. 1600–1800; (3) emerging capitalism and middle-class aspirations, ca. 1800–1850 and later; (4) industrial drawing systems, dominated by South Kensington in English-speaking countries and colonies, ca. 1850–1910; (5) ideology of the self-expressive child artist, ca. 1910–1960; (6) turn toward intellectual rigor, ca. 1960 to the present. [258]*

The division between artist and artisan is reflected in the distinction between art and craft which has existed since the development of aesthetics and the notion of 'fine' art during the eighteenth century. For Allen Speight the development of artist to artisan relates to the:

> *new and widening distinction that emerges in the eighteenth century between 'free' artists on the one hand and artisans or 'handicraftsmen' on the other hand: while genius, inspiration and creativity characterize the activity of the former, the latter are described in terms of skill, working according to a rule, and working within a trade. [259]*

Speight goes on to explain that discussions concerning the distinctions between creative activity and products of the human hand and the 'origin of art' are found in the works of thinkers such as Hegel. [260] According to Speight, Hegel addresses the status of the artist by drawing a distinction between artist and artisan and the status of

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[258] M. A. Stankiewicz, 'Capitalizing Art Education: Mapping International Histories', in L. Bresler (ed.), *International Handbook of Research in Arts Education*, Springer, Dordrecht, 2007, p.7

[259] A. Speight, 'Artisans, Artists and Hegel's History of Art', *Hegel Bulletin*, Vol.34, No.2, 2013, pp.203-222, available from http://journals.cambridge.org.ezproxy.usq.edu.au/download.php?file=%2F6873_0DEF8CDC89CB3720180A1836E5CB6899_journals__HGL_HGL34_02_S2051536713000127a.pdf&cover=Y&code=4be7e610d16b7968535dff80e4f96db5 (accessed 15/06/2014) p.203

[260] A. Speight, p.204

the artistic creation, whether it is a conscious or unconscious activity and how this fits within the larger tradition of the' imitation of nature' that Hegel rejects. [261]

An artisan is considered to be highly skilled by virtue of a long period of training that occurs within a bonded apprenticeship. A structure of apprenticeships and guilds have existed since the middle ages and these are examined by Carol Loats who points to an established system of ritualistic apprenticeships and guild structures that enabled an artisan to identify with a particular group or trade and provide opportunities for professional advancement. [262] However, according to David Landau and Peter Parshall, a flourishing community of unregulated and consequently unprotected artisans coexisted alongside the guilds. [263] Recent scholarship concerning the artisanal guild system indicates a range of views: from the stifling influence of the guilds to the provision of certification resulting in wider recognition of the artisan. [264] In addition to a guild system, artisans also practiced within a hierarchical structure whereby some professions enjoyed a higher status in society than others. Heather Swanson points to a wide variation in artisanal status ranging from 'the wealthy and prestigious pewterers and goldsmiths' to the 'destitute members of the textile and building crafts.' [265] The term 'artisanal' has a continuous history within European history although the category has changed in context over time. According to Margaret Pappano and Nicole Rice premodern artisans are typically bounded by two historical markers; 'the rise of urban centres in the medieval period and the reorganization of commodity production as a result of industrial capitalization in the early modern period'. [266] These economic categories were significant to a rise in artisanal practices because, according to Pamela Long, the 'development of urbanism in the eleventh and twelfth centuries brought with it

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[261] A. Speight, p.204

[262] C. L. Loats, 'Gender, guilds and work identity: Perspectives from sixteenth-century Paris, *French historical studies*, Vol.20, No.1, 1997, pp.15-30, available from
http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=693d38c8-ae96-4734-9467-cede16dec4c8%40sessionmgr112&vid=0&hid=125 (accessed 18/08/2014) pp.15-17

[263] D. Landau & P. Parshall, *The Renaissance Print 1470 – 1550*, Yale University Press, London, 1994, p.11

[264] D. Landau & P. Parshall, p.11

[265] H. Swanson, *Medieval Artisans: An Urban Class in Late Medieval England*, Basil Blackwell, Oxford, 1989, p.2

[266] M. A. Pappano & N. R. Rice, 'Medieval and Early Modern Artisan Culture', *Journal of Medieval and Early Modern Studies*, Vol.43, No.3, 2013, pp.473-485, available from
http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=4f862c4d-03f2-45c7-8140-c23dd94ad77a%40sessionmgr198&hid=101 (accessed 28/04/2015), p.473

the rise of the merchant class and the great expansion of artisanal crafts and trades.'[267]

Research indicates that artisanal identity was shaped by the categories of knowledge that existed in premodern times. As such, scholars have addressed both the concept of artisanal knowledge and the transmission of such knowledge from a variety of approaches. According to Lisa H. Cooper, the study of late medieval English artisans has recently moved 'toward an examination of artisanal culture that attends to both craft labour and craft life as forms of practice, bodies of knowledge, and realms of experience that distinguished medieval artisans from other members of the social body'. [268] For Pamela Long the focus concerns the concept of artisanal writing. In the 1997 essay *Power, Patronage, and the Authorship of Ars*, Long investigates the links between the authorship of the mechanical arts and patronage and its relevance to the historiography of early modern science and by extension the development of experimental philosophy. According to Long 'artisan-trained practitioners authored a significant number of books concerning the mechanical arts' and they 'represent a select group of artisans, most of whom had turned away from the support of craft guilds to the patronage of elite rulers; they wrote books in part to further that patronage'.[269]

The artisanal influences on the development of knowledge has also been addressed by Pamela Smith in the 2004 work *The Body of the Artisan: Art and Experience in the Scientific Revolution* [270] and by Sachiko Kusukawa's 2012 publication, *Picturing the Book of Nature: Image, Text, and Argument in Sixteenth-Century Anatomy and Medical Botany*. [271] Some scholars attribute the rise in artisanal intellectual activity to the decline of Latin as the prominent language of literature. Edgar Zilsel, for

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[267] P. O. Long, *Openness, Secrecy, Authorship technical arts and the culture of knowledge from antiquity to the renaissance*, The Johns Hopkins University Press, Baltimore 2001, p.88

[268] L. H. Cooper in M. A. Pappano & N. R. Rice, 'Medieval and Early Modern Artisan Culture', *Journal of Medieval and Early Modern Studies*, Vol.43, No.3, 2013, pp.473-485, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=4f862c4d-03f2-45c7-8140-c23dd94ad77a%40sessionmgr198&hid=101 (accessed 28/04/2015), p.473

[269] P. O. Long, 'Power, Patronage, and the Authorship of Ars: From Mechanical Know-How to Mechanical Knowledge in the Last Scribal Age', Isis, Vol.88, No.1, 1997, pp.1-14, available from www.jstor.org.ezproxy.usq.edu.au/stable/pdfplus/235824.pdf (accessed 19/08/2014), , p.3

[270] P. H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution,* The University of Chicago Press, Chicago, 2004

[271] S. Kusukawa, *Picturing the Book of Nature: Image, Text, and Argument in Sixteenth-Century Anatomy and Medical Botany*, The University of Chicago Press, Chicago, 2012

example, argues that books published by 'mechanics' in languages other than Latin resulted in the dissolution of the barrier between the liberal and the mechanical arts. [272] For others this rise in literacy is due to the impact of mechanical printing. Elizabeth Eisenstein proposes that the printing press functioned as an agent of change because the emergence of print culture served to initiate a communication revolution. [273] The scholar speculates on the notion of a link between increased output of old texts and the emergence of new theories. Even though some authorities conclude that printing did not speed up the adoption of new theories, Eisenstein questions the origins of the 'old' theories the 2005 publication *The Printing Revolution in Early Modern Europe*. [274]

A plethora of images depicting 'science' are evidence that artistic practice has long relied on scientific discoveries in order to create work. Lynn Gamwell has attempted to demonstrate that the visual arts have drawn extensively from scientific achievement in the 2002 publication *Exploring the Invisible: Art, Science, and the Spiritual*. [275] Gamwell's work concerns the methods by which artists have portrayed the invisible, a practice which began with the transition from speculative philosophy to experimental science. That is, 'as bigger telescopes were pointed at the sky, and better microscopes focused on specimens, the invisible suddenly came into view and inspired artists to capture these strange new landscapes.' [276] Gamwell's 'landscapes' range from Casper David Friedrich's 1818 *Wanderer above a Sea of Fog*, and J. M. W. Turner's experiments with light and colour to Anselm Kiefer's 1998 artist's book, *The secret Life of Plants*. Consequently, artists have responded to science in a variety of ways. These responses are described by José Javier Campos-Bueno as works devoted 'to the exaltation of science' as well as 'the representation of the value of scientific activity.' [277] Included in these descriptions are the portraits of

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[272] E. Zilsel, 'The Sociological Roots of Science', Social Studies of Science, Vol.30, No.6, 2000, pp.935-949, available from http://ecology-and-socialism.wikispaces.com/file/view/The+Sociological+Roots+of+Science+-+Zilsel.pdf (accessed 11/11/2014)

[273] E. Eisenstein, *The Printing Revolution in Early Modern Europe* (2nd edn.), Cambridge University Press, New York, 2005, p.46

[274] E. Eisenstein, 2005, p.46

[275] L. Gamwell, *Exploring the Invisible: Art, Science, and the Spiritual,* Princeton University Press, Princeton, 2002

[276] L. Gamwell, 2002, p.306

[277] J. J. Campos-Bueno, 'Art and Science in Sorolla's Painting A Research in Dr. Simarro's Lab', *Psychologia Latina*, Vol.1, 2010, pp.9-26, available from http://eprints.ucm.es/10784/1/Campos_2010_art_science_sorolla_simarro_Psychol_Lat.pdf (accessed 03/02/2013) pp.13-14

scientists or 'works praising the triumph of the skilled professions and of science'.[278] Such portraits include Gerrit Dou's 1665 work *The astronomer and The astronomer by candlelight*. Campos-Bueno claims that artists gained greater freedom to depict such topics of scientific progress through the combination of the onset of Renaissance and the decline of the power of the Church. [279] Previously, the development of painting has been linked to the existence of patrons, that is, 'the church, the nobility, and the kings were interested in protecting art and culture as a means to enhance and spread their power'. [280] Ludmilla Jordanova also draws attention to the conventions for depicting scientists as men of learning and scholarship rather than of manual labour. [281] Jordanova argues that in addition to constructing identity, the portraits of scientists have functioned to unite art and science over time by presenting the public face of science and medicine to an engaged audience, past and present. [282]

Rather than practice in a traditional studio, many artists are seeking to work within a laboratory environment in order to establish a framework of cross-disciplinary and multidisciplinary research. Such research ranges from biologically informed art to 'new media art'. New media art is frequently associated with the production of art through the use of digital technology and robotics. However, according to contemporary art critic and curator Domenico Quaranta, the world of 'New Media Art came into being as cultural niche in the Sixties and Seventies, and became a bona fide art world in the Eighties and Nineties, developing its own means of production and distribution, and cultivating an idea of "art" that is completely different from that entertained by the contemporary art world.'[283] Quaranta argues that new media art is not defined by medium, genre, movement, or aesthetic category, rather it is the art that is produced, discussed, critiqued and viewed in a specific "art world", that we will call the "New Media Art world"'. [284] For Beatriz da Costa this 'new media art',

[278] J. J. Campos-Bueno, p.13
[279] J. J. Campos-Bueno, p.9
[280] J. J. Campos-Bueno, p.9
[281] L. Jordanova, Defining Features: Scientific and Medical Portraits 1660-2000, Reaktion Books in association with the National Portrait Gallery, London, 2000, p.41
[282] L. Jordanova, 2000, p.101
[283] D. Quaranta, 'The Postmedia Perspective', *Rhizome*, [webpage] posted 12 Jan, 2011, available from http://rhizome.org/editorial/2011/jan/12/the-postmedia-perspective/ (accessed 3/08/2015)
[284] D. Quaranta, *Beyond New Media Art*, trans. Carruthers, R., LINK Editions, Brescia, 2013, p.35

sometimes referred to as 'emergent technology art' or (at worst) 'computer art', not only represents a new disciplinary area within visual art, but a re-examination and expansion of the so-called traditional areas of expression. [285]

New media art might also involve live media and involve the concepts of bioart, molecular art, and genetic art. For art curator Jens Hauser, 'bioart' is a proliferating and mutant term inasmuch as the 'growing interest in art forms that deal with the biological disciplines at large has created a niche for a proliferating murky and woolly generic term: bioart. . . which stands for both biomedia and biotopics, and tends to abolish their ontological differentiation.' [286] The subject of human genetics is current across a range of media cultures including art. Kate O'Riordan comments that genomic art has a long history of interest and investment. [287] Of interest to O'Riordan are the three overlapping levels of genomic art, whereby:

> [O]ne is public art works created directly from sciart projects, or projects like them. In this area a number of projects have emerged that bring together scientists and artists in order to engage publics with science, and also in the hope that art might engage science. The second area is art works that have taken up genomics as their subject because of its interest for the artist, a particular community, or because of its general topicality as a subject. This might be termed genomic themed art. The third relevant area of genomic art is bioart, or tactical bioart. This latter area of the arts takes up biological materials, like bodily tissues, as the artistic media itself. In this area body parts and tissues such as skin, saliva and semen are part of the materiality of the artwork, and tactical bioart particularly is attached to a political agenda of activism. [288]

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[285] B. da Costa, 'When Art Becomes Science', in B. da Costa & K. Philip (eds.), *Tactical Biopolitics: Art, Activism, and Technoscience*, The MIT Press Cambridge, 2008, p.367

[286] J. Hauser, 'Toward a Phenomenological Approach to Art Involving Biotechnology', in B. da Costa & K. Philip (eds.), *Tactical Biopolitics: Art, Activism, and Technoscience*, The MIT Press Cambridge, 2008, p.83

[287] K. O'Riordan, *The Genome Incorporated: Constructing Biodigital Identity*, Ashgate, Farnham, 2010, p.10

[288] K. O'Riordan, p.10

3.2.5 The Ways of Knowing

It is widely accepted by scholars that Plato's notion of knowledge as justified true belief is a narrow definition. Thus, scholars have sought a range of definitions that account for the varied and complex concepts about the nature of knowledge which are wider than the traditional conceptions that are grounded in ontology and epistemology. Theorist George Siemens holds that the traditional definitions are no longer adequate because the characteristics and contexts of knowledge have changed over time. [289] Whereas Michel Foucault advances the idea that knowledge is 'that of which one can speak in a discursive practice', as well as the space in which the subject may take up a position and speak of the objects with which he deals in his discourse', in addition to 'the field of coordination and subordination of statements in which concepts appear, and are defined, applied and transformed', and 'lastly, knowledge is defined by the possibilities of use and appropriation offered by discourse'. [290] Siemens suggests a description of knowledge is more useful than a definition because a description would establish a site for dialogue and debate about contemporary knowledge. [291] For Michelle Buehl and Patricia Alexander knowledge is both multidimensional and multilayered, consequently beliefs about such knowledge are similarly multidimensional and multilayered. [292] This means that 'individuals may possess general beliefs about knowledge, but still hold distinct beliefs about more specified forms of knowledge'. [293] One notion of knowledge is that it is desirable in itself and for its own sake. Samuel Johnson commented in 1763 that knowledge is also desirable because it is useful. [294] The notion of 'useful information' was particularly significant during Britain's industrial revolution and works such as John Imison's *The School of Arts: Or, an Introduction to Useful Knowledge* originally published in 1785, covered particular branches of science

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[289] G. Siemens, *Knowing Knowledge*, George Siemens/Elearnspace, 2006, available from http://www.elearnspace.org/KnowingKnowledge_LowRes.pdf p.vi

[290] M. Foucault, *The Archaeology of Knowledge*, trans. A. M. S. Smith, Routledge, London, 1989, pp.182-183

[291] G. Siemens, p.vi

[292] M. M. Buehl & P. A. Alexander, 'Beliefs about academic knowledge', *Educational Psychology Review*, Vol.13, No.4, 2001, pp.385-418, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=cf71194e-2433-4a67-97c0-222b6f36f41c%40sessionmgr114&vid=0&hid=115 (accessed 05/02/2015) p.389

[293] M. M. Buehl & P. A. Alexander, p.389

[294] S. Johnson cited in J. Burns, 'From Polite Learning to Useful Knowledge' History Today, Vol.36, No.4, 1986, p.21, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=3&sid=4e89ff1a-6b85-4123-8e93-0a957dc5e794%40sessionmgr110&hid=110 (accessed 06/08/2015) p.21

which included, mechanical powers, electricity, pneumatics, optics and astronomy and many 'philosophical instruments'. [295]

The concept of 'useful knowledge' is utilised by Joel Mokyr in order to 'deal with natural phenomena that potentially lend themselves to manipulation, such as artefacts, materials, energy, and living beings'. [296] Mokyr classifies useful knowledge as either propositional or prescriptive. Propositional knowledge is 'knowledge (that is to say, beliefs) about natural phenomena and regularities. Such knowledge can then be applied to create knowledge "how," that is, instructional or prescriptive knowledge, which we may call techniques.' [297] This distinction between propositional knowledge or episteme and prescriptive knowledge or techne is significant because it differs in important respects from the distinctions between science and technology and the distinctions between theory and empirical knowledge. Knowledge, according to Martin Davies and Kenneth Sievers, is an organic process involving situated knowers in a world of facts and information which require interpretation, as such, 'the knower begins to interpret this information by means of various *ways* of knowing and drawing upon, and influencing, a number of *areas* of knowledge'. [298] Davies and Sievers identify four ways of knowing; emotion, reason, language, and sense perception and recognise the six areas of knowledge which parallel the discipline divisions in all major world universities. [299] These areas of knowledge are broadly categorised as natural and human sciences, mathematics, the arts, ethics and history.

The ways of knowing are concerned with how knowledge about the world is acquired and how our relationship with this knowledge is determined. Drawing on the work of Belenky, Clinchy, Goldberger, and Tarule, Marlene Schommer- Aikins and Marilyn Easter describe ways of knowing as 'connected knowing and separate knowing', which in turn are concerned with procedural knowing and constructed

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[295] J. Imison, *The School of Arts or an Introduction to Useful Knowledge* (4th ed.), J. Murry & S. Highley, London, 1796, available from Internet Archive
https://ia801409.us.archive.org/15/items/schoolartsorani00imisgoog/schoolartsorani00imisgoog.pdf p.vi
[296] J. Mokyr, *The Gifts of Athena Historical Origins of the Knowledge Economy*, Princeton University Press, Princeton 2002, p.3
[297] J. Mokyr, 2002, p.4
[298] W. M. Davies & K. H. Sievers, *The Nature of Knowing: A Resource Manual For The International Baccalaureate*, IBID Press, Melbourne, 2006, p.5
[299] W. M. Davies & K. H. Sievers, p.5

knowing. [300] Thus, the two epistemic paradigms; ways of knowing and epistemological beliefs, are considered when examining the concept of 'personal epistemology'. Another distinction concerns the difference between personal epistemology and epistemology. Barbara Hofer contends that personal epistemology relates to the beliefs we hold about knowledge and knowing, whereas epistemology, as a philosophical enterprise, 'is concerned with the origin, nature, limits, and justification of human knowledge'. [301] The notion that epistemology is diverse and multidimensional is explored in the 2008 publication *Knowing, Knowledge and Beliefs: Epistemological Studies across Diverse Cultures*. [302] According to Myint Swe Khine, the purpose of this edited collection of essays is to provide both a theoretical framework and a model for contemporary research on the role of epistemological beliefs in learning. [303] This will be achieved in part by addressing questions that include; what is knowledge? Is knowledge fixed or ever-changing? How can we measure individuals' beliefs about the nature of knowledge and knowing? [304]

'Knowing' is described by Larry Reynolds as a process that raises two basic questions; 'What do I know? How do I know what I think I know?' [305] For Reynolds there are several approaches that contribute to knowing. Methodology is one such approach and as an aspect of epistemology, methodology 'is generally seen as the system of values, beliefs, principles and rules that guide analysis within a given discipline' and the methodology(ies) 'that prevails within a discipline plays a major role in the nature of questions that are asked as well as the answers that are offered.' [306] Methodology is also described as an explanation, argumentation or rationale for adopting a particular way of working, as well as the theoretical basis informing

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[300] M. Schommer-Aikins & M. Easter, 'Ways of Knowing and Epistemological Beliefs: Combined effect on academic Performance', *Educational Psychology*, Vol.26, No.3, 20006, pp.411-423 available from http://www-tandfonline-com.ezproxy.usq.edu.au/doi/pdf/10.1080/01443410500341304 (05/04/2015) p.

[301] B. K. Hofer, 'Personal Epistemology as a Psychological and Educational Construct: An Introduction', in P. R. Pintrich & B. K. Hofer (ed.), *Personal epistemology: The psychology of beliefs about knowledge and knowing*, Lawrence Erlbaum Associates, Mahwah, 2002, pp.34

[302] M. S. Khine (ed.), *Knowing, Knowledge and Beliefs: Epistemological Studies across Diverse Cultures*, Springer, Dordrecht, 2008

[303] M. S. Khine, 'Preface', in M. S. Khine (ed.), *Knowing, Knowledge and Beliefs: Epistemological Studies across Diverse Cultures*, Springer, Dordrecht, 2008, p.v

[304] M. S. Khine, p.v

[305] L. Reynolds, *Alternative Microeconomics,* Boise State University, Boise, 2005, E-book available from http://cobe.boisestate.edu/lreynol/WEB/Micro.htm p.26

[306] L. Reynolds, p.26

choices about ways of working.[307] According to this account methodology might be considered as a discipline's way of knowing.

Disciplines are described by Michael Carter as domains of specialised knowledge characterised by an emphasis on rigorous research, which is typically empirical. [308] Within contemporary academic debate it is presumed that a discipline is determined by specific domains of knowledge and particular ways of knowing. [309] Accordingly, the 'discipline specific ways of reasoning' assume that there are two components of academic learning within a discipline. [310] These are identified as content knowledge or 'a disciplines body of knowledge'; this is the conceptual or declarative knowledge or the 'knowing about', and procedural or process knowledge, which relates to 'ways of knowing and reasoning that are accepted as appropriate and necessary for learning and understanding within the particular field.' [311] Within the concept of specific disciplinary thinking Judith Langer, Carla Confer and Mary Sawyer indicate ways of knowing and reasoning as being appropriate and necessary for learning and understanding within the particular field. This means that reasoned thought involves the ability to understand the ways in which information or a body of facts are presented and arguments are developed. [312] This requires comprehending not just the content of a discipline, but a capacity to interpret critique and present the information in ways appropriate to that specific field of inquiry. [313]

Evolutionary biologist John Moore selected the title of his project, *Science as a Way of Knowing – Evolutionary Biology*, because it reflected the project's philosophy of science. [314] Consistent with the scientific method Moore's three principles: 'making the question or problem explicit, using the hypothetico-deductive mode in teaching,

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[307] M. Wilson, & S. van Ruiten, *Handbook for Artistic Research Education,* The European League of Institutes of the Arts, 2013, e-book available from http://www.elia-artschools.org/images/products/120/share-handbook-for-artistic-research-education-high-definition.pdf p.275

[308] M. Carter, 'Ways of Knowing, Doing, and Writing in the Disciplines', *College Composition and Communication,* Vol.58, No.3, 2007, pp.385–418 available from http://www.stetson.edu/other/writing-program/media/ways%20of%20knowing.pdf (accessed 03/05/2014) p.386

[309] M. Carter, p.404

[310] M. Carter, pp.387-388

[311] M. Carter, pp.387-388

[312] J. A. Langer, C. Confer, & M. Sawyer, 'Teaching Disciplinary Thinking in Academic Coursework', Report, *National Research Centre on Literature Teaching and Learning*, State University of New York, Albany, 1993, pp.1-42, available from http://www.albany.edu/cela/reports/langer/langerteachingdiscipthink.pdf (accessed 07/05/2014) p.1

[313] J. A. Langer et al, p.1

[314] J. A. Moore, 'Science as a Way of Knowing: Evolutionary Biology', *American Zoologist*, Vol.24, 1984, pp.467-534, available from http://www.sicb.org/dl/saawok/467.pdf (accessed 06/04/2015)

and emphasizing that science is a self-correcting enterprise' functioned to provide understanding as well as information. [315] For Kathleen Gordon the modernist scientific way of knowing is characterised by 'Reductionism - seeing things only in terms of their mechanistic parts; Objectivism - claiming science and scientists are objective, neutral and unbiased; Determinism - asserting that time is reversible and thus all future events can be accurately predicted; and dualism's of mind/body, subject/object, humans/nature'. [316] However, the criteria for establishing the objectivity and rationality of science are being challenged. Gordon suggests that 'beliefs emerging from post-modern science advocate making fundamental changes in the modern value base' this includes transforming prevailing concepts and replacing inappropriate processes. [317] For Xenia Meyer and Barbara Crawford the 'scientific' way of knowing is not only one way of knowing science, but science itself is a cultural way of knowing. [318] The view of science as a cultural way of knowing functions to acknowledge that science is laden with cultural underpinnings, interpretations, and a language of its own. [319]

Research involves many ways of knowing. And for Elizabeth Grierson and Laura Brearley 'there is a growing need for the articulation of research methodologies appropriate to creative arts practice and diverse cultural knowledge systems' because, 'traditional methodologies of research, such as those in the social sciences and scientific disciplines are unsuitable for those in the creative fields of making, performing, inventing'. [320] Grierson claims 'there is a particular kind of making and doing that is at stake in the realm of creative arts as a formalised research practice in the academic setting' meaning 'it has the components of aesthetics and the potential always of making-new as a defining characteristic; taking intuitive leaps as it

[315] J. A. Moore, p.471

[316] K. Gordon, 'Challenging and Changing Ways of Knowing in Science and Science Education', *Botanic Gardens Conservation International*, Public Engagement available from *https://www.bgci.org/education/1688/* (accessed 06/08/2015) web page

[317] K. Gordon, web page

[318] X. Meyer & B. A. Crawford, 'Teaching science as a cultural way of knowing: merging authentic inquiry, nature of science, and multicultural strategies', *Cultural Studies of Science Education*, Vol.6, No.3, 2011, pp.525-547, available from http://www.bu.edu/hps-scied/files/2012/12/Crawford-HPS-Teaching-science-as-a-cultural-way-of-knowing.pdf (accessed 04/02/2015) p.531

[319] X. Meyer & B. A. Crawford,.531

[320] E. Grierson & L. Brearley, 'Ways of Framing: Introducing Creative Arts Research', in E. Grierson & L. Brearley (eds.), *Creative Arts Research: Narratives of Methodologies and Practices*, Sense Publishers, Rotterdam, 2009, p.4

engages with its lineages of practice'.[321] Thus, discourses of creativity are by implication generative. Whereas Simon Penny suggests the 'new paradigms of cognition offer us a new way to pursue an understanding of cultural practices that involve the construction of artefacts, organized spaces, and systems of gestures and movements among people as cognitional in a rich and sophisticated way.' [322] Speaking at the 2011 conference *Art as a Way of Knowing*, Penny argues 'the kinds of intelligences deployed in the arts have been relegated to the *merely artisanal* simply because they engage materiality directly and do not traffic primarily in the symbolic notations that have become the lingua franca of our age.' [323]

American philosopher John Dewey proposes that knowledge of facts is but one mode of knowing because knowledge is also produced or gained through the 'experimental action' of experience. [324] In Greek thought experience meant art, which according to Dewey 'reflected the contingencies and partialities of nature, while science – theory – exhibited its necessities and universals'. [325] Furthermore, experience or art, which includes 'fine arts as well as industrial technologies,' continue to be 'affairs of practice'. For Dewey, art as a mode of inquiry and knowledge production is significant because 'art is the most direct and complete manifestation there is of experience as experience'. [326]

The terms 'objectivity' and 'subjectivity' are each described in relation to their opposite term and as concepts they are associated with philosophical scholarship. The terms also feature prominently within discourses that concern both art and science. Stephen Wilson argues that this is due in part to long held assumptions of science's claim to an objective truth and art's cultivation of an idiosyncratic subjectivity. [327] Computer scientist Richard Sutton reveals the problems involved in challenging these assumptions, that is, 'as scientists and observers we are

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[321] E. Grierson, 'Ways of Knowing and Being: Navigating the Conditions of Knowledge and Becoming a Creative Subject', in E. Grierson & L. Brearley (eds.), *Creative Arts Research: Narratives of Methodologies and Practices*, Sense Publishers, Rotterdam, 2009, p.18

[322] S. Penny, 'What Is artful cognition?', Conference Paper, *Art as a Way of Knowing,* Exploratorium 3-4 March, 2011, San Francisco, available from https://www.exploratorium.edu/knowing/pdfs/Penny.pdf (accessed 08/04/2015) p.8

[323] S. Penny, p.8

[324] J. Dewey, *Experience and Nature,* George Allen & Unwin, London 1929, p.149

[325] J. Dewey, 1929, p.355

[326] J. Dewey, *Art as Experience,* Perigee Books, New York, 1934, p.309

[327] S. Wilson, 2002, p.49

accustomed to praising the objective and denigrating the subjective, so reversing this customary assessment requires some defence'. [328] Sutton argues that both assumptions have a place in scholarly inquiry. For example, 'subjective experience can be viewed as data in need of explanation, when there is a sense that only the subjective is clear and unambiguous.' [329] Whereas 'the objective view is one that is common across people, that is, something is objectively true if it predicts the outcome of experiments that you and I both can do and get the same answer.' [330] The issues of ontology and epistemology further complicate the theoretical discourse concerning objectivity and subjectivity. Social theorist Christopher Powell argues that problems arise because the meanings change in context. [331] Ontology on one hand is about things, thus ontological statements 'are statements about what we think is real', and epistemology on the other hand 'is about knowledge. Epistemological statements are statements about what we think is true.' [332]

American philosopher Thomas Nagel explored the distinction between the subjective standpoint and the objective standpoint in *The View from Nowhere* published in 1986. [333] This exploration revealed that the subjective standpoint is the personal individual perspective, which is the view from internal world, whereas the objective standpoint is the impersonal perspective adopted when the world is conceived externally. [334] Nagel concedes that these are two opposing views but the distinction between more subjective and more objective views is really a matter of degree, and covers a wide spectrum. [335] The relationship between the image and the objectivity/subjectivity dichotomy was central to the work of Lorraine Daston and Peter Galison in their seminal text *Objectivity* where the historically and culturally complex development of objectivity can be traced through the images drawn from the long tradition of scientific atlases. [336] The difficulty in describing subjectivity

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[328] R. Sutton, 'Subjective Knowledge', University of Alberta: Incomplete Ideas, [web blog], 6 April 2001, available from http://webdocs.cs.ualberta.ca/~sutton/IncIdeas/SubjectiveKnowledge.html (accessed 05/05/2015) web page

[329] R. Sutton, web page

[330] R. Sutton, web page

[331] C. Powell, 'Objectivity and Subjectivity in Classical Sociology', *The Practical Theorist,* [web blog] 10 March 2014, available from http://practicaltheorist.wordpress.com/2014/03/10/objectivity-and-subjectivity-in-classical-sociology / (accessed 22/07/2014) web page

[332] C. Powell, web page

[333] T. Nagel, *The View from Nowhere*, Oxford University Press, New York, 1986

[334] T. Nagel, *The View from Nowhere*, Oxford University Press, New York, 1986, p.5

[335] T. Nagel, p.5

[336] L. Daston & P. Galison, *Objectivity*, Zone Books, New York, 2010

without referring to objectivity is acknowledged by Daston and Galison who note that subjectivity and objectivity emerged as mutually defining complements. The scholars claim that the history of objectivity is part of the history of the 'self', that is, if 'objectivity came into existence to negate subjectivity, then the emergence of objectivity must tally with the emergence of a certain kind of wilful self, one perceived as endangering scientific knowledge.' [337]

Objectivity has long been constitutive of the modern scientific model. According to Janet Stemwedel objectivity is 'perhaps one of the values that scientists and non-scientists associate with science'. [338] Historian of science Lorraine Daston proposes that it was Kant who appropriated the old scholastic derivative *objektiv* into philosophy, and that the thinker's 'objective validity' pertains 'not to external objects *in se*, but rather to the relational categories [such as time, space and causality] which are the preconditions of experience.'[339] Moreover, the terms 'objective' and 'subjective' were native to scholastic philosophy and their meanings have changed over time. [340] Thus, objectivity is a multi-layered concept with a confused history, and during the nineteenth century objectivity had become the creed of scientists, 'the ideal that corresponded to the practice of wellnigh constant, impersonal communication.' [341]

Subjectivity has been described by Kim Atkins as the essence of philosophy because it is grounded in the human capacity to reflect upon and evaluate their thoughts, feelings and actions. [342] In the 2005 publication *Self and Subjectivity* Atkins tells us that the French thinker René Descartes is credited with the inception of the philosophy of the subject, although mention of the 'inner man' is to be found in the work of Augustine of Hippo who is also referred to as Saint Augustine. [343] The relationship between subjectivity and knowledge is clarified by Ikujiro Nonaka and Ryoko Toyama who discount the notion that knowledge is objective, absolute and

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[337] L. Daston & P. Galison, p.37
[338] J. D. Stemwedel, 'The ideal of objectivity', *Scientific American*, [web blog] 26 February, 2013, available from http://blogs.scientificamerican.com/doing-good-science/the-ideal-of-objectivity/ (accessed 06/04/2015) web page
[339] L. Daston, 'Objectivity and the Escape from Perspective', *Social Studies of Science,* Vol.22, No.4, 1992, pp.597-618, available from http://andler.dec.ens.fr/wp-content/uploads/2012/02/Daston1.pdf (accessed 19/03/2013 p.600
[340] L. Daston, 1992, p.602
[341] L. Daston, 1992, p.602
[342] K. Atkins , 'Introduction', in K. Atkins, (ed.) *Self and Subjectivity*, Blackwell Publishing, Malden, 2005, p.7
[343] K. Atkins , p.7

context-free. According to Nonaka and Toyama 'knowledge cannot exist without human subjectivities and the contexts that surround humans. 'Truth' differs according to who we are (values) and from where we look at it (context)'. [344] From such accounts, an interpretation of knowledge, which is consistent with various interpretivist traditions of philosophy that emphasises subjectivity, contrasts with the objective view of reality maintained by positivist tradition. For scholars of knowledge such as Ikujiro Nonaka and Vesa Peltokorpi, the interpretivist tradition 'in its various forms, relates to the humanistic and historistic tradition that first developed in Germany in the 19th century'. [345] Consequently, current interpretative philosophies identify with hermeneutic, phenomenological and pragmatic philosophies.'

In addition to the oral transmission of ideas, information and concepts are customarily communicated through visual images and words. The notion that the visual is a form of legitimate knowledge remains a contentious concept. However, Elliot Eisner states that 'it has become increasingly clear since the latter half of the 20th century that knowledge or understanding is not always reducible to language. . . . Thus not only does knowledge come in different forms, the forms of its creation differ. The idea of ineffable knowledge is not an oxymoron' [346] Scholars of communication, particularly scholars of graphic design, argue that the visual encompasses all graphic forms of representation including word and image. [347] Johanna Drucker, for example, claims that in contrast to the verbal, the visual is traditionally perceived as an unreliable form of representation; but in contemporary

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[344] I. Nonaka & R. Toyama, 'The theory of the knowledge-creating firm: subjectivity, objectivity and synthesis', *Industrial and Corporate Change*, Vol.14, No.3, 2005, pp.419-436, available from http://icc.oxfordjournals.org/content/14/3/419.full.pdf (accessed 07/07/2014) p.421

[345] I. Nonaka & V. Peltokorpi, Objectivity and Subjectivity in Knowledge Management: A Review of 20 Top Articles', *Knowledge and Process Management*, Vol.13, No.2, 2006, pp.73–82, available from https://ai.wu.ac.at/~kaiser/birgit/Nonaka-Papers/Objectivity-and-Subjectivity-in-Knowledge-Management-2006.pdf (accessed 17/07/2014) p.75

According to the Encyclopedia Britannica, Humanism, term freely applied to a variety of beliefs, methods, and philosophies that place central emphasis on the human realm. Most frequently, however, the term is used with reference to a system of education and mode of inquiry that developed in northern Italy during the 13th and 14th centuries and later spread through continental Europe and England. http://www.britannica.com/topic/humanism

Writing in the 2012 publication *Philosophy and Grammar: Papers on the Occasion of the Quincentennial of Uppsala University* Georg Henrik von Wright notes that the term 'humanism' appears to have originated in Germany to refer to the Renaissance notions on scholarship and the second return to the ancient classics which occurred in late 18the and early 19th century, p.1

[346] E. Eisner, 'Art and Knowledge', in J. G. Knowles, & A. L. Cole, *Handbook of the Arts in Qualitative Research: Perspectives, Methodologies, Examples, and Issues*, Sage Publications, Thousand Oaks, 2008, p.5

[347] W. Ryan & T. Conover, T., *Graphic Communication Today* (4th edn.), Thompson Delmar Learning, New York, 2004, p.6-8: P. B. Meggs & A. W. Purvis, Meggs' *History of Graphic Design* (4th edn.), John Wiley & Sons, Inc, Hoboken, 2006

debate the image is being reconsidered by some scholars as a credible method of presenting knowledge. [348] Visual approaches to research concern many fields of inquiry. For Lynn Butler-Kisber and Tiiu Poldma 'the burgeoning interest in arts-informed research and the increasing variety of visual possibilities as a result of new technologies have paved the way for researchers to explore and use visual forms of inquiry.' [349] Collage making and concept-mapping for instance are widely regarded as useful approaches to visual research. This approach provides 'a place for the researcher to document and record ideas, concepts, and meanings gleaned during the making process itself'. [350]

3.2.6 The Art of Rhetoric

Rhetoric is generally understood to mean the art of persuasive discourse. The Oxford English Dictionary describes 'rhetoric' as both 'the art of using language effectively so as to persuade or influence others', and as a 'treatise on the theory and practice of rhetoric'. [351] A concise description of rhetoric provided by Oxford Reference notes that:

> *In Greek, the art of speaking so as to persuade, was from the first tied up with ethics (persuasion of what is true) and literature (use of language in order to please). It was a branch of the medieval Trivium and therefore an important part of the school syllabus up to the 17th cent. Literary rhetoric is concerned with the organization (inventio and dispositio) and embellishment (elocutio) of works. The first of these is prominent in many 18th- century works (Tristram Shandy and A Tale of a Tub, for instance), and the second is important in its provision of poetic 'devices' (figures and tropes) in poets from Chaucer to the present day.* [352]

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[348] J. Drucker, 2010, pp.1-3

[349] L. Butler-Kisber & T. Poldma, 'The Power of Visual Approaches in Qualitative Inquiry: The Use of Collage Making and Concept Mapping in Experiential Research', *Journal of Research Practice*, Vol.6, No.2, 2010, pp.1-16, available from http://web.a.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=6954bc52-f5f0-42ed-8801-8fb85e763a87%40sessionmgr4003&vid=0&hid=4114 (accessed 10/05/2013)p.1

[350] L. Butler-Kisber & T. Poldma, p.1

[351] Oxford English dictionary, 'Rhetoric', OED [web page] available from http://www.oed.com.ezproxy.usq.edu.au/view/Entry/165178?rskey=sp35Hu&result=1#eid (accessed 20/09/2015) web page

[352] Oxford Reference, 'Rhetoric', *Oxford University Press*, [web page] available from http://www.oxfordreference.com.ezproxy.usq.edu.au/view/10.1093/oi/authority.20110803100418535?rskey=MlpNgJ&result=2 (accessed 20/09/2015) web page

According to James Jasinski 'rhetoric' is a term with multiple meanings which frequently 'reflect different attitudes toward language and linguistic representation and, even more particularly, the use of language for persuasive purposes'. [353] Jasinski's 2001 *Sourcebook on Rhetoric: Key Concepts in Contemporary Rhetorical Studies* provides alphabetized glossary of key terms and concepts in contemporary rhetorical studies. [354] The aim of the publication is to provide an account of the perspectives that constitute contemporary rhetorical studies by illustrating the major issues, themes and arguments that have engaged the attention of contemporary rhetorical scholars. [355]

In the 1985 publication *Rhetoric: Concepts, Definitions, Boundaries,* William Covino and David Jolliffe observe that even though any conception of rhetoric entails ambiguities and limitations, rhetoric is a 'primarily verbal, situationally contingent, epistemic art that is both philosophical and practical and gives rise to potentially active texts'. [356] Drawing on Cicero, Covino and Jolliffe also suggest that through its strategies of influence, which acts to change manners, minds and lives, rhetoric constructs knowledge of the world. [357] Thereby emphasising rhetoric's association with knowledge.

According to John Lyne and Carolyn Miller, the idea of rhetoric as a way of knowing challenges the Platonic distinction between knowledge and opinion and thus the general classical distinction between rhetoric and dialect. [358] As a consequence, the notion of rhetoric as knowledge has been the subject of much debate. However rhetoricians, including Richard Cherwitz, support claims that rhetoric is epistemic in arguing that to 'advance the contention that rhetoric is epistemic is to explore the very avenues by which man comes to know'. [359] Two recent, but differently focused,

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[353] J. Jasinski, *Sourcebook on Rhetoric: Key Concepts in Contemporary Rhetorical Studies*, SAGE, Thousand Oaks, 2001, p.xiii
[354] J. Jasinski, p.xiii
[355] J. Jasinski, p.xiii
[356] W. A. Covino & D. A. Jolliffe, 'An Introduction to Rhetoric', in W. A. Covino & D. A. Jolliffe (eds.), *Rhetoric: Concepts, Definitions, Boundaries*, Allyn & Bacon, Boston, 1985, p.5
[357] W. A. Covino & D. A. Jolliffe, p.5
[358] J. Lyne & C. R. Miller 'Introduction: Rhetoric, Disciplinarity, and Fields of Knowledge ',in A. A. Lunsford, K H. Wilson & R. A. Eberly (eds.), *The SAGE Handbook of Rhetorical Studies,* SAGE Publications, Thousand Oaks, 2009, p.168
[359] R. Cherwitz, Rhetoric as '"A Way of Knowing": An Attenuation of the Epistemological Claims of the "New Rhetoric', *The Southern Speech Communication Journal*, Vol.42, No.3, 1977, pp.207-219, available from https://docex.usq.edu.au/zportal/zengine?VDXaction=GetAttachment&illno=462137&objectno=42719&objectseq=1&is_popup_window=true (accessed 04/06/2015) p.213

developments have re-established the notion of rhetoric as epistemic. The 'rhetoric of inquiry' enabled a variety of disciplines to discuss modes of argument and persuasion as well as explore various rhetorical strategies, whereas the 'rhetoric of science' focused on the internal practices of the sciences and its public manifestations. [360] Drawing on the work of Aristotle, philosopher of science Alan Gross suggests that rhetoric has two distinct roles in the public understanding of science. [361] In the 'deficit' model rhetoric acts in the minor role of creating public understanding by accommodating the facts and methods of science to public needs and limitations, whereas in the 'contextual model' rhetoric and rhetorical analysis play major roles. [362] According to Gross the deficit model implies the status of public understanding is epistemologically diminished, resulting in the marginalisation of the public. [363] In contrast the contextual model recognises that 'public understanding has genuine, not diminished epistemological status, different in kind, but not in significance from the epistemological status conferred by the methods of science', in this way, the public's cognitive conclusions need not defer to those of science; in the case of its ethical, social, and political conclusions, it is science that must defer'. [364]

Visual rhetoric is a recent development in the field of rhetoric and, in contrast to a verbal mode of communication, refers to the way in which we communicate visually. Noting a shift in the field of rhetoric to include the visual rhetorical scholars Charles Hill and Marguerite Helmer include a range of positions concerning 'visual rhetoric' in the 2004 edited collection of essays *Defining Visual Rhetorics*. [365] These positions range from the 'possibility of a visual argument' to an examination of existing methodologies such as a Roland Barthes' semiotic approach and W. J. T. Mitchell's 'pictorial turn'. Hill and Helmers write about the impracticability of seeking a single definition or methodology for exploring a cross-disciplinary study of the visual, suggesting that 'it may be too soon to settle on accepted practices, disciplinary

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[360] J. Lyne & C. R. Miller, p.168
[361] A. G. Gross, 'The roles of rhetoric in the public understanding of science', *Public Understanding of Science*, Vol.3, No.1, 1994, pp.3-23, available from http://www.tc.umn.edu/~agross/AlanGross/pdffiles/publicun.pdf (accessed 28/08/2014) p.5
[362] A. G. Gross, 1994, p.5
[363] A. G. Gross, 1994, p.19
[364] A. G. Gross, 1994, p.19
[365] C. A. Hill, C & M. Helmers (eds.), *Defining Visual Rhetorics*, Lawrence Erlbaum Associates, London, 2004, Taylor & Francis e-Library, 2008

conventions, and perhaps even on terminological definition'. [366] Additionally, Sharon Crowley and Debra Hawhee describe visual rhetoric as 'a branch of rhetorical studies that considers all aspects of the visual—from the persuasive force of images to words and how they function as images'. [367] This account includes not only the visual aspect of words on a background but how they interact with non-discursive images such as drawings, paintings, photographs, or moving pictures. [368]

3.3: Summary

The preceding literature review serves to provide the context and background to this study by critically examining the existing publications in areas that are relevant to this study. Art and science, for example, are separate and diverse fields of inquiry and practice, and although the terms originated in antiquity and concern different modes of knowing, there continues to be competing claims of what comprises 'art' or 'science'. The image as a topic of research had until recently attracted scant attention from scholars. However, a plethora of academic literature and multidisciplinary conferences indicates an increase in interest in the image as a complex area of inquiry across several disciplines. The image-maker is not only traditionally associated with art, but also has well established links with science, in that image-makers have long functioned to make 'science' accessible to other artists and scientists as well as to a wider audience. The ways of knowing are widely described as the various methods by which we acquire knowledge as this review has established; several different ways of knowing have been identified including knowing through both art and science. Rhetoric is traditionally described as the study of the means and ends of persuasion, however, the recent emergence of visual rhetoric as a field of study that is concerned with how images communicate transmit meaning.

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[366] M. Helmers & C. A. Hill, 2008, p.19
[367] S. Crowley & D. Hawhee, *Ancient Rhetorics for Contemporary Students* (3rd edn.), Pearson Longman, New York, 2004, p.343
[368] S. Crowley & D. Hawhee, p.346

Chapter 4:

Beyond Two Structures: Framework for Inquiry

4.1: Determining the Conceptual Framework

4.1.1 Understanding the Conceptual Framework

This chapter seeks to construct a framework of interlinking concepts from relevant fields of inquiry which will function to support and inform the questions that guide the study. Although various descriptions exist, a conceptual framework is described by Robyn Smyth as a scaffold for research that enables the researcher to make meaning of the research findings. [369] Furthermore, a conceptual framework is intended as a starting point for reflection about the research and its context. [370] Consequently, a conceptual framework is significant to this study because it offers a critical lens through which to consider the study. This means that this chapter is the site where reasoned, defensible choices are made about how to explore the research topics or themes hereto underexplored. [371] It is also the site in which to explore existing research questions in new contexts or re-examine established topics or questions using different theoretical or epistemological frames. [372] The aim of this chapter is to therefore provide the parameters by which to explore the complex issues involved in understanding the significance of the image to art's claim as a knowledge discipline. This will be achieved by explaining 'either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them'. [373] Thus, as an organisational tool this

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[369] R. Smyth, 'Exploring the usefulness of a conceptual framework as a research tool: A researcher's reflections', *Issues in Educational Research*, Vol.14, No.2, 2004, 167-180, available from
http://search.informit.com.au.ezproxy.usq.edu.au/fullText;dn=200412121;res=IELAPA (accessed 11/07/2015) p.168

[370] R. Smyth, 'Exploring the usefulness of a conceptual framework as a research tool: A researcher's reflections', *Issues in Educational Research*, Vol.14, No.2, 2004, 167-180, available from
http://search.informit.com.au.ezproxy.usq.edu.au/fullText;dn=200412121;res=IELAPA (accessed 11/07/2015) p.168

[371] S. M. Ravitch & M. Riggan, *Rigor & Reason: How Conceptual Frameworks Guide Research*, SAGE Publications, Thousand Oaks, 2012, p.14

[372] S. M. Ravitch & M. Riggan, p.14

[373] M. B. Miles & M. Huberman, *Qualitative Data analysis* (2nd edn), SAGE Publications, Thousand Oaks, 1994, p.18

conceptual framework provides the platform for the consideration of the image as a site of intellectual inquiry and as a communicative device for art and for science.

A significant feature of a conceptual framework is that unlike a theoretical framework, which is derived from existing theory in the literature, a conceptual framework is constructed rather than found. Joseph Maxwell makes this point in explaining that although the conceptual framework incorporates borrowed work, the overall coherence of the structure is something that the researcher builds not something that exists ready-made. [374] In keeping with Smyth this conceptual framework functions in three ways. First this chapter will provide links from the literature; second, this chapter will function as a reference point from which to locate the research questions, and finally this chapter serves to implement a guiding set of principles against which judgements could be made. [375] This last criterion also aides in ensuring the validity of the study. Additionally, the utilisation of existing theory and research as a resource for developing a conceptual framework is consistent with a literature-based thesis which allows previously explored issues to be approached from a new perspective.

4.1.2 Focusing the Conceptual Framework

Rather than provide a detailed account of the phenomena being studied, the purpose of this conceptual framework is to determine what concepts will inform this study and identify the relationships among them. For this study the concepts and the links between them are inherently complex. This is because images are not just concerned with art and science but are associated with multiple bodies of knowledge. Consequently, the conceptual framework for this study is constructed from a multidisciplinary network of concepts in order to ensure a comprehensive understanding about the subject being investigated. In keeping with the work of Yosef Jabareen, this chapter concerns understanding and interpretation rather than

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[374] J. A. Maxwell, *Qualitative Research Design: An Interactive Approach* (2nd edn), Sage Publications, Thousand Oaks, 2005, p.35

[375] R. Smyth, 'Exploring the usefulness of a conceptual framework as a research tool: A researcher's reflections', *Issues in Educational Research*, Vol.14, No.2, 2004, 167-180, available from http://search.informit.com.au.ezproxy.usq.edu.au/fullText;dn=200412121;res=IELAPA (accessed 11/07/2015) p.168

explanations and measured outcomes. [376] Considering the diverse nature of images and the multi-disciplinary character of the inquiry this position is important, primarily because there are different interpretations concerning the images as well as different ways to describe artistic and scientific modes of inquiry. Therefore this framework has identified three broadly described areas that incorporate knowledge from several disciplines.

The three specific concepts that constitute this conceptual framework were constructed following a critical review of the literature that focused on the role of the image in the knowledge debate. As markers with distinctive features these concepts are referred to as 'art and science', 'the image' and, 'visual rhetoric'. However, because these concepts will be constructed through an engagement with multiple knowledges rather than a single area of inquiry, as frequently is the case, a particular way of considering these concepts was sought. In order to describe a complicated notion such as a single concept this study adopts the approach of Gilles Deleuze and Félix Guattari whereby there is no concept with only one component, inasmuch as 'every concept has components and is defined by them'. [377] Furthermore, 'components, or what defines the consistency of the concept, its endoconsistency, are distinct, heterogeneous, and yet not separable', that is, 'each partially overlaps, has a zone of neighbourhood [ ] or a threshold of indiscernibility, with another one'. [378] Thus the aforementioned concepts are described by the sum of their components and are discussed in the following sections of this chapter as follows. Concept one concerns the broad area of 'art and science' through both definitional and historical perspectives as well as the position of each discipline within the knowledge debate. Concept two considers the image through an engagement with past meanings as well as through current interpretations. Concept three involves the notion of visual rhetoric and is therefore concerned with the means by which images construct and

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[376] Y. Jabareen, 'Building a Conceptual Framework: Philosophy, Definitions, and Procedure', *International Journal of Qualitative Methods,* Vol.8, No.4, 2009, pp.49-62, available from http://www.researchgate.net/publication/265991064_Building_a_Conceptual_Framework_Philosophy_Definitions_and_Proced ure (accessed 09/07/2015) p.57

[377] G. Deleuze & F. Guattari, *What is philosophy?,* trans. T. Tomlinson & G. Burchell, Columbia University Press, New York, 1991, p.15

[378] G. Deleuze & F. Guattari, p.19

transmit meaning. This chapter concludes by discussing how these frameworks support and inform this study.

4.2: Concept 1: Art and Science

4.2.1 Art and Science: A Broad Concept

4.2.1 [i] Contemporary linkages

For the purposes of this study, 'art and science' is broadly understood as not only constituting the ideas and principles that involve the separate disciplines of 'art' and 'science' and those areas of 'indiscernibility', but this concept also concerns the links between these disciplines. Such linkages range from shared philosophical groundings to beneficial alliances, whereby art and science have both learned from and informed the other. Scholars make the point that these are well established pathways even though these disciplines are separate areas of inquiry with different approaches to and ideas about knowledge. And, despite the so-called tension between art and science that has dominated Western thought since Greek antiquity, ideas concerning associations between art and science are central to the work of contemporary theorists, including among others, Martin Kemp, James Elkins, Stephen Wilson and Siân Ede, as well Michael Lynch and Bruno Latour. The art-science dialogue is also maintained through institutions such as the *Gulbenkian Foundation* and the *Wellcome Trust*, which foster programmes that promote art-science collaboration and research. Such ventures also feature at the Leiden University where the Arts and Genomics Centre's *New Representational Spaces Programme* is described as a project 'which investigates the interactions of arts and genomics and aims to describe and analyse the unique role that the visual arts can have in the critical evaluation and dissemination of the results of genomics research.' [379] According to the *Centre*, the visual arts have the potential to contribute to scientific debate and to disseminate scientific knowledge. [380] From this view art is deemed to be in the service of science.

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[379] The Arts & Genomics Centre, 'About the Arts & Genomics Centre ', *The Arts & Genomics Centre*, Leiden, The Netherlands, [web page] available from http://www.artsgenomics.org/organisation web page
[380] The Arts & Genomics Centre, web page

In contrast to the previously mentioned art-science initiatives, artist-in-residence programmes are increasingly viewed as the vehicle for collaboration between art and science as these approaches are premised on the notion of a mutual transfer of knowledge between both disciplines. For Jill Scott, concerns about knowledge transfer and issues relating to knowledge in general are problematic primarily because art and science are very different ways of knowing. [381] However, Scott suggests that 'some sharing of ideologies could become a solid base for valuable innovation, production, distribution and socio-cultural consumption potentials' because artists 'are beginning to understand scientific methodologies and scientists are beginning to see the value of aesthetics and communication skills by artists'. [382] This is not a new concept, because across changing epistemic periods these two forms of inquiry have both claimed to be sites of creativity, argumentation, rhetoric, emotion, and beauty. Art and science have at times also made claims to prescribed forms of rigour and objectivity as well as specific forms of rationality and empiricism.

4.2.1 [ii] *Before* 'art' and 'science'

The conventions by which 'art' and 'science' are distinguished are based in the ancient differentiation between making and thinking. These conventions provide the avenue to understand both the evolving concept of knowledge and why the notion of art as a credible form of inquiry has at various times been opposed in some areas of academic discourse. Even though the terms 'art' and 'science' originated in antiquity these practices have changed over time and in context. For this reason scholars such as Pamela Smith argue that any 'consideration of 'art' and 'science' must engage with the terms themselves, both in their present meanings . . . and with regard to their early modern definitions'. [383] Therefore, in order to understand the contemporary ideas of art and of science and so as to avoid terminological confusion and ambiguity, it is necessary to provide some understanding of the process by which 'art' and 'science' have developed through time.

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[381] J. Scott, 'Suggested Transdisciplinary Discourses for More Art-Sci Collaborations', in J. Scott (ed.), *Artists in Labs: Processes of Inquiry,* Springer Wien, New York, 2006, p.24
[382] J. Scott, 2006, p.24
[383] P. H. Smith, 2006, p.85

According to conventional thought, the current disciplines of art and science originated from ancient forms of knowledge that were associated with either practical or theoretical ways of knowing. Philosophers such as Plato considered theory and practice as complex and sometimes overlapping methods of inquiry, whereas Aristotle clearly distinguished between these two intellectual virtues. This, according to Richard Parry, is the case even though the philosopher himself 'refers to techne or craft as itself also episteme or knowledge because it is a practice grounded in an 'account' - something involving theoretical understanding'. [384] Although there are differing views concerning the precise interpretation of the terms, current accounts concur that the contemporary word 'art' is derived from the Latin ars, which is translated from the Greek term techne. Bernard Frischer notes that *techne* also forms the root of the word technology, while science is derived from the Latin *scientia*, a translation of the Greek term *episteme* which is interpreted as knowledge. [385] In keeping with Aristotle's scheme of knowledge, the concept of *techne* is associated with productive knowledge, in contrast *episteme* is concerned with theoretical knowledge. Frischer proposes that in this scheme of knowledge:

> *Aristotle understood episteme to mean a body of knowledge about existing things that are unchanging and eternal. Knowledge of such things can be codified, taught, and learned. . . Complementary to, but less precise than episteme is techne. Techne is the knowledge of things that might exist (but do not necessarily exist) and that are brought into existence not by themselves but by an efficient cause that is their maker. Such things might be actions or objects. Thus, Aristotle divides techne into two branches, the practical, concerned with actions, and the "poetic," concerned with objects. A techne involves logos, or a "rational quality" (. . .) which must be applied in accordance with the truth. So a techne has a necessary relationship to episteme, the study of the truth about unchanging*

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[384] R. Parry, 'Episteme and Techne', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*, Fall edition, 2008, [web page] available from http://plato.stanford.edu/entries/episteme-techne/ (accessed 10/06/2014)web page
[385] B. Frischer, 'Art and Science in the Age of Digital Reproduction: From Mimetic Representation to Interactive Virtual Reality', *Virtual Archaeology Review*, Vol.2, No.4, 2011, pp.19-32, available from http://varjournal.es/doc/varj02_004_06.pdf (accessed 27/11/2013) p.20

and eternal things. [386]

However, the translation of *episteme* to mean knowledge and *techne* to mean either craft or art 'may inappropriately harbour some of our contemporary assumptions about the relation between theory (the domain of 'knowledge') and practice (the concern of 'craft' or 'art')'. [387] These concerns pertain to issues such as the long held tension between theory and practice. They also concern the assumption that 'theory' is detached from reality, whereby reality is the world of the practical; as well as the supposition that 'practice', which has little understanding of what practice actually does, in turn results in irregular practices.

The aforesaid interpretations have attracted the notice of scholars, including Lars-Olof Åhlberg, who has described the idea that *techne* and *ars* translate as 'art' as both inaccurate and anachronistic.[388] Åhlberg's concerns focus on what he sees as significant differences between the modern concept of art and the *techne* of antiquity. However in keeping with the rationale of reconciling the image as a valid area of inquiry and art as a way of knowing, this study adopts the previously noted positions advanced by Martin Kemp and Pamela Smith. This means that any identification of the present practices of art and science is based on some resemblance of past practices whereby an understanding of the different terms of 'art' and 'science' must occur within a wide scope of past and present meanings. This position provides the frame in which to explore both the evolving concept of knowledge with regard to making and thinking, as well as art's position within the current knowledge debate.

It is generally accepted that 'art' in previous times had a different meaning than the current concept of art. Lars-Olof Åhlberg informs us that what we now consider to be art was unknown in antiquity. [389] During these times activities such as painting and sculpture were regarded as crafts rather than art forms. And, during the early modern times 'art' was more broadly defined than it is today. For instance, Smith wrote that during this period, 'art' or '*ars'* possessed a much broader connotation of practice and experience, and was used in the case of the mechanical arts to refer to the work

[386] B. Frischer, p.20
[387] R. Parry, web page
[388] L- O. Åhlberg, p.134
[389] L- O. Åhlberg, p.134

of the human hand.[390] Scholars widely acknowledge that the eighteenth century marked a change in the concept of art when the category of 'fine art' came to replace a craft-based idea of art. For instance, Larry has noted that 'after over two thousand years of signifying any human activity performed with skill and grace, the concept of art was split apart', creating a new category of the fine arts which 'are a matter of inspiration and genius, meant to be enjoyed for themselves in moments of refined pleasure, whereas the crafts and popular arts require only skill and rules that are meant for mere use of entertainment'.[391] The ensuring craft versus art debate not only separated ordinary pleasures from aesthetic concerns but has also served to separate the artist from the craftsperson.

Research shows that prior to the eighteenth century the terms 'artist' and 'artisan' were used interchangeably to apply to any sort of craftsperson. In this system the phrase 'work of art' primarily referred to a 'work of human production' or by 'ingenious craft', in contrast to the works of the nature of God.[392] This was taken to mean that, in contrast to the Creator, the artisan as maker modifies what already exists in nature. This notion is consistent with Aristotle's concept of *techne* whereby knowledge is brought into existence by the action of a maker. The distinction between 'artist' and 'artisan' is significant to this thesis because the scope of this study extends beyond the modern concept of 'art' to include works produced by those image-makers who identified as either artisan or artist or, in some instances, as both. Throughout this study image-makers have been variously referred to as artists, artisans, or artist/artisan, and the choice of term is dependent on the terms and descriptions utilised by the various authors when referring to specific image-makers.

Prior to the emergence of science as a recognised discipline, knowledge about the natural world was grounded in a broad field of study referred to as natural philosophy. Ann Blair describes natural philosophy as the central discipline dedicated to laying out the principles and causes of natural phenomena.[393] Contrary

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[390] P. H. Smith, 2006, p.85
[391] L. Shiner, *The Invention of Art: A Cultural History,* The University of Chicago Press, Chicago, 2001, p.5
[392] L. Shiner, 'Western and non-Western Concepts of Art', in A. Neill & A. Ridley (eds.), *Arguing about Art: Contemporary Philosophical Debates* (3rd edn.), Routledge, New York, 2008, p.466
[393] A. Blair, 'Natural Philosophy', *The Cambridge History of Science Volume 3: Early Modern Science*, Cambridge Histories Online, 2008, pp.363-406, available from

to some reports natural philosophy was not a static discipline, but was a way of knowing that adapted to changing intellectual environments to eventually develop into the modern concept of science. According to Blair natural philosophy progressed from a bookish Aristotelian discipline, that was institutionalized in medieval universities, to become associated with 'new authorities, new practices, and new institutions. [394] This progression led to a decline in the authority of Aristotelian philosophy and the realisation that knowledge could be influenced by a variety of philosophies. Scholars such as Smith argue that the Aristotelian scheme of knowledge, which held until the seventeenth century, proposed that theory (*episteme* or *scientia*) was certain knowledge, whereas practice (*praxis* or *experientia*) which involved both *praxis* and *techne* was concerned with production through human activity. [395] This scheme of knowledge was significant because it differentiated between the philosopher, who was concerned with certain and therefore true (or theoretical) knowledge and the crafts-person, who was concerned with productive knowledge which was not as certain as theory. The Aristotelian concept held that practice is imperfect knowledge about nature because it concerns making rather than 'disinterested' knowing. However, due to new beliefs and practices about nature, the three areas of knowledge, *episteme, praxis,* and *techne*, became linked to form a new philosophy which became the precursor to what is now referred to as 'science'. [396] In this way the new philosophy, in contrast to previous philosophies, was no longer confined to set of theories concerning accumulated knowledge but instead consisted of a set of practices that involved observation and experimentation in the production of new knowledge. This meant that the new philosophy involved both theoretical and practical knowledge and therefore accorded making with thinking.

This new approach required a different type of practitioner, that is, a philosopher that engaged with practice as well as theory. Steven Shapin describes these new practitioners as the natural philosophers who identified themselves as 'moderns' set against 'ancient' modes of thought and practice, because, in their view they were

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http://universitypublishingonline.org.ezproxy.usq.edu.au/cambridge/histories/popups/pdf_viewer.jsf?cid=CBO9781139054010 A024&ref=true&pubCode=CUP&urlPrefix=cambridge&productCode=CHO (accessed 09/02/2014) p.365

[394] A. Blair, p.365
[395] P. H. Smith, 2004, p.17
[396] P. H. Smith, 2004, p.18

'proposing some very new and very important changes in knowledge of natural reality and in the practices by which legitimate knowledge was to be secured, assessed, and communicated'. [397] Such changes in intellectual thinking are believed to have been responsible for what is referred to as the Scientific Revolution. For Sachiko Kusukawa, the Scientific Revolution is 'a movement which broke away from the Aristotelian qualitative explanation of natural phenomena to pursue the mathematical, quantitative explanation of natural change, and culminated in the triumph of experiment and observation over the occult, the superstitious and the religious.'[398] The Scientific Revolution was home to thinkers that included among others, Nicholas Copernicus, René Descartes and Isaac Newton. The scientific revolution represented great intellectual and cultural change in the Western world and has been variously described as a sweeping epistemological transformation, a series of changes in European thought, and an intellectual revolution which attempted to explain man's place in the natural world.

Understanding how the idea of knowledge progressed is significant to this study because science has long been associated with theoretical knowledge and the separation of theoretical knowledge from practical knowledge is frequently utilised to differentiate between the scientific and the artistic ways of knowing. For Pamela Smith, Aristotle's separation of theory and practice marked the social divide between scholars and artisans in early modern Europe. [399] However, this gap in status narrowed when claims to knowledge about nature by image-makers was recognised as useful to the emerging new philosophy. Consequently, some scholars propose that the artisanal skills of observation and 'accurate' pictorial depiction played a significant role in the development of the previously mentioned new philosophy. David Landau and Peter Parshall, for example, argue that 'accurate visual representation was more than just a technical accomplishment. It was a highly specialized form of observation employed by artists who had achieved their own standards of verity quite apart from the focused interests of natural philosophers.' [400]

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[397] S. Shapin, *The Scientific Revolution*, The University of Chicago Press, Chicago, 1996, p.5
Steven Shapin is an historian and sociologist of science
[398] S. Kusukawa, *The Transformation of Natural Philosophy: The case of Philip Melanchthon*, Cambridge University Press, Cambridge, 1995, p.2
[399] P. H. Smith, 2004, p.17
[400] D. Landau & P. Parshall, p.257

On this point Smith points to the existence of two different models that are concerned with the artisanal influence on the rise of the new science, 'one posits direct influence and the other a development of shared values'.[401] These models focus on science's influence on art, whereas Smith is concerned with the reciprocal and complex relationship among artisans, practitioners and scholars. [402] This relationship concerned the artisanal artefacts that provided a link between the different ways of knowing. This is in keeping with this study's objectives, which aims to demonstrate not only that art is a legitimate way of knowing but that images are a site of inquiry to both art and to science.

4.2.2 The Idea of Art

4.2.2 [i] Labelling art

Providing a means to distinguish art from other human practices has long been problematic for art theorists. This is because through time art as a concept has been meaningful through a range of contexts. Whether is possible or even useful to define art, the notion of a distinguishing definition of art has dominated philosophical aesthetics since the publication of Immanuel Kant's work *The Critique of Judgement*.[403] However, rather than distinguish art from everyday activity the twentieth century saw many artists express the desire to blur the boundaries between art and life. In the 1984 influential publication *Theory of the Avant-Garde* Peter Bürger argues that the aim of the 'historical avant-garde' artists was to collapse of the boundaries between art and everyday life and dissolve the special statue of the art-work.[404] Whereas the formalist critic Clement Greenberg placed a premium on high art and as such believed that art must remain separate from life.[405] Despite the various concepts of art most contemporary theorists agree that art, like other forms of knowledge, is culturally and historically determined. Barry Sandywell for instance, explains that specific terms such as 'artworks' function culturally and socially in that they 'are the products of skilful semiopraxis which particular communities designate as objects of

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[401] P. H. Smith, 2004, p.21

[402] P. H. Smith, 2004, p.17

[403] G. Graham, *Philosophy of the Arts: An introduction to aesthetics* (3rd edn.), Routledge, London, 2005, p.223

[404] P. Bürger, *Theory of the Avant-Garde*, trans. Shaw, M., University of Minnesota Press, Minneapolis, 1984, p.49

[405] S. Barns, *Greenwich Village 1963: Avant-garde Performance and the Effervescent Body*, Duke University Press, Durham, 1993, p.105

value: that is, objects ascribed with aesthetic values and/or objects that fulfil aesthetic functions (for example, as instruments of the imagination, utopias, placebos in a desolate world)'. [406] Although images, including those such as Leonardo da Vinci's anatomical studies, are considered worthy of study by art and by science it is beyond the scope of this study to distinguish art from non-art. Accordingly, this study accepts as 'art' the images and works that have been identified as such in the various studies that have been referenced in the course of this project.

Due to the diversity of what might be described as art, contemporary theorists are frequently confronted with the question: What is art? However, because of what is described as 'a complex series of shifting definitions of art in the modern era', this question remains unresolved. [407] Despite being a contentious issue, the notion of a definition of art is considered a useful concept in some situations, particularly in relation to distinguishing between art and nonart. For Robert Stecker a definition of art 'attempts to identify the essential nature of art, or at least principles of classification for distinguishing art from nonart. Traditionally it searches for characteristics that all artworks share and nonartworks lack'.[408] The notion of a definition of art based on distinguishing characteristics has been sceptically received by some theorists. Morris Weitz, for example, argues a definition of art is not possible because art 'has no set of necessary and sufficient properties.' [409] Weitz suggests further that the essence of art, or what distinguishes it from other activities cannot be defined, therefore art might be understood as an 'open concept' that allows for the possibility of new conditions rather than one that is closed and restrictive. [410] The idea that the essence of art is indefinable was challenged by scholars such as Maurice Mandelbaum. On this notion Larry Shiner refers to Mandelbaum's suggestion that we might not be able to define art in terms of any visual or perceptual properties, but we might be able to define it in terms of its relational properties, in

[406] B. Sandywell, *Dictionary of Visual Discourse: A Dialectical Lexicon of Terms*, Ashgate, Surry, 2011, p.153

[407] M. Kemp, 'A fluid definition of art', *Nature*, Vol 429, No.6991, 2004, p.506, available from http://www.nature.com.ezproxy.usq.edu.au/nature/journal/v429/n6991/pdf/429506a.pdf (accessed 10/11/2013) p.506

[408] R. Stecker, *Aesthetics and the Philosophy of Art: An Introduction* (2nd edn.), Rowman & Littlefield Publishers, New York, 2010, p.8

[409] M. Weitz, p.28

[410] M. Weitz, p.34

terms of art's social context. [411] This might involve, for example, the social context as defined by the Artworld

Other attempts at defining the essence of art focus on approaches whereby the art status of an object is determined by an institution. The *Artworld,* for example, determines that an artefact is an art work by conferring the status of 'art' on a specific work. [412] In his 1964 essay the *Artworld*, art critic Arthur Danto attempted to provide a definition of art and coined the term 'the art world' to mean 'an atmosphere of artistic theory, a knowledge of history of art.' [413] In other words, a philosophical approach is considered the most appropriate way in which to understand the historical development of the concept of art. Drawing on the work of Hegel, Danto's essay was highly influential and was seen by George Dickie as the direction that art must take. Danto's term 'artworld' was utilised by Dickie 'to refer to the broad institution in which works of art have their place.'[414] By means of clarification, Stephen Davies offers Arthur Danto's argument that 'a piece cannot become art unless there is a place prepared for it within the Artworld in consequence of the prior history of art production, both generally and by the given artist.' [415] In this way *The Artworld* functioned as a social system in which works were identified as art according to specific criteria. As Noël Carroll explains, 'if we can isolate those features of the social context of the practice in virtue of which a candidate for art status is deemed an artwork, we will have a way of sorting art from nonart'. [416] By conferring the status of 'art' upon a work, an institutional theory of art therefore functions to distinguish art from those artefacts that are not art.

For Shiner, art worlds are networks of artists, critics, audiences, and others who share a common field of interest along with a commitment to certain values, practices, and

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[411] M. Mandelbaum, cited by L Shiner, in C. Mansour, 'Art, a modern phenomenon: An interview with Larry Shiner', *Platypus Review,* No.67, 2014, [web page] available from http://platypus1917.org/2014/06/01/art-modern-phenomenon-interview-larry-shiner/ (accessed 06/05/2015) web page

[412] G. L. Hagberg, 'The Institutional Theory of Art: Theory and Antitheory', in P. Smith & C. Wilde (eds.), *A Companion to Art Theory,* Blackwell Publishers, Oxford, 2002, p.490

[413] A. C. Danto, 'The Artworld', *The Journal of Philosophy,* Vol.61, No.19, 1964, pp.571-584, available from http://faculty.georgetown.edu/irvinem/visualarts/Danto-Artworld.pdf (accessed 16/06/2014) p.580

[414] G. Dickie, 'What is Art? An Institutional Analysis', in S. M. Cahn, & A. Meskin, (eds.) *Aesthetics A Comprehensive Analogy*, Blackwell Publishing, Malden, 2008, p.429

[415] S. Davies, *p.173*

[416] N. Carroll, *Philosophy of Art: a contemporary introduction,* Routledge, London, 1999, p.226

institutions. [417] In contrast, systems of art are wider in scope. A 'system of art', which includes various art worlds and sub worlds of literature, music, dance theatre, film, and visual arts, 'embraces the underlying concepts and ideals shared by various art worlds and by the culture at large, including those who only participate marginally in one of the art worlds'. [418] Rather than refer to a rigid definition of art, a system of art serves as a site in which this study might investigate the various images that portray science. In this way, a constructed inclusive system of art, accommodative of various art worlds, would include the images that belonged to an older system of art such as 'craft' and 'fine art' as well as those contemporary images created through collaborative art/science research. However, regardless of the different ways of interpreting art this study adopts Diarmuid Costello's and Jonathan Vickery's notion of art as discourse, whereby art is 'a conceptual field within which and around which move various kinds of objects, activities, processes, ideas and theories, subcultures and movements, institutions and exhibitions'. [419] This concept of art provides an avenue to think about art as a knowledge form that engages with and about the various ideas of art itself as well as other knowledges, including science, so as to gain new insights about art's place within the wider academic debate.

4.2.2 [ii] Art's way of knowing

Of relevance to this thesis is the issue of knowledge claims through visual representation within artistic and scientific inquiry. This topic raises questions that concern reasoned argument. For instance, does knowledge constructed through artistic reasoning have the same academic value as the knowledge that is based on 'scientific reasoning'? [420] Additionally, does knowledge always require a rational basis for higher understanding? These questions are particularly significant for visual artists and image-makers in general because until recent times reasoning was

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[417] L. Shiner, 2001, p.5
[418] L. Shiner, 2001, p.5
[419] D. Costello & J. Vickery, 'General Introduction', in D. Costello & J. Vickery (eds.), *Art: key contemporary thinkers*, Berg, New York, 2007, p.ix
[420] Scientific reasoning - is the foundation supporting the entire structure of logic underpinning scientific research. Writing in 'The Emergence of Scientific Reasoning', Bradley Morris, Steve Croker, Amy Masnick and Corinne Zimmerman argue that scientific reasoning encompasses the reasoning and problem-solving skills involved in generating, testing and revising hypotheses or theories, and in the case of fully developed skills, reflecting on the process of knowledge acquisition and knowledge change that results from such inquiry activities.

discussed primarily in terms of verbal texts. For this study, reasoning involves both visual and verbal modes of representation because research shows that the arts and the sciences have at times supported different ways of contributing to and representing knowledge. In relation to the questions concerning nature of knowledge that is available through art, Danielle Boutet has responded by presenting the idea that the *practice* of art is a form of knowledge by asking, 'what can one know through art?' [421] This question is premised on highlighting the qualifying differences between art and science. Drawing on the work of Franco-Bulgarian philosopher Tzvetan Todorov, Boutet notes that art and science are separate forms of knowledge:

> *Where a scientist proceeds through analysis, taking a totality apart into its most basic elements and looking at them separately, an artist knows through synthesis, apprehending a totality in a global intuition. While the scientist uses deduction and induction to study the facts of nature, the artist uses metaphors and correspondences to reveal the meaning in nature.* [422]

Until recently it was believed that knowledge could be generated through scientific processes only. But as David Novitz explains, the notion that 'science alone could furnish us with useful knowledge about the world; that there are no other secure sources of knowledge and understanding', is being dismantled as philosophers strive to empower others who occupy different realities. [423] However, scepticism continues to surround art's claim to knowledge while the epistemic value of science has traditionally enjoyed a privileged status. This is despite the existence of a number of critical debates concerning science's claim that higher knowledge exists through the concepts of 'truth' and 'objectivity'.

Rather than question science's occupancy of the intellectual high ground many scholars concur that art should also enjoy this position of respect and authority because like science, art also functions to make sense of the world. [424] However, an

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[421] D. Boutet, 'Vision and Experience: The Contribution of Art to Transdisciplinary Knowledge', *Transdisciplinary Journal of Engineering & Science,* Vol.4, 2013, pp.105-115, available from http://www.theatlas.org/index.php?option=com_phocadownload&view=category&id=29:volume-4-december-2013&Itemid=76 (accessed 10/04/2014) p.105

[422] D. Boutet, p.105

[423] D. Novitz, 'Knowledge and Art', in I. Niiniluoto, M. Sintonen, & J. Woleński (eds.), *Handbook of Epistemology*, Springer, Dordrecht, 2004, p.988

[424] S. Ede, 2000, p.20

artist's methods of meaning making differ from those of a scientist's. Siân Ede notes that scientific pronouncements are based in rational discourse, whereas art has the capacity to move us to contemplation through various modes of communication. [425] These modes involve 'visualising, abstracting, imagining, inventing, pretending, storytelling, re-presenting and ceaselessly reinterpreting things'. [426] From Ede's account, scientific knowledge is communicated through a 'rational process', in contrast art has the capacity to engage with an intellectual issue through 'many resonances'. [427] In keeping with Ede, it is not the aim of this study to claim that one concept of knowledge privileges another, but to present the notion that art is one of multiple ways of knowing by describing the various processes by which art might legitimately claim to be a knowledge discipline.

Although art is recognised as a system of communication and as a medium for the transmission and transformation of culture, it continues to be marginalised in terms of its contribution to knowledge. With few exceptions, and despite 'its epistemological potency . . . for representing both natural and cultural phenomena—art has been conceptually relegated within educational discourse largely to a domain of technique and production.' [428] For example, with the exception of discussions that involve the art disciplines, art itself is rarely considered in the wider academic discourse. For Angela Vettese this lack of recognition in an academic context represents an intellectual gap that is premised on a distance between 'making and thinking'. [429] This distance is in keeping with the ancient distinction between *techne* and *episteme*. This is also an unresolved and long-held concept that dissociates art from the thinking process in which there are consequences when considering visual art as a field of knowledge. For example, a view exists that art's claim to legitimate knowledge will be disregarded if it continues to be linked to production rather than be associated with thinking and planning. [430] However, other views propose a re-

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[425] S. Ede, 2000, p.20
[426] S. Ede, 2005, p.2
[427] S. Ede, 2000, p.20
[428] M. McDougall, et al, p.6
[429] A. Vettese, 'Foreword: How Do We Teach Art', in A. Ambrožič, & A. Vettese (eds.), *Art as a Thinking Process: Visual Forms of Knowledge Production*, Sternberg Press Co-published Iuav University of Venice, Venice, 2011, pp.3-17, available from http://www.elia-artschools.org/images/products/110/art-as-a-thinking-process-visual-forms-of-knowledge-production.pdf p.9
[430] A. Vettese, p.9

examination of the notion of knowledge itself, in particular the relationship between art and epistemology. Although this relationship remains contentious, for Sarah Worth 'it seems fairly obvious that we gain something meaningful from experiences and interactions with works of art. It does not seem so obvious whether or not the experiences we have with art can produce propositional knowledge that is constituted by true justified belief'. [431] This view is concerned with determining the cognitive status of art, that is, what can we learn from art? Worth's view offers opposing positions relating to the notion of art as a way of knowing:

> *Those who argue that we can learn from art generally argue that our engagement with art arouses certain emotions or activities that are able to facilitate or produce knowledge. They would argue that there is some aspect of the artwork which can help to produce greater understanding of the world around us. Art is thus seen as a source of insight and awareness that cannot be put into propositional language; but it can help us to see the world in a new or different way.*
>
> *Those who deny that we can learn from art often argue that there can be no knowledge that is not propositionally-based knowledge. . . Those who argue this line want to defend the notion that since art cannot provide facts or generate arguments, then we cannot learn from it. Further, those who believe we cannot learn from art argue that art cannot be understood as a source of knowledge because it is not productive of knowledge, taken in the traditional sense of justified true belief.* [432]

Therefore if art is unable to provide justified true belief it is rejected as knowledge, alternatively, art is considered to be a source of knowledge because it has the capacity to produce greater understanding and different ways of considering the world. From this account 'understanding' and the 'different ways of looking' would be construed as either the advancement of existing knowledge or new knowledge.

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[431] S. E. Worth, 'Art and Epistemology', *Internet Encyclopedia of Philosophy*, [web page] available from http://www.iep.utm.edu/art-ep/ (accessed 14/09/2015) web page
[432] S. E. Worth, web page

The concept of understanding is considered to be critical to ways of knowing, that is, the knowing 'why' in addition to the knowing 'how' and 'what'. These associations between understanding and knowledge have their origins in ancient philosophical debate. Plato for example, believed the highest goal for a philosopher was to discover the ideas behind apparent nature. [433] These associations extended to include the arts through the Aristotelian theory on mimesis. For instance, Aristotle understood mimesis as an activity that is related to an experience of learning or understanding rather than just simple copying.[434] Accordingly, mimesis concerns not just human creativity and notions of reality but also human understanding and cognition. Therefore art has cognitive value by virtue of its capacity to impart understanding and knowledge. For Immanuel Kant understanding was a significant constituent of cognition. Writing in the *Critique of Pure Reason* Kant notes the two sources of human cognition are sensibility, which gives us access to the sensible world, and understanding, which enables us to grasp the intellectual world. [435] In the *Critique of Judgement* Kant argues that imagination and understanding are cognitive faculties. [436] This third *Critique* concerns the position of judgement in relation to understanding and reason, which involves the concept of reflective judgement. For Kant, the judgement of taste concerns cognition in general, which is described as the harmony of the cognitive faculties [imagination and understanding] in free play. [437] In this way an aesthetic judgement is based on harmony between understanding, as source of reason, and the many representations provided by the imagination. The relationship between understanding, cognition, and art has also attracted the interest of contemporary scholars. Drawing on the work of Nelson Goodman, Catherine Elgin suggests that the arts function cognitively because the 'job of aesthetics is to explain how'. [438] This contention is based on the concept that it is understanding

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[433] H. Klinke, 'Introduction: The Image and the Mind', upcoming in H. Klinke (ed.), *Art Theory as Visual Epistemology*, Cambridge Scholars Publishing, Newcastle upon Tyne, 2014, pp.1-10, available from http://www.cambridgescholars.com/download/sample/57887 (accessed 04/05/2014) p.1

[434] M. Granatella, 'The Role of Mimesis in Aristotle's Poetics: A Fundamental Cognitive System', Athens, ATINER's Conference Paper Series, No: PHI2012-0196, 2012, pp.5-13, available from https://www.academia.edu/2641795/The_Role_of_Mimesis_in_Aristotles_Poetics_A_Fundamental_Cognitive_System (accessed 28/06/2014) p.10

[435] M. Rohlf, 'Immanuel Kant', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*, 2014, Summer Edition, [web page] available from http://plato.stanford.edu/entries/kant/ (accessed 07/07/2014) web page

[436] I. Kant, 1987, p.63

[437] D. W. Crawford, 'Kant', in B. Gaut & D. M. Lopes, *The Routledge Companion to Aesthetics* (3rd edn.), Routledge, London, 2013, p.50

[438] C. Z. Elgin, 'Relocating Aesthetics: Goodman's: Epistemic Turn' in C. Z., Elgin (ed.), *Nelson Goodman's Philosophy of Art,* Garland Publishing, New York & London, 1997, p.1

rather than propositional knowledge that is the central concept of epistemology. For Goodman knowing is not about determining what is true, rather knowledge is about finding a fit, consequently any growth in knowledge is achieved through understanding rather than by 'formation or fixation or belief.'[439] The idea that art can demonstrate a legitimate claim as a form of knowledge through its association with understanding is significant to the aims of this chapter, because such a notion provides a conceptual link with visual rhetoric. This idea also serves to emphasise the role of understanding in the knowledge debate.

4.2.3 The Idea of Science

4.2.3 [i] Labelling science

Science is described as a way of explaining the natural world. Science also refers to a set of practices as well as the historical accumulation of knowledge. In current usage the term 'science' may describe both the endeavour and the result of a process, or may refer to the body of knowledge itself. Various descriptions concerning identity and distinguishing characteristics of science are provided by scholars and scientific institutions such as the National Academy of Sciences and the Science Council. These are reflected in those definitions provided by Oxford English Dictionary which range from; science as 'the state or fact of knowing; knowledge or cognizance of something; knowledge as a personal attribute', to the idea that science is:

> *A branch of study that deals with a connected body of demonstrated truths or with observed facts systematically classified and more or less comprehended by general laws, and incorporating trustworthy methods (now esp. those involving the scientific method and which incorporate falsifiable hypotheses) for the discovery of new truth in its own domain.*[440]

The OED notes that science is also described through its relationship with art, whereby science is 'a discipline, field of study, or activity concerned with theory rather than method, or requiring the knowledge and systematic application of

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[439] N. Goodman, *Ways of Worldmaking*, Hackett Publishing Company, Indianapolis, 1988, p.22
[440] Oxford English Dictionary, 'Science', OED [web page] available from http://www.oed.com.ezproxy.usq.edu.au/view/Entry/172672?redirectedFrom=science#eid (accessed 16/05/2015) web page

principles, rather than relying on traditional rules, acquired skill, or intuition'. [441] Consequently, a range of descriptions concerning science exist, but most serve to advance the notion that science is an organised, systematic, and theoretical way of knowing based on rigorous testing of phenomena.

The terminology surrounding the practice of science, which for this study includes medicine and technology, is problematic to academic inquiry. This is because 'science', which is derived from the Latin *scientia*, has progressed from meaning knowledge in general, to refer to a specific type of knowledge.[442] The term 'scientia' was utilised by philosophers to demonstrate that their work was the result of the new 'science'. This practice is apparent in the inclusion of the term in the titles of treatises such as Niccolò Tartaglia's 1558 *Nova scientia*. This publication involved the new science of projectile motion concerning the trajectory of ballistics based on the theoretical foundation of Euclidean geometry and Aristotelian natural philosophy. [443] Even though what is now referred to as 'science' was 'natural philosophy' until the nineteenth century, Sydney Ross writes that 'philosophy' and 'science' were used interchangeably to refer to specialised areas of knowledge such as experimental science or experimental philosophy; and moral science or moral philosophy. [444] This is most notable in the titles of 'scientific' publications, such as Isaac Newton's 1687, *The Mathematical Principles of Natural Philosophy* and *Elements of the philosophy of plants: containing the principles of scientific botany ... with a history of the science,* and the 1821 *Elements of Philosophy of Plants Containing the Principles of Scientific Botany; Nomenclature, Theory of Classification, Phythography; Anatomy, Chemistry, Physiology, Geography, and Diseases of Plants* by Augustin Pyramus de Candolle and Kurt Polycarp Joachim Sprengel. By consensus of opinion it was determined that these two areas of knowledge were to be distinguished from each other. Consequently, philosophy was allocated to the theological and metaphysical, and science to the experimental and

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[441] Oxford English Dictionary, 'Science', web page

[442] B. Frischer, p.20

[443] J. Büttner, P. Damerow, J. Renn & M. Schemmel 'The Challenging Images of Artillery: Practical Knowledge at the Roots of the Scientific Revolution', in W. Lefèvre, J. Renn & U. Schoepflin (eds.), *The Power of Images in Early Modern Science*, Birkhäuser, Basel, 2003, p.13

[444] S. Ross, 'Scientist: The Story of a Word', *Annals of Science,* Vol.18, No.2, 1962, pp.65-85, available from http://siba.unipv.it/fisica/articoli/A/Annals%20of%20Science_vol.18_no.2_1962_pp.E1-85.pdf (accessed 20/08/2013) p.69

physical branches of knowledge. [445] Hence, the term 'philosopher' or 'natural philosopher' could no longer be applied to those scholars who were associated with the natural and physical sciences.

The term 'scientist' was initially coined in 1834 by historian and philosopher of science William Whewell. It was during this time that the different sciences were becoming more specialised and formally separating from mathematics. Sidney Ross proposed that Whewell was concerned with the tendency for the 'separation and dismemberment 'of the sciences, arguing that 'science, even mere physical science, loses all traces of unity.' [446] For Whewell there was a need to designate a collective name to the students of knowledge of the material world. This would be a term that would describe these 'gentlemen' with reference to their pursuits. Arguing that 'philosopher' was felt to be too wide and lofty, Whewell proposed that by analogy with 'artist', the word 'scientist might be formed. [447] Historians note that this was a time when science was transitioning from a pursuit of the gifted amateur to those of the professional and the designation 'scientist' implied specialism and professionalism. [448] In this way the establishment of 'scientist' as a specific designation resulted in strengthening this new position of science which involved both episteme and techne.

4.2.3 [i] Science's modes of knowing

During science's long association with knowledge, its methods of obtaining and disseminating knowledge have continuously changed in order to reflect the dynamic nature of science and of knowledge itself. In contrast to the ancient concept of science as a theoretical form of knowledge, the contemporary 'scientific method' also involves practical and productive ways of knowing as well as theoretical knowledge. Fredrick Betz describes this modern epistemology of science as a

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[445] S. Ross, p.69
Ross does not identify the authors of this 'consensus' but mentions that the term 'science' was brought into prominence with its modern meaning in the creation of the *British Association for the Advancement of Science* in 1831
[446] W. Whewell in S. Ross, 'Scientist: The Story of a Word', *Annals of Science*, Vol.18, No.2, 1962, pp.65-85, available from http://siba.unipv.it/fisica/articoli/A/Annals%20of%20Science_vol.18_no.2_1962_pp.E1-85.pdf (accessed 20/08/2013) p.71
[447] W. Whewell, p.72
[448] W. Whewell, p.64-65

methodology conceived within research projects and performed according to techniques of scientific method, whereby:

> *Scientific method is an empirical/theoretical process of inquiry into nature to discover and understand (1) what things exist in nature (discovery), and (2) how natural things work (understanding). Scientific method consists of research techniques for performing experiments to discover nature (empirical) and for constructing theory based on these experiments (theoretical) to understand and explain nature.* [449]

Ancient scholars, such as Aristotle, were aware that knowledge could be gained from observing nature, however, the idea of a 'scientific method' as a process for obtaining knowledge is located in the writings of later scholars who are recognised for their contributions to the development of the scientific method. These scholars include the thirteenth century philosopher Roger Bacon who drew on the writings of Islamic scholars; Francis Bacon whose methods are published in the 1622 *Novum Organum*, and René Descartes whose 1637 treatise *Discourse on Method* is considered influential to the development of modern philosophy as well as the natural sciences. [450] The 'new' philosophies signalled a change in the notion of knowledge. This change is attributed to a shift in the conception of nature from the supernatural to what was directly observable, whereby the natural world must now be considered, described, and explained through experiment and theory and scientific paradigms. [451] This would mean that because it was quantifiable through measurement the 'scientific method' could provide explanations for phenomena previously attributed to religion or magic. Rather than a single method, contemporary science represents a multiplicity of approaches which are reflected in disciplinary-specific scientific methods. For example, a Popperian approach might appeal to some physicists whereas behavioural scientists may prefer a Feyerabendian philosophy. This plurality of views provides an avenue to investigate new ways of knowing for science, including visual modes of constructing and transmitting knowledge.

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[449] F. Betz, *Managing Science: Methodology and Organization of Research*, Springer, Dordrecht, 2011, p.9
[450] The full original title to Bacon's text was *Novum Organum Scientiarum* ('new instrument of science') and Descartes' text *Discourse on Method and Meditations on First Philosophy* is frequently referred to as simply *Discourse on Method*
[451] F. Betz, p.21

4.3: Concept 2: The Image

4.3.1 About Images

Current dialogue concerning the topic of images emphasises both the significance and the pervasiveness of the image in contemporary life. It is the ubiquitous characteristic of images that prompted Mark Linder to argue that now 'is the time for images'; because, 'images are an incessant, conspicuous and peculiarly influential aspect of contemporary life. Today the status of images is greater, and different, than ever before. If ever there was a subject in need of theorization and application, images are it'. [452] Although Linder's focus is architectural imagery, many of the ideas and concerns proposed by the author resonate with those of this study. As Linder writes:

> *We have many compelling ways to focus and clarify our understanding of the contemporary status of images. Images are a complex subject of inquiry and a quickly evolving mode of cultural currency that is historically deep, technically challenging, and discursively sophisticated, and that taps evolved human cognitive capacity. In an effort to understand the operation, potential, and manipulation of media, numerous artists and theorists today are turning to the matter of images and proposing ways of thinking and acting that can be sustained technically and conceptually by images. [453]*

However much of the speculation concerning images arises from seemingly uncomplicated questions, most notably; what are these entities that are referred to as images? Despite many attempts by scholars this question remains unanswered, an indication, according to these scholars, that images constitute a problematic field of intellectual inquiry.

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[452] M. Linder, 'Images and Other Stuff', *Journal of Architectural Education*, Vol.66, No.1, 2012, available from, http://www.tandfonline.com/doi/pdf/10.1080/10464883.2012.717503 (accessed 13/07/2014) p.3
[453] M. Linder, p.3

4.3.2 Image: Historical Debates

4.3.2 (i) The Image: genesis

The most defining accounts about the image in Western thought are traced to the ancient Greek philosophers Plato and Aristotle, in particular Plato's *Simile of the Cave* and Aristotle's writings on mimesis and imitation in the *Poetics*. Sunil Manghani describes the *Simile of the Cave*, whereby Plato presents the idea that rational though can dispel illusion thus providing access to true knowledge and emancipation, as one of the most influential passages on images in the history of philosophy. [454] One of the aims of Plato's allegory was to explain the nature of reality. Plato argued the 'idea' is reality and 'mimesis' is an imitation of life which is removed from reality, inasmuch as images are imitations and thus do not represent truth. Aristotle's position differed from that of Plato, because Aristotle believed mimesis to be an inherently human attribute, whereby art is an imitation of life. This notion is emphasized in the *Poetics*, where Aristotle wrote, 'Tragedy, then, is an imitation, not of men, but of an action and of life.' [455] For Aristotle there was a need to reveal the concealed characteristic of ideas, that is to say, 'it is through forms of simulated representation and imitation that we can properly reflect the world'. [456] Consequently, two distinct ways of considering image theory has emerged from these accounts. Jacqueline Lichtenstein suggests that in a Platonic account, 'images are developed along with a general theory of knowledge, against a metaphysical background', but for Aristotle the 'image has to do with community, with relations to others'. [457] This distinction is significant because the meaning of the term 'mimesis' has its origins in theatre, a public art, where it was concerned with the relationship between audience and actor. [458] Expressly, 'the theory of the image, in Aristotle, is developed inside a theory of theatre, and not of painting'. [459] This paradigmatic example of each philosopher proposed by Lichtenstein - painting for Plato and theatre for Aristotle – presents one of many readings of Plato and Aristotle. For

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[454] S. Manghani, 2014, p.422
[455] Aristotle, *The Poetics of Aristotle*, (3rd edn. revised) trans. S. H. Butcher, Mc Millan & Co Limited, London, 1902, p.27
[456] S. Manghani, 2014, p.422
[457] J. Lichtenstein in 'Accounts of Images, and Accounts that Begin From Images', in J. Elkins & M. Naef (eds.), *What is an Image?*, The Pennsylvania State University Press, Pennsylvania, 2011, p.33
[458] J. Lichtenstein p.33
[459] J. Lichtenstein p.33

W.J.T. Mitchell this paradigmatic example not only highlights the notion that a person is an imitative being, but also connects to the presumption that the image is always visible, whether in painting or in theatre. [460] In this way, Aristotle's theory of mimesis is applicable across all media to include visual images.

Early Greek philosophy and biblical writings continue to influence contemporary image theory, in particular the notions of 'iconophobia', which refers to the mistrust of fear of images, and 'iconophilia' which indicates a love of images. Initial references in the *Bible* bestow significance upon the image when in 'Genesis' 'God created man in his own image', later in 'Exodus' God prohibited the production of 'graven images'. The biblical denunciation of images also include Abraham's destruction of the idols in order to prevent the worshipping of false gods. The destruction of images concerns the concept of iconoclasm, which generally refers to the practice of breaking icons for religious or political reasons, whereby icons are described as 'the sacred images representing the saints, Christ, and the Virgin, as well as narrative scenes such as Christ's Crucifixion'. [461] Thus, a deep mistrust of images, or certain kinds of images, is manifest in the challenging of established beliefs by the destruction or condemnation of images by iconoclasts. [462] The 'Byzantine Iconoclasm', occurring during the eighth and ninth centuries, is considered to be one of the most significant disputes involving icons. This crisis marked a deep dispute over the uses of icons within social and political spheres. Sunil Manghani explains that 'on one hand iconoclasts – upholding the doctrine against 'graven images' – sought to purify the church of idolatry, while iconophiles considered the value of specific icons as a means to propagate ideas and maintain social order.' [463] For Manghani, the phenomenon, whereby some images are overturned by iconoclasts in favour of other specific unifying political symbols, which are later denounced, is a recurring pattern. [464] Prominent examples of such disputes include the English Civil War, China's Cultural Revolution and the collapse

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[460] W. J. T. Mitchell in 'Accounts of Images, and Accounts that Begin From Images', in J. Elkins & M. Naef (eds.), *What is an Image?*, The Pennsylvania State University Press, Pennsylvania, 2011, p.33

[461] S. Brooks, 'Icons and Iconoclasm in Byzantium', in Heilbrunn Timeline of Art History, *The Metropolitan Museum of Art*, New York, 2000, [web page] available from http://www.metmuseum.org/toah/hd/icon/hd_icon.htm (accessed 15/08/2015) web page

[462] S. Manghani, 2014, p.422

[463] S. Manghani, 2013, p.65

[464] S. Manghani, 2013, p.65

of communism in Europe. In recent times public art institutions such as London's Tate Britain and National Gallery have become targets for iconoclastic attacks. Martin Oldham suggests such attacks result from a perception by some that the aforementioned institutions represent a cultural or political establishment from which some people feel disenfranchised or excluded, even though most strive to be more accessible and less elitist. [465] These types of attacks have resulted in damage to artworks such as Mark Rothko's *Black on Maroon* and Nicolas Poussin's work, *The Adoration of the Golden Calf*. In a more subtle form of iconophobia images are simply withdrawn from circulation with the aim of eliminating their visibility. [466] This type of iconophobia is similar to the present concept of censorship whereby certain ideas are suppressed by different authorities.

Consideration of the historical origins surrounding the issues of scepticism regarding the image is important to this study. This is primarily because of this study's focus on the images of science, a discipline which at various times has times has distained the use of images as a form of research. Concerns relating to the distrust of images have been noted in the writings of scholars since Plato. Such apprehension about the image has attracted the interest of scholars ranging from René Descartes to Karl Marx and Sigmund Freud and include, among others, Jean Baudrillard. [467] This interest was addressed in the 2002 exhibition *Iconoclash: Beyond the Image Wars in Science, Religion and Art*. The exhibition concerned the 'crisis of representation' by focusing on the disagreement between iconoclasts and iconophiles 'on the field of representation, denying or believing in the possibility of representation, in the referential functions of chains of signs.' [468] This exhibition presented contrasting accounts of iconoclasm and iconophilia. Writing in the introduction of the exhibition catalogue Bruno Latour defines *Iconoclash* as the situation of '*uncertainty* about the

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[465] M. Oldham, 'Iconoclasm Today', *Apollo Magazine*, London, [web page] 12 Oct 2013, available from http://www.apollo-magazine.com/iconoclasm-today/ (accessed 08/05/2015) web page

[466] C. Larsson, 'Suspicious Images: Iconophobia and the Ethical Gaze', *M/C Journal: A Journal of Media and Culture*, Vol.15, No.1, 2012, available from http://www.journal.media-culture.org.au/index.php/mcjournal/article/viewArticle/393 (accessed 15/06/2014) web page

[467] S. Manghani, 2013, p.63

[468] ZKM, *ICONOCLASH. Beyond the Image Wars in Science, Religion and Art,* ZKM | Centre for Art and Media [web page] 2002, [last update: Monday, 25 July 2005] available http://zkm.de/en/publication/iconoclash-beyond-the-image-wars-in-science-religion-and-art (accessed 10/08/2014) web page

exact role of the hand at work in the production of a mediator.' [469] The situation of 'uncertainty' relates to the choice of either a destructive hand or a beneficial and productive hand in the production of an image, and Latour has assigned different roles to the hand in relation to imagery. In religious imagery for example, the 'spoiling' hand is absent because as *acheiropoiete* images they appeared miraculously, similarly with scientific imagery the hand is seen as 'sullying the sanctity of objectivity . . . forbidding any claim to truth'. [470] Art as the product of the human hand does not claim to be a miracle from God or to be objectively seeking the truth. In contrast to the images of science and religion, 'the hand at work is visible everywhere' in the images of art. [471] For Latour, *Iconoclash*, as the assemblage of different patterns of image rejection and image construction, and of image confidence and image diffidence, represented a cabinet of curiosities containing interpretable objects, rather than an art show or a philosophical argument. [472] For this study this assemblage not only presents the different way of considering the uncertainties and ambiguities that continue to surround the image, but it serves to emphasise that despite their destruction images continue to be created, and furthermore, there is a need of intermediaries like the image so that we can have access to such ideas as God, nature and the truth.

4.3.2 (ii) Image and word: historical dichotomy

Scholarly accounts of the image frequently involve an association with the word that is described as antagonistic rather than a harmonious. Scholars indicate that such dichotomous discord might have biblical origins. Drawing on the work of David Freedberg, Sunil Manghani claims the episode of Moses breaking the verbal icons of the divine word, which are the tablets on which the commandments are written, poses an obvious tension between word and image. [473] Manghani goes on to explain that in breaking the verbal icons Moses also destroys the idol which is the golden calf, thereby making an explicit connection between idolatry and sin; as a

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[469] B. Latour, 'What is Iconoclash? or Is there a world beyond the image wars?' in P. Weibel & B. Latour, *Iconoclash, Beyond the Image-Wars in Science, Religion and Art*, ZKM and MIT Press, Cambridge, 2002, p.20
[470] B. Latour, 2002, p.18
Acheiropoiete images refers to icons made without hands
[471] B. Latour, 2002, p.20
[472] B. Latour, 2002, p.23
[473] S. Manghani, 2013, p.64

consequence, the image is regarded as a corrupting force. [474] The Reformation provides further references to the tension between text and image, such as the supposed absence of images in some Protestant churches, in particular Calvinist churches, which is a preeminent faith in countries such as Holland and Germany. However, art historian Angela Vanhaelen informs us that although word and image might have been repositioned in the Church, one does not completely supplant the other, meaning that 'iconoclasm did not herald the advent of a completely logocentric culture'. [475] Paradoxically, the late sixteenth century and seventeenth century is referred to as the Golden Age of Dutch Painting due to the proliferation of paintings by highly acclaimed artists. According to Michael O'Connell, the utilisation of devotional imagery in the English Reformation mirrored that of the Dutch Reformation, whereby the official replacement of one system for the other was by no means total or unambiguous. [476] There were however wider implications of this struggle between 'the culture of the image and the culture of the word' which was primarily 'a clash between religious systems, one based on an incarnational structure of religious understanding and the other resting on the logocentric assumptions of early modern humanism empowered by print culture'.[477] According to O'Connell:

> *There, as in much of Northern Europe, Reformation iconoclasm brought to an end a semiotic and symbolic field for apprehending and imagining the sacred. What would be gained was an increasingly sophisticated use of verbal modes of knowing and expressing, the fruit of which in England would be a religious culture based on the vernacular Bible and on preaching, a culture that finds aesthetic expression, for example, in the poetry of Donne, Herbert, Vaughan, Marvell, and Milton. What was lost was a visual aesthetic that had materialized religious concepts and experience in traditions of painting, sculpture in stone and*

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[474] S. Manghani, 2013, p.64

[475] A. Vanhaelen, *The Wake of Iconoclasm: Painting the Church in the Dutch Republic*, Pennsylvania State University Press, University Park, 2012, p.36

[476] M. O'Connell, *The Idolatrous Eye: Iconoclasm and Theatre in Early-Modern England: Iconoclasm and Theatre in Early-Modern England*, Oxford University Press, Oxford, 2000, p.58

[477] M. O'Connell, p.58

> *alabaster, wood carving, stained glass, and theatrical*
>
> *performance.* [478]

By correlating the absence of iconoclasm in Italy with the existence of a strong theoretical and practical alliance with the visual arts, O'Connell is making the case for a visual epistemology; that is, for Italian artists and their public, the visual was not simply a means of devotion, but a mode of knowing, interpreting, and reflecting upon central understandings of the culture. [479] From this point of view it was what the image represented that commanded devotion, rather than the image itself.

The subject of 'image and word' has been explored in various ways. For Angela Vanhaelen the 'conflict' between word and image is often posited as the root of iconoclasm, and such interpretations usually turn on assumptions about the victory of text over image. [480] Other scholars view the 'word/image dichotomy' as a significant contribution to cultural heritage. W. J. T. Mitchell for instance, argues that the 'history of culture is in part the story of a protracted struggle for dominance between pictorial and linguistic signs, each claiming for itself certain proprietary rights on a "nature" to which only it has access'. [481] Rather than one of antagonism, the relationship between the different arts, specifically between verbal and pictorial representation, is frequently examined through a 'model' of comparison. For example, the dominant model for the recent interdisciplinary study of verbal and visual representation concerned the tradition of the 'sister arts' criticism and the pedagogy of 'literature and the visual arts'. [482] This model was primarily concerned with revealing the similarities as well as comparing the differences between the visual and literary arts.

The relative merits of the visual and literary arts have long been argued, however the most notable debates concern Aristotle's *Poetics* and Horace's *Ars Poetica* as well as the *paragone*, which for Tim Shephard is 'a kind of speculative investigation proceeding through a comparison of various arts which loomed large in the

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[478] M. O'Connell, p.58
[479] M. O'Connell, p.162
[480] A. Vanhaelen, p.36
[481] W. J. T. Mitchell, *Iconology: Image, Text, Ideology*, University of Chicago Press, Chicago, 1986, p.43
[482] W. J. T. Mitchell, 1994, p.84

Renaissance reception of the ancient discourse on the arts'. [483] Traditionally, these debates focused on comparing the art of poetry to the art of painting. Horace's dictum *ut pictura poesis*, for example, interpreted 'as is painting, so is poetry' suggests an equivalence between painting and poetry. Horace's words carried the authority of antiquity which appealed to artists, because 'the study of letters enjoyed a higher status in Renaissance Italy'. [484] In Shephard's view, the paragone serves as the site where artists attempted elevate the status of one artistic medium above the others, and therefore must be seen the context of the visual artists' quest for parity of status with other arts across the fifteenth and sixteenth centuries. [485] The motto 'ut pictura poesis' has long been employed by scholars to compare 'image' with 'word' through the merits of competing art forms such as painting and literature. Thus, Horace's concept has been employed by a range of scholars seeking to support their particular argument in relation to the arts.

Eighteenth-century scholar Gotthold Ephraim Lessing refuted the Humanist's interpretation of Horace's phrase, which has supported the Humanist claim that painting shared the same honours long accorded to poetry. In the 1766 essay *Laocoön*, Lessing claimed the difference between painting and poetry lay in the particular qualities of each medium, in that the visual arts are thought to be spatial and the poetic arts are temporal.[486] In other words, space-based image-arts and time-based poetry produced different kinds of images, a painting provided a spectator with an image that was to be taken in all at once, while poetry created a series of images that rose up before the reader or auditor. [487] However, as Barbara Maria Stafford argues, 'the expressive spatial arts are not exclusively spatial . . . they prod viewers to experience time by inviting us to engage in the construction or deconstruction of the image. [488] Works such as Albrecht Dürer's *Large Piece of Turf* and the *Young Hare* have long invited this type of contemplation from a range of viewers. For

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[483] T. Shephard, 'Leonardo and the Paragone' in T. Shephard & A. Leonard (eds.), *Routledge Companion to Music and Visual Culture,* Routledge, New York, 2013, p. 229
[484] T. Shephard, p. 229
[485] T. Shephard, p. 229
[486] R. W. Shaw, 'Ut pictura poesis: Vergil's Laocoön and beyond', *South African Journal of Art History* Vol.16, 2001, pp.20-33, available from http://repository.up.ac.za/xmlui/bitstream/handle/2263/15252/Shaw_Ut%282002%29.pdf?sequence=1 (accessed 24/06/2014) pp.20-21
[487] R. Mitchell & J. Khalip, 'Introduction: Release—(Non-) Origination—Concepts', in J. Khalip & R. Mitchell (eds.), *Releasing the Image: From Literature to New Media*, Stanford University Press, Stanford, 2011, p.7
[488] B. M. Stafford, 1996, p.32

Pamela Smith the work's appeal was 'more than the description of nature, its beauty and its copiousness', it was in 'the depiction of the particularity: this *one* dandelion gone to seed, the hair of an animal standing up in *this* particular way', mostly it was 'the extreme artifice of catching daily life in action'. [489] More recently, Clement Greenberg sought to detach the practice of painting from the constraints of narrative representation. In his 1940 essay, *Towards a Newer Laocoön* the art critic compelled painting to reject the dominance of literature and embrace the qualities of its own materiality by re-asserting its material flatness. [490] Greenberg argues that visual art, in particular abstract painting, could retreat into its own materiality and be purely aesthetic, thus detaching itself from literature and society. [491] In this way art could maintain its 'purity' and thus its distance from culture and therefore everyday life.

For W. J. T. Mitchell however, 'the medium is more than the material . . . more than more than simply the image plus the support', rather the medium includes 'the entire range of practices that make it possible for images to be embodied in the world as pictures'; the medium of painting, for example is 'not just the canvas and the paint . . . but the stretcher and the studio, the gallery, the museum, the collector, and the dealer-critic system'. [492] Instead of focusing on the 'incompatibilities' of media this broader socio-cultural view of the image takes into account a heterogeneous nature of representation and art in general, including the widely voiced concept that there is no purely visual or verbal art. Mitchell highlights this point in observing that 'all media are mixed media, combining different codes discursive conventions, channels, sensory and cognitive modes'. [493] Because the interaction between images and texts is constitutive of representation, Mitchell suggests that all representations are heterogeneous and that transgressing the text-image boundaries tends to be the rule rather than the exception. [494] Despite the notions of conflict between word and image these transgressions have occurred since antiquity. Mary Hocks and Michelle Kendrick write that the complex word-image association consists of contradictions,

[489] P. Smith, 2004, p.vii

[490] C. Greenberg, 'Towards a Newer Laocoön', in C. Harrison & P. Wood (eds.), *Art in Theory 1900-1990: An Anthology of Changing Ideas,* Blackwell, 1992, Oxford

[491] C. Greenberg, 'Towards a Newer Laocoön', in C. Harrison & P. Wood (eds.), *Art in Theory 1900-1990: An Anthology of Changing Ideas,* Blackwell, 1992, Oxford, p.556-557

[492] W. J. T. Mitchell, 2005, 198

[493] W. J. T. Mitchell, 1994, p.95

[494] W. J. T. Mitchell, 1994, p.5 & W. J. T. Mitchell, 1986, p.155

overlaps and paradoxes that not only existed ancient rhetoric but continue to persist in current rhetorical studies. [495] In this way a dialectical and dynamic engagement between word and image, that has prevailed through the art of rhetoric, might be considered as a form of mixed-media and a mode by which both art and science create and present knowledge.

While the dichotomous model, concerning word and image, has proven influential, Rui Carvalho Homem and Maria de Fátima Lambert note that the present currency is one of a relational nexus which entails a reading of the intermedial that underscores notions like contamination and hybridity. [496] However, the authors concede that it would be a mistake to discard the vantage afforded by the historical perspective. This is because an historical retrieval foregrounds the 'longevity of the impulse to allow visual and verbal *to commingle*' as well as the equally 'long-lived urge to discriminate and discursively construct a neat apartness.' [497] The dichotomous model continues to be influential in academic debate and it is particularly relevant to this thesis. This is because the concept of 'image and word' remains a contentious issue for visual representation, in particular the notions surrounding the legitimacy of images in scientific inquiry. The issues of 'trust' and 'depth' for example, have been a consistent problem for images in the history of science. Historian of science M. Norton Wise insists that images have appeared on 'the one hand, as much too powerful, likely to lead to the deceptive excesses of imagination rather than the calm reflections of reason, and, on the other, as much too weak, capable of illuminating only the surface of things rather than their deep structure'.[498] Thus, the differing views concerning the hierarchy of the image within scholarly discourse are demonstrated in different fields of inquiry. In contrast to science's scepticism surrounding the veracity of images, art historians such as Oskar Bätschmann call for a displacement of logocentric criticism by the establishment of a pictorial logic. [499]

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[495] M. E. Hocks & M. R. Kendrick, p.1
[496] R. M. G. C. Homem & M. F. Lambert, 'Introduction', in R. M. G. C. Homem & M. F. Lambert. (eds.), *Writing and Seeing: Essays on Word and Image*, Editions Rodopi, Amsterdam, 2005, p.13
[497] R. M. G. C. Homem & M. F. Lambert, p.13
[498] M. N. Wise, 'Making Visible', *Isis*, Vol.97, No.1, 2006, pp.75-82, available from http://www.jstor.org/stable/10.1086/501101 (accessed 29/10/2012) p.79
[499] S. Aymes-Stokes, M-O. Bernez, C. Serée-Chaussinand, 'Word and Image: Theory in the 21st Century', *Presentation: The 2010 Word & Image Conference in Dijon*, *Interfaces,* Vol.32, 2011, pp.1-8, available from http://college.holycross.edu/interfaces/vol32/articles/Presentation.pdf (accessed 12/07/2014) p.3

These different perspectives are significant because they relate to the role and function of images, and to a lesser extent text, within the different forms of intellectual inquiry. Their significance is also relevant in determining what an image is and what constitutes visual representation.

4.3.3 Images: Describing rather than Defining

Despite the proliferation of images in contemporary life, the concept of the image continues to be indeterminate and problematic in theoretical discourse. According to Sunil Manghani it is because of the variety and ubiquity of these images that we remain unable to say definitely what images are and what significance they hold. [500] Research shows that images predate the written word, and as a form of communication they function to make concepts visible, transform perceptions and create new insights, they are also fragmented across fields of inquiry which has resulted in the existence of many and diverse concepts of the image.

Writing in the 2005 publication, *What Do Pictures Want? The Lives and Loves of Images*, W. J. T. Mitchell reveals that 'image' means any likeness, figure, motif, or form that appears in some medium or other. [501] Thus, difficulties involving any inquiry of the image have arisen because there is a high level of ambiguity concerning image identity. This ambiguity is accentuated in Mitchell's all-inclusive description which functions to reveal the different characteristics of an image:

> *It can denote both a physical object (a painting or a sculpture) and a mental, imaginary entity, a psychological imago, the visual content of dreams, memories, and perception. It plays a role in both the visual and verbal arts, as the name of the represented content of a picture or its overall formal gestalt (what Adrian Stokes called the "image in form"); or it can designate a verbal motif, a named thing or quality, a metaphor or other "figure," or even the formal totality of a text as a "verbal icon." It can even pass over the boundary between vision and hearing in the notion of*

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[500] S. Manghani, 2013, p.xxi
[501] W. J. T. Mitchell, 2005, p.xiii

> *an "acoustic image." And as a name for likeness, similitude,*
> *resemblance, and analogy it has a quasilogical status as one of the*
> *three great orders of sign formation, the "icon," which (along with*
> *C. S. Peirce's "symbol" and "index") constitutes the totality of*
> *semiotic relationships.* [502]

Bruno Latour has provided an equally inclusive description, commenting that an image is 'any sign, work of art, inscription, or picture that acts as a mediation to access something else.' [503] This indeterminateness serves to emphasise the challenges that describing and defining the image poses for image scholars. Furthermore, some scholars have extended the notion of the image to include 'thinking. Michael Leja for example, argues that the term 'image' forces a convergence of three fundamental human activities of seeing, thinking, and depicting, whereby 'images frequently have been understood to be the currency of the three, so a comprehensive history would have to venture into many of the disciplines that bear on these activities'.[504] Taking these descriptions of the image into consideration, very little would be excluded when explaining what an image is.

More than any other discipline images have traditionally been associated with the visual arts, however, most images are not art. There is a vast array of images that are not included within the traditional boundaries of Western art. These 'non-art' images include imagery from science, technology, commerce, medicine, music and archaeology. Although the majority of these images function primarily to convey information, James Elkins argues that these images should be considered alongside both the canonical and extra-canonical examples of art. [505] This is because these images 'can be just as compelling, eloquent, expressive, historically relevant, and theoretically engaging' as those of any canonical example of art. [506] However, defining these images is problematic because the distinctions between them is

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[502] W. J. T. Mitchell, 2005, p.2
[503] B. Latour, 2002, p.20
[504] M. Leja, 'Scenes from a History of the Image', *Social Research,* Vol.78, No. 4, 2011, pp.999-1028, available from http://web.a.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=add2a9a0-560f-47bb-92a1-b8171a5bca92%40sessionmgr4001&vid=1&hid=4106 (accessed 14/03/2014), p.999
[505] J. Elkins, 1999, p.ix
[506] J. Elkins, 1999, p.ix

unclear. Nonetheless Elkins considers the label of 'informational' as a convenient fit because:

> *There is no good name for such images, which include graphs,*
> *charts, maps, geometric configurations, notations, plans, official*
> *documents, some money, bonds, seals and stamps, astronomical*
> *and astrological charts, technical and engineering drawings,*
> *scientific images of all sorts, schemata, and pictographic or*
> *ideographic elements in writing: in other words, the sum total of*
> *visual images that are not obviously either artworks or religious*
> *artefacts . . . at first it may appear that they are intrinsically less*
> *interesting than painting . . . bound by the necessity of performing*
> *some utilitarian function and therefore unable to mean more freely.*
> *Their affinity with writing and numbers seems to indicate they are*
> *incapable of the expressive eloquence that is associated with*
> *painting and drawing, making them properly the subject of*
> *disciplines such as visual communication, typography, printing,*
> *and graphic design.* [507]

Likewise, Julia Marshall questions the privileging of fine art as the most influential or valuable category of images, arguing for the inclusion of informational images within the study of art. [508] Thus, the line between fine-art and non-art images is permeable and within the different systems of art definitions concerning images are increasingly fluid.

The image as a field of inquiry has not figured prominently in philosophy because, according to John Krois, 'philosophy's major interest was language, the image remained terra incognita'. [509] As Krois explains, the philosophy of science had previously dismissed the use of images in science because these images are aligned with art, and the images of science were ignored by the art historians who deemed

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[507] J. Elkins, 'Art History and Images That Are Not Art', *The Art Bulletin,* Vol.77, No.4, 1995, pp.553-557, available from http://www.jstor.org.ezproxy.usq.edu.au/stable/pdfplus/3046136.pdf (accessed 13/04/2013) p.553 : *The Domain of Images*, Cornell University Press, Ithaca, 1999, p.4

[508] J. Marshall, 'Articulate Images: Bringing the Pictures of science and Natural History into the Art Curriculum', *Studies in Art Education,* Vol.45, No.2, 2004, pp.135-152, available from www.jstor.org/stable/1321097 (accessed 18/02/2013) p.135

[509] J. M. Krois, p.1

them not to be 'art'. [510] Currently these 'unclaimed images' are the subject of an extensive body of literature that anchors the artistic to scientific practices. According to Caroline Jones and Peter Galison these images might have been rejected by the institutions of art but they remain readable as constructions of visual knowledge. [511] These so-called 'problem images' are now attracting the interest of art historians such as Barbara Stafford and the previously mentioned Elkins. These scholars are attempting to understand the conceptual roles played by images that range from Feynman's graphs to digitalised computer visualisations of data and patent sketches. Jones and Galison argue that these images are not just read by students of art and science studies alike, but there is intense intellectual debate concerning the relationships, links and 'grey areas' that involve the images of art and the images of science. [512] Thus, the questions of knowing and viewing within artistic and scientific practice might be in part answered within wider practices of image production and knowledge.

The images that concern this thesis are the visual representations of science which frequently involve a broad range of visual material and formats. These are the 'exteriorized' images that have been created in visible, material form by an artist, designer, or scientist that function to represent or record perceptions as well as embody concepts. [513] Maps, for example, are abstract concepts. Elkins argues that graphic constructions like maps, diagrams, emblems and schemata are *notations*, which are 'images using organising principles other than formats associated with pictures or writing systems. [514] Alternatively, the natural world might be recorded and presented in naturalistic or realistic renderings as exemplified by the illustrations that exist in anatomical or botanical publications. In addition to the aforementioned unclaimed images that are primarily attracting interest from various schools of science, this study also involves the images that concern the scholars of art. In contrast to the images of science which function to illustrate and embody theories,

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[510] J. M. Krois, p.1

[511] C. A. Jones & P. Galison, p.6

[512] C. A. Jones & P. Galison, p.6

[513] J. Marshall, 'Image as Insight: Visual Images in Practice-Based Research', *Studies in Art Education A Journal of Issues and Research*, Vol.49, No.1, 2007, pp.23-41, available from http://www.naeaworkspace.org/studies_single/Studies%2049%281%29_Fall2007_individual/A2_Studies%2049%281%29_Fall 2007-3.pdf (accessed 08/03/2013) p.28

[514] J. Elkins, 1999, p.85

scholars including Carole Gray and Julian Marlins argue that art images 'are not theories because they do not present fulsome, wide-ranging visions of reality'. [515] This is because as manifestations of an individual artist's hypotheses or interpretations of reality that resonate with others, art images do 'not explain reality as much as they evoke reality'. [516] However, it is widely acknowledged that artists, like scientists, are theorists. Arthur Danto made this claim when he offered a philosophical argument in which to explain what distinguished art from non-art, in that artists are theorists because they create works that embody a theory of art. [517] Julia Marshall suggests that artists are theorists because they question, observe, analyze, synthesize, and hypothesize as scientists do and shape thought into conceptual images.[518] For artists then, theories are primarily an issue of process rather than outcome, and for this reason the images that represent art theories tend to be metaphorical rather than literal representations.

4.4: Concept 3: Visual Rhetoric

4.4.1 Focus: Persuasion and Understanding

Visual rhetoric generally refers to the way in which images persuade. However for this study, visual rhetoric concerns the strategies by which artistic and scientific concepts are communicated. Therefore visual rhetoric not only involves the way in which images construct argument but also concerns the way that images create meaning and thus invite understanding. According to Sonja Foss an invitation for understanding is an opportunity for others to see our world the way we do, not in the hope that they will change, but that they will understand. [519] This notion of understanding expands on existing ideas of visual rhetoric as well as on the traditional concepts of rhetoric itself which describes rhetoric as the effective use of

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[515] J. Marshall, 2007, p.32
[516] J. Marshall, 2007, p.32
[517] D. Carrier, 'Arthur C. Danto', in D. Costello & J. Vickery (eds.), *Art: key contemporary thinkers*, Berg, New York, 2007, pp.116
[518] J. Marshall, 2007, p.32
[519] S. K. Foss, in L. K. Hahn, L. Lippert & S. T. Paynton, *Survey of Communication Study,* Cengage Learning/Wikibooks, Directory of Open Educational Resources, 2011, available from
http://www.csus.edu/indiv/s/stonerm/ComS5SurveyOfCommunicationTextbook.pdf p.90
Invitational rhetoric was proposed by Foss and Griffin in 1995. It constitutes an invitation to the audience to enter into the rhetor's world and see it as the rhetor does. Although change is not the goal of invitational rhetoric, should change occur, it is the result of new understandings and insights, gained by the audience questioning their own assumptions and positions. In this situation rhetors frequently seek to create an environment that facilitates understanding.

persuasive language, whereby language is either an oral or written form of expression. Although images have long been valued for their rhetorical characteristics, visual rhetoric is a relatively recent field of study that draws on diverse fields of inquiry such as communication studies, art history and visual studies. However most theorists, including Foss, ground visual rhetoric both theoretically and methodologically in the ancient discipline of rhetoric. Consequently, some understanding of the theoretical foundations of visual rhetoric was deemed appropriate in order to conduct this inquiry.

4.4.2 Rhetoric

4.4.2 (i) The development of rhetoric

For many scholars the debate over the nature, function, and scope of rhetoric is both enduring and problematic. Andrea Lunsford, Kirt Wilson and Rosa Berry for example, argue that rhetoric is a plastic art that is notoriously hard to pin down because it 'moulds itself to varying times, places, and situations', therefore arguments about how to define rhetoric and what its scope should be, characterize the long history of Western rhetoric. [520] However Aristotle's definition of rhetoric, as the art (or techne) of determing the achievable means of persuasion, is regarded as the starting point for any discussion concerning the topic of rhetoric. Writing in the *Rhetorica* the philosopher suggested:

> *Rhetoric may be defined as the faculty of observing in any given*
> *case the available means of persuasion. This is not a function of*
> *any other art. Every other art can instruct or persuade about its*
> *own particular subject matter; for instance, medicine about what is*
> *healthy and unhealthy, geometry about the properties of*
> *magnitudes, arithmetic about numbers, and the same is true of the*
> *other arts and sciences. But rhetoric we look upon as the power of*
> *observing the means of persuasion on almost any subject presented*
> *to us; and that is why we say that, in its technical character, it is*

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[520] A. A. Lunsford, K. H. Wilson & R. A. Eberly, 'Introduction: Rhetorics and Roadmaps', in A. A. Lunsford, K. H. Wilson & R. A. Eberly (eds.), *The SAGE Handbook of Rhetorical Studies*, SAGE Publications, Thousand Oaks, 2009, p.xix
Plastic art refers to the arts that involve shaping and moulding

not concerned with any special or definite class of subjects. [521]

Even though it is believed that rhetoric originated in Syracuse on the island of Sicily, the first theories of rhetoric were developed in ancient Greece. Karen Foss tells us that classical rhetorical theories were dominated by the ideas of both Plato, who emphasised the limitations of rhetoric, and Aristotle, who was 'interested in codifying rhetorical instruction and in developing a pragmatic approach to the subject, in contrast to the moral perspective Plato brought to the subject'. [522] Classical rhetoric was primarily concerned with the art of public speaking which, as reported by Matthew Rampley, 'was central to cultural, legal, and political life, consequently the ability to speak effectively, and, above all, persuasively, was a highly prized skill'.[523] Furthermore, this was a codified 'art of speaking' which produced complex taxonomies of rhetorical figures including the familiar metaphor, simile and metonomy. [524] The aim of rhetoric was to persuade an audience through constructed argument. This was achieved through the effective utilisation of proofs which are also referred to as appeals. [525] Therefore rhetoric, for the Ancient Greeks, involved the use of logos or logical argument, ethos or speaker credibility, and pathos or emotional argument to construct a persuasive argument. [526] James Herrick writes that instruction in rhetoric was also part of formal education in ancient Rome, where the scholar Cicero is credited with organising rhetoric by developing a means of dividing the work of the orator into units, which are referred to as canons. [527] Rhetoric therefore became 'the art of discourse, of systematically and artfully thinking through the five canons of rhetoric: invention, organization, style, delivery, and memory'. [528] These canons continue to serve as a guide for the creation,

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[521] Aristotle, 'Rhetorica', trans. W. Rhys Roberts, in Ross D. W. (ed.), *The Works of Aristotle*, The Clarendon Press, Oxford, 1924, E-book and text archive available from Internet Archive, https://ia600407.us.archive.org/22/items/theworksofaristo11arisuoft/theworksofaristo11arisuoft.pdf (accessed 05/08/2014) 1355b

[522] K. A. Foss, 'Rhetorical Theory', in S. W. Littlejohn & K. A. Foss (eds.), *Encyclopedia of Communication Theory*, Sage Publications Inc, Los Angeles, 2009, p.854

[523] M. Rampley, 'Visual Rhetoric', in M. Rampley (ed.), *Exploring Visual Culture, Edinburgh University Press*, Edinburgh, 2005, p.133

[524] M. Rampley, p.134

[525] Appeals or proofs consist of logos, pathos and ethos. Cherri Porter points out that modern rhetoricians have added Aristotle's description of mythos as an appeal. This proof assumes that people value their membership in a society and share in its cultural heritage. Mythos is the sum total of stories, values, faith, feelings, and roles that make up the social character of a people. Proof by mythos often calls upon patriotism, cultural pride, and heroes or enemies as evidence

[526] K. A. Foss, p.853

[527] J. A. Herrick, p.97

[528] K. A. Foss, p.853

appearance and delivery of a wide range of persuasive texts that include both verbal and visual modes of communication.

According to Rampley, rhetoric had come to occupy second place to logic during the Middle Ages. [529] This hierarchical structure within places of learning functioned to maintain an Aristotelian model of teaching, which placed philosophical reasoning above rhetoric, even though the philosopher had elevated rhetoric to a level with dialectic as an equally valid means of conveying opinion. [530] Although rhetoric was considered inferior to philosophy it was utilised by the medieval Church as a means to lead followers to 'truth and understanding'. James Herrick writes that the Christian Church, as the dominant institution during this time, adapted certain sources of rhetoric, including the work of Cicero, to its own educational and social ends, such as the defence of Christianity [531] Rhetoric was thus employed for sermonising or instruction as well as for literary correspondence such as letter writing. [532] During this time rhetoric continued its role as a practical art and it was not until the Renaissance that rhetoric was recognised as a subject for philosophical inquiry. [533] This occurred at a time when a renewed interest in language, by the Humanist scholars, resulted in a rise in the status of rhetoric as an intellectual pursuit. Humanism mixed Christian morality with a search for education and inquiry that honoured classical sources, thus the importance of rhetoric lie in its potential to preserve cultural values and to generate new insights. [534] Scholars point out that 'Enlightenment Rhetorics' involved a shift in emphasis from the invention of argument to concerns of style and delivery. Herrick for example, notes this change reflected the influence of scholars such as Peter Ramus and René Descartes where 'argument' and 'proof' were moved from the domain of rhetoric into the domains of logic, dialectic, and mathematics. [535] And, where rhetoric has previously functioned to both discover and communicate knowledge, Barbara Warnick suggests it was now

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[529] M. Rampley, 2005, p.134
[530] J. Golinski, *Making Natural Knowledge: Constructivism and the History of Science*, Cambridge University Press, Cambridge, 1998, p.104
[531] J. A. Herrick, p.140
[532] Timothy Borchers in *Rhetorical theory: An introduction,* notes that attention was paid to a rhetor's style or the aesthetic qualities thus rhetors wrote beautiful letters in order to show that they were worthy of positive judgment
[533] K. A. Foss, p.853
[534] J. A. Herrick, p.171
[535] J. A. Herrick, p.171

more concerned with the communication of content rather than the discovery of knowledge through reasoning. [536] As such, rhetorical scholarship focused on matters such as style, taste, delivery and imagination, in contrast to earlier emphasis on argument, proof, invention and reason. [537] Therefore, rather than an external focus on discourse and the discovery of knowledge, the focus of rhetoric shifted to reception, which primarily concerned the mind and imagination.

Because scientific thinking and the 'scientific method' was the preferred model of intellectual discourse, there was a notable decline in interest in rhetorical theory at the beginning of the twentieth century. This was because theory was dominated by reason whereby rational argument was aligned 'with the new ideals of objectivity and empirical, scientific approaches had become the new type of appeal'. [538] However, confidence in scientific thinking as the appropriate solution to human concerns began to diminish as the century progressed. [539] It was realised that even though science had made advances in areas such as medicine it could not provide appropriate methods for examining social ph enomena, thus, a new method was required. In their search for a new mode of discussing human concerns such as motivation, moral values and decision making theorists returned to the foundational components of rhetoric, argumentation and the audience.[540] Herrick adds that 'scientists were increasingly willing to admit, as the twentieth century progressed, that much of the discourse of science was not formulary, clinical, and syllogistic, but decidedly strategic, argumentative, and rhetorical'. [541] This renewed interest in rhetoric is evident in a variety of disciplines including the sciences and the arts. In addition to argument and rational discourse contemporary rhetoricians are concerned with wider concerns such as context, knowledge, and power. And, even though the term has been flexible since ancient times, Aristotle's notion of rhetoric as primarily the art of persuasion, and to a lesser extent Plato's ideas of rhetoric as deceitful, has determined the way in which rhetoric continues to be described.

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[536] B. Warnick, *The Sixth Canon: Belletristic Rhetorical Theory and Its French Antecedents*, University of South Carolina Press, Columbia, 1993, p.129
[537] J. A. Herrick, p.171
[538] K. A. Foss, p.855
[539] J. A. Herrick, p.195
[540] J. A. Herrick, p.196
[541] J. A. Herrick, p.196

4.4.2 (ii) Contemporary descriptions of rhetorical theory

Many theorists continue to consider rhetoric as a persuasive art, yet, current descriptions extend beyond Aristotle's definition to reflect theoretical diversity and complexity. For Kenneth Burke rhetoric is 'the use of language as a symbolic means of inducing cooperation in beings that by nature respond to symbols', whereby inducing cooperation involves 'the use of words by human agents to form attitudes or to induce actions in other human agents'. [542] Whereas Douglas Ehninger describes rhetoric in terms of organised practical discourse that seeks to inform, evaluate, or persuade, and therefore is distinguished from discourse that seeks to please, elevate, or depict. [543] In addition to a focus on language and systems theory George Kennedy's broad description centres on the communicative aspect of rhetoric, in that:

> *Rhetoric in the most general sense may perhaps be identified with the energy inherent in communication: the emotional energy that impels the speaker to speak, the physical energy expanded in the utterance, the energy level coded in the message, and the energy experienced by the recipient in decoding the message.* [544]

According to these descriptions rhetoric is a complex concept involving a range of meanings. William Covino and David Jolliffe observe that this complexity arises because 'rhetoric is not a *content* area that contains a definite body of knowledge, like physics; instead, rhetoric might be understood as the study and practice of shaping content'. [545] For this study rhetoric is viewed as communicative device that organises or shapes information for the purpose of eliciting a response from an audience. Consequently, the description advanced by Lee Bartel provides the notion of rhetoric that most appropriately accommodates the considerations of this project whereby:

> *The concept rhetoric includes all presentational and performative*

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[542] K. Burke, *A Rhetoric of Motives*, University of California Press, Berkeley, 1969, p.43, 41
[543] D. Ehninger, 'On Systems of Rhetoric', Philosophy and Rhetoric, Vol.1, No.3, 1968, pp.131-44, available from http://web.a.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=60c5486d-edb2-46bb-b468-70f8be2205b5%40sessionmgr4005&vid=0&hid=4214 (accessed 30/09/2015) p.131
[544] G. T. Howard, *Dictionary of Rhetorical Terms*, Xlibris Corporation, Bloomington, 2010, p.172
[545] W. A. Covino & D. A. Jolliffe, 1995, p.4

aspects of communication that carry meaning beyond the literal denotative (logical) meaning of the text. In addition, it includes strategic substantive communication crafted for a particular audience to elicit a particular response based on that audience's reality—their expectations, values, fears, and so on. [546]

Accordingly, the response of an audience usually involves a change or reinforcement in beliefs or actions. However, rather than focus on change per se, recent developments in rhetoric emphasise understanding, which might or might not involve change. Invitational rhetoric for example, was developed by Sonja Foss and Cindy Griffin in 1995 as an alternative to the traditional concept of rhetoric as persuasion. Invitational rhetoric is described as an invitation to understand as a means to create a relationship rooted in equality, immanent value, and self-determination. [547] Although Foss claims that than change is not the objective of invitational rhetoric, for this study the concept of understanding is in itself a change, in that it is a change from a state of no or little understanding to one of enlightenment or greater understanding of a phenomena that is being considered.

4.4.2 (iii) Outline of rhetorical concepts specific to this study

Because the aim of this chapter is to explore the relationships between the key concepts in order to advance the notion that art, like science, contributes to the knowledge debate there is a considered focus on rhetoric because rhetoric is common thread through which these concepts are understood. Thus, in relation to reconciling the notions of persuasion and understanding with the concepts of art and science, the image, and visual rhetoric, it was deemed appropriate to outline the key rhetorical notions of argument, context and knowledge as they relate to the wider examination of images.

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[546] L. Bartel, 'Rhetoric in Research Reporting', in A. Mills, G. Durepos, & E. Wiebe (eds.), *Encyclopedia of Case Study Research*, Volume 1 & 2, SAGE, Los Angeles, 2010, p.830
[547] S. K. Foss, 'Invitational Rhetoric', in S. W. Littlejohn & K. A. Foss (eds.), Encyclopedia of Communication Theory, Sage Publications Inc, Los Angeles, 2009, p.569

Argument

Argument has long been associated with rhetoric in that 'rhetoric' applied to the ability to eloquently persuade or convince an audience by way of argument. A successful argument also utilises the three rhetorical appeals which are referred to as ethos, logos and pathos. Argument, which is described as the process of persuading an audience to understand or behave in an intended manner through reasoned discourse, involves either dialect or rhetoric. These terms are frequently used interchangeably, however, Scott Jacobs explains that rhetoric is a unilateral process by which a speaker attempts to persuade through the use of monologue and text, and in contrast dialect represents a bilateral process whereby each party endeavours to reach a consensus through dialogue and debate. [548] Furthermore:

> *Rhetoric adds motivational appeal and linguistic style in order to animate the inferential forms and propositional content of logic. Dialectic adds institutional commitments and deliberative format in order to test inferential forms and propositional content. Dialectic searches for truth; rhetoric makes truth effective. Rhetoric is a structure of identification, dialectic a structure of opposition. The materials of rhetoric are symbolic inducements; the materials of dialectic are pragmatic acts. The tendency in rhetoric is to situate; the tendency in dialectic is to transcend. [549]*

Consequently, argument concerns both rhetoric and dialect. However in keeping with Jacobs' description, the visual image, whose aim is to persuade, would be deemed rhetorical rather than dialectical.

Context

Context generally refers to the situation that surrounds an event, text or idea in terms by which it can be understood, thus, context is intrinsic to meaning. The notion of context is not a new concept to rhetoric. Cherri Porter explains that when rhetoric is defined as discovering in the particular case the available means of persuasion,

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[548] S. Jacobs, 'Rhetoric and Dialectic from the Standpoint of Normative Pragmatics', *Argumentation*, Vol.14, No.3, 2000, pp 261-286, available from http://www.usc.edu/dept/LAS/iids/docs/Jacobs%20%282000%29%20ARG%20Rhetoric%20and.pdf (accessed 06/12/2014)pp.261-262
[549] S. Jacobs, p.261

'particular case' refers to context. [550] In this way rhetoric involves determining the specific context in which successful strategies of persuasion might occur. According to Janet Atwill, Aristotle's definition emphasises the notion that rhetoric is always subject to the contingencies of context. [551] It is through the concept of context that rhetoric is described as techne because rhetoric is not an eternal unchanging form of knowledge. For current scholars context is frequently discussed in terms of a rhetorical situation. The term 'rhetorical situation' was first coined by Lloyd Bitzer to refer to a situation in which rhetorical discourse is created. [552] For Bitzer rhetoric was 'a mode of altering reality . . . by the creation of discourse which changes reality through the mediation of thought and action'. [553] According to this view a rhetorical situation refers to the particular conditions in which the rhetor attempts to bring about change through the purposeful use of discourse. Such conditions involve the audience, the purpose of the issue, the genre, which is concerned with specific conventions, and the context in which the issue is presented.

Theorists such as Charles Kostelnick note that although visual language is shaped by the image-maker for 'a specific audience and purpose and culminates with the reader interpreting that language in a specific situation', the rhetorical act is embedded in a wider set of rhetorical circumstances. [554] This means that visual language develops within a discourse that is encapsulated in conventional codes that embody cultural values and norms, which are inherently rhetorical because they influence how, at a given historical moment, communities use visual language to achieve certain ends. [555] From these accounts the rhetorical strategies that concern images are dependent on context in two ways. First, these strategies depend on the situation in which the work is both produced and consumed, and second, an effective strategy relies on a knowledgeable audience. This means that both image-maker and viewer are aware of the prescribed conventions involved in the event.

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[550] C. Porter, 'Introduction to Argument and Rhetoric', *Sources, Citation, Argument and Logic Resources*, pp.1-4, http://www.cherriporter.com/docs/introductiontorhetoricandargument.pdf (accessed 15/06/2014) p.1
[551] J. M. Atwill, *Rhetoric Reclaimed: Aristotle and the Liberal Arts Tradition*, Cornell University Press, Carbonale, 2009, p.175
[552] L. F. Bitzer, p.1
[553] L. F. Bitzer, p.6
[554] C. Kostelnick, 'Melting-Pot Ideology, Modernist Aesthetics, and the Emergence of Graphical Conventions: The Statistical Atlases of the United States, 1874–1925', in C. A. Hill & M. Helmers (eds.), *Defining Visual Rhetorics*, Lawrence Erlbaum Associates, London, 2004, Taylor & Francis e-Library, 2008, p.215
[555] C. Kostelnick, 2004, p.215-216

Knowledge

The relationship between rhetoric and knowledge has long been problematic for scholars. Complications have arisen because of the long-held attitudes that reflect Platonic notions of rhetoric as deceitful and because different ideas about knowledge exist. Aristotle wrote on the relationship between knowledge and rhetoric in the *Rhetorica,* arguing that as rhetoric was the counterpart of dialect it concerned the knowledge of all people instead of belonging to a separately defined form of knowledge. [556] The philosopher also determined that rhetoric involved observation which was an activity associated with an art. [557] Thus, in contrast to episteme or theoretical knowledge Aristotelian rhetoric is identified as techne, which as practical and productive knowledge is brought into existence by an efficient cause that is the maker. [558] More recently, scholars have proposed varying positions concerning the relationship of rhetoric to epistemology. Robert Scott in his seminal and influential essay *On Viewing Rhetoric as Epistemic* questioned the prevailing notions of knowledge and truth by claiming that rhetoric is epistemic. [559] Drawing on the works of Stephen Toulmin and Douglas Ehninger, Scott proposes that one must consider truth not as something fixed and final but as something to be created moment by moment in the circumstances in which one find themselves and with which one must cope, furthermore, in this consideration of human affairs, rhetoric is a way of knowing; it is epistemic'. [560] Scott also supports the notion that there is more than one way of knowing and a variety of ways in which to contribute to knowledge. For example rhetoric was one of a plurality of ways of knowing that seeks to understand how persuasion occurs, that is, it is in understanding how human action is decisive that rhetoric makes its contribution to knowing'. [561] For this reason rhetoric as a way of knowing concerns the mechanisms by which change occurs through persuasive images. For Brian Ott and Greg Dickinson rhetoric also involves logic, that is, as a

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[556] Aristotle, 1924, 1354a
[557] Aristotle, 1924, 1354a
[558] In Aristotle's system of knowledge, theory concerned knowledge for its own sake. Techne concerned productive knowledge which concerned making and practical knowledge which involved doing
[559] R. L. Scott, 'On Viewing Rhetoric as Epistemic', Central States Speech Journal, Vol.18, No.1, 1967
[560] R. L. Scott, 'On Viewing Rhetoric as Epistemic', Central States Speech Journal, Vol.18, No.1, 1967, p.17
[561] R. L. Scott, 'On Viewing Rhetoric as Epistemic: Ten Years Later', *Central States Speech Journal*, Vol. 27, No.4, 1976, pp.258-266, available from http://www.tandfonline.com/doi/pdf/10.1080/10510977609367902#.Ve4XVpdKWrg (accessed 12/01/2015) p.261

way of knowing, images shape not only what we see but how we see. [562] As this study demonstrates the process of visually shaping knowledge has long been employed by practitioners of both art and science as a means to construct and transmit meaning.

4.4.3 Visual Rhetoric

4.4.3 (i) The term 'visual rhetoric'

Most rhetorical scholars concur that the term 'visual rhetoric' involves both an artefact or product, and a process of inquiry. Janice Edwards argues that when visual rhetoric is defined in artefactual terms it refers to a rhetorical expression in visual form, such as the way a visual image functions to influence or convey meaning. [563] For Sonja Foss this artefact is not just the tangible evidence of a creative act but it also has a communicative function. [564] The second interpretation concerns rhetoric as a mode of inquiry. Here, visual rhetoric constitutes a theoretical perspective:

> *- or what might be called a rhetorical-perspective on visual imagery to distinguish it from the other sense of visual rhetoric—is a critical-analytical tool or a way of approaching and analysing visual data that highlights the communicative dimensions of images. It is a particular way of viewing images—a set of conceptual lenses through which visual images become knowable as communicative or rhetorical phenomena. [565]*

Consequently, visual rhetoric has provided a framework in which to produce and interpret images. Petra Aczél suggests this is a perspective that recognises the significance of images in human understanding, discursive practices, and media communication.[566] Therefore visual rhetoric might be seen as the purposeful

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[562] B. L. Ott & G. Dickinson, 'Visual Rhetoric and /as Critical Pedagogy', in A. A. Lunsford, K. H. Wilson & R. A. Eberly (eds.), *The SAGE Handbook of Rhetorical Studies*, SAGE Publications, Thousand Oaks, 2009, p.398
The notion that rhetoric is understood as the practice of shaping content is also mentioned by Covino and Joliffe [1995, p.4]

[563] J. L. Edwards, p.220
[564] S. K. Foss, 2008, p.304
In keeping with Foss, for this study, tangible evidence might include painting, an advertisement, a photograph, or a building and constitutes the data of study for rhetorical scholars interested in visual symbols.
[565] S. K. Foss, 2005, p.145
[566] P. Aczél, 'Challenges of Rhetoric in the Era of "Bytes and Likes"', in G. Kišiček & I Z. Žagar (eds.), *What Do We Know About The World? Rhetorical and Argumentative Perspectives,* University of Windsor, Windsor, 2013, p.336

construction of the elements of visual media in a way that is meaningful to a particular audience, in a specific context.

4.4.3 (ii) Visual rhetoric: reconsidering rhetorical concepts

Argument

According to Leo Groarke many scholars, including Roland Barthes, Martin Jay and W.J.T Mitchell, have recognized the importance of visual images in everyday discourse and debate.[567] However, positions concerning the actuality of visual argument among scholars range from absolute denial to complete acceptance. David Fleming for example, claims that argument can only occur in a verbal mode, whereas Ian Dove suggests there that is a legitimate place for visual elements within argumentation. [568] Problems concerning the legitimacy of visual argument relate to traditional assumptions of the image itself. Drawing on traditional accounts of the meaning of images, David Birdsell and Leo Groarke suggest that these assumptions 'maintain that images cannot assert; that they are too vague and ambiguous to function as propositions; that they are emotional and never cognitive; that they cannot express negations; and that words have ultimate authority in the realm of argument'. [569] Such claims have been dismissed by image theorists as well as many argumentation theorists who propose that argument should not be restricted to a verbal activity. The aforementioned Birdsell and Groarke for example, describe visual argumentation as arguments which are conveyed in images, and 'like verbal arguments, they can be understood and analysed through the standard components of arguments'. [570] These standard components involve an Aristotelian rhetorical framework that traditionally applies to verbal argument. However, not all images serve an argumentative purpose. Groarke tells us that most works of art do not function as arguments or attempt to persuade, instead some are created for the purposes of advocacy or reflection and therefore function as a way to convince the

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[567] L. Groarke, 1996, p.105
[568] I. J. Dove, 'On Images as Evidence and Arguments', in F. H. van Eemeren, B. Garssen (eds.), *Topical Themes in Argumentation Theory: Twenty Exploratory Studies,* Springer, Dordrecht, 2012, pp.223-224
[569] D. S. Birdsell & L. Groarke, 'Outlines of a Theory of Visual Argument, *Argumentation and Advocacy*, Vol.43, No.3/4, 2007, pp.103-113, available from http://web.a.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=bd242da0-dbe2-4498-9a13-25a6ff09597b%40sessionmgr4004&vid=0&hid=4204 (accessed 2/12/2014) p.104
[570] D. S. Birdsell & L. Groarke, p.103

viewer of a particular point of view. [571] However, Groarke makes a case for suggesting that works such as Jacques Louis David's 1793 painting *The Death of Marat* (Fig. 4), and the political photomontages of John Heartfield, which in various ways portray the horrors of war and oppression, are valued in part for the arguments they convey. Groarke notes that in his work, David, as a proponent for the new French Republic, evokes the martyrdom of Christ in order to encourage high moral standards and patriotic self-sacrifice. [572] Whereas Heartfield elicits the notion of brutality and butchery in his 1933 image *Goering: The Executioner of the Third Reich* (Fig. 5), thereby alluding to the horrors perpetrated by the Third Reich during the Second World War.

Figure 4
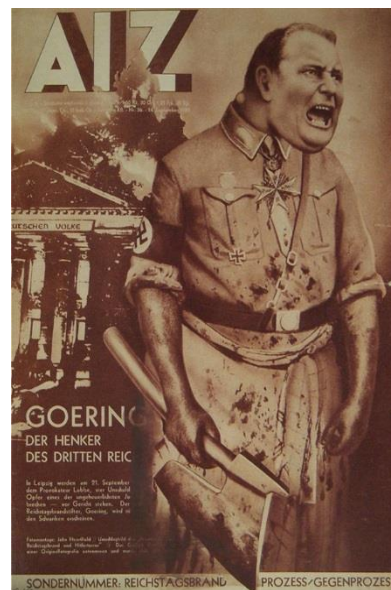
Figure 5

Context

In keeping with the previous accounts concerning the relationship of context to rhetoric, this study argues that context is an essential component in determining the meaning of rhetorical images. Jens Kjeldsen writes this is because, despite attempts by theorists such as Gunther Kress and Theo van Leeuwen, the nature of visual communication does not allow a proper vocabulary for meaning-making elements in

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[571] L. Groarke, 1996, p.118
[572] L. Groarke, 1996, p.120

images. [573] This means that because we cannot utilise verbal modes of reasoning within visual models, images only have a particular meaning in a specific context. Lester Olsen demonstrated the relationship of meaning to context in his examination of Benjamin Franklin's 1754 political cartoon *Join, or Die* (Fig. 6) within a framework of rhetorical iconology of the American Revolutionary era. [574] Franklin's image, depicting the American colonies as a fragmented serpent, was originally circulated in response to the French and Indian wars in an attempt to encourage unity of the British colonies. [575] The image was latter appropriated for the revolutionary cause, and in 1765 *Join, or Die* 'had come to symbolise colonial opposition to British law during a sustained intercolonial challenge to Parliamentary sovereignty'. [576] By comparing the same image within different contexts Olsen has argued that by changing contexts some images function differently. For example, Franklin's image initially represented the need for unity, whereas in a later context the image was used as an argument for separation.
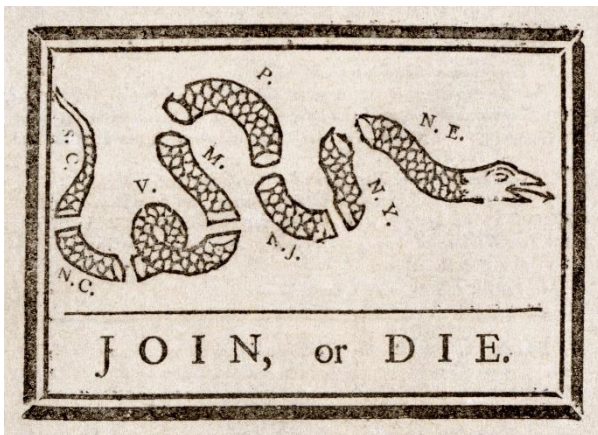

Figure 6

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[573] J. E. Kjeldsen, 'Virtues of visual argumentation: How pictures make the importance and strength of an argument salient', in D. Mohammed & M. Lewiński (eds.), *Virtues of Argumentation*, Proceedings of the 10th International Conference of the Ontario Society for the Study of Argumentation (OSSA), 22-26 May 2013, Windsor, pp.1-13 https://www.academia.edu/7632359/Virtues_of_visual_argumentation_How_pictures_make_the_importance_and_strength_of_an_argument_salient (accessed 15/10/2015) p.3

[574] [574] L. C. Olson, 'Benjamin Franklin's pictorial representations of the British colonies in America: A study in rhetorical iconology', *Quarterly Journal of Speech*, Vol.73, No.1, 1987, pp.18-42, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=7c3ef90e-03d3-461d-b6e1-ed51943174d6%40sessionmgr111&hid=109 (accessed 10/10/2015) p.18

Rhetorical iconology refers to the study of the methods by which advocates have utilised visual representations in attempts to enlist the will of an audience. central to rhetorical iconography are the 'ambiguities of appeals for agreement among people whose interests, concerns, values, feelings, and expectations may be in conflict

[575] L. C. Olson, 1987, p.25

[576] L. C. Olson, 1987 p.26

For rhetorical scholars the unstable meaning of images that is related to shifting contexts is problematic because it is difficult to determine issues such as origin and intention. Eric Jenkins explains that 'as images circulate, their meaning changes, prompting different identifications and affections', and this circulation 'continually alters situations and contexts by varying the rhetors, audiences, exigencies, and constraints'.[577] Yet the polysemic nature of images that results from changing contexts is frequently exploited, Benjamin Franklin's 1754 political cartoon is one case in point. A most noted example of exploitation due to changing context are Leonardo da Vinci's anatomical drawings. These works are more often identified as art rather than science, primarily because these images are often displayed within the context of art. For instance New York's Metropolitan Museum of Art hosted the 1984 exhibition *Leonardo da Vinci: Anatomical Drawings from the Royal Library, Windsor Castle*, which features a selection of Leonardo's anatomical studies.

Some scholars have addressed this characteristic of images by grounding them in a specific context. Which according to Jenkins might range from a specific rhetorical situation and a historical period to a cultural formation or epochal regime of power and knowledge. [578] Whereas other thinkers concede that such a practice masks the elasticity of rhetoric, suggesting that an alternative to the notion of the rhetorical situation might be useful. Catherine Chaput proposed a less restrictive rhetorical circulation model which would supplement rather than replace an existing rhetorical situation model. [579] Chaput holds that, although Bitzer's rhetorical situation requires knowledges that aids in understanding situations as well as knowledges that inform us about the best course of action demanded by those situations, this supplementary model connects rhetorical inquiries to multiple disciplinary knowledges by unhinging our fixed attachment to situations. [580] Consequently, images are no longer restricted by the strict definitions and histories of distinct fields of inquiry. In this way images

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[577] E. S. Jenkins, 'The Modes of Visual Rhetoric: Circulating Memes as Expressions', *Quarterly Journal of Speech*, Vol.100, No.4, 2014, pp.442-466, available from http://www.tandfonline.com/doi/pdf/10.1080/00335630.2014.989258 (accessed 27/10/2014) p.445

[578] E. S. Jenkins, p.444

[579] C. Chaput, 'Rhetorical Circulation in Late Capitalism: Neoliberalism and the Overdetermination of Affective Energy', *Philosophy & Rhetoric*, Vol.43, No.1, 2010, pp.19–20, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=2769e701-13c2-4557-bbf1-b07eb97f9545%40sessionmgr112&hid=109 p.21

[580] C. Chaput, p.21

not only have a different meaning in different contexts for different viewers, they also count as a form of knowledge to be circulated across the disciplines that include art and science. This model is best demonstrated through the concept of 'borrowing' the images from Vesalius 1543 anatomical atlas *De humani corporis fabrica* and placing them into new contexts such as museums of art and medicine as well as virtual spaces, thereby enabling wider access to the to the images by scholars from various disciplines. [581] Images such as those referred to as the 'muscle-men' (Fig. 7) have been circulated through various situations and as a consequence have been referenced by a range of scholars such as artists, scientists, historians and philosophers.
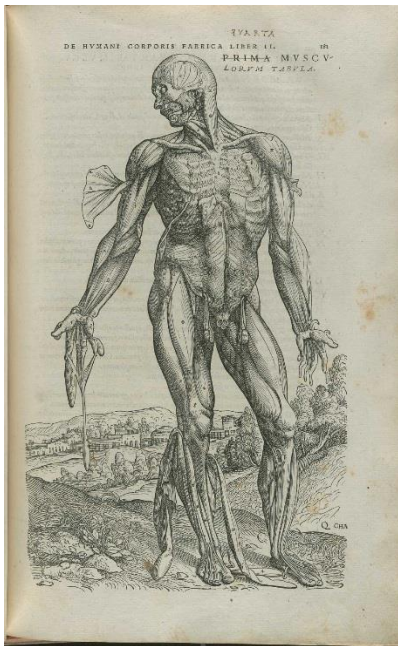
Figure 7

Referencing the work of W.J.T Mitchell, Janice Edwards proposes a contrasting view, whereby images are 'situated in historical, social, and cultural contexts and are deeply influenced by those contexts in their construction, uses, and interpretations.

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[581] Martin Kemp notes that the work, intended for medical scholars, was recommended reading for artists. Vesalius himself stated that the illustrations of the superficial muscles were designed in part to aid artists.
M. Kemp, in S. Lacey, 'Artistic Influences on Andreas Vesalius's 'De humani corporis fabrica libri septem' and Its Influence on the Arts in the Sixteenth and Seventeenth Centuries', *Doctus Artiflex*, 31 May, 2012, [web blog] http://sharonlacey.wordpress.com/2012/05/31/artistic-influences-on-andreas-vesaliuss-de-humani-corporis-fabrica-libri-septem-and-its-influence-on-the-arts-in-the-sixteenth-and-seventeenth-centuries/   (accessed 20/09/2013)

They are rhetorical texts in that they express and constitute cultural norms'. [582] In this way visual rhetoric is concerned with image making as well as viewer response.

Knowledge

In their third perspective of visual rhetoric Brian Ott and Greg Dickinson treat rhetoric as a way of knowing. Drawing on the work of Thomas Benson these theorists propose that visual rhetorics are not merely devices of persuasion but are also underlying forms that make thought possible. [583] This perspective of visual rhetoric is based in the concept of logic which is widely reported to concern the issues of cognition and perception. This is understood to occur because images shape both what we see and how we see. Therefore, according to a perceptual and cognitive account seeing is creative; selective; spatial; and contextual. [584] For Petra Aczél seeing is also figurative as it is 'the resource and the reinforcement of conceptual metaphors and the regulator of the rhetorical figures and their envisioning'. [585] In this instance visual rhetoric concerns both the logic of seeing and the processes of cognition.

According to Robert St Clair the relationship of visual rhetoric to knowledge is frequently expressed through the visual metaphor. [586] The visual metaphor is described as one of the most familiar rhetorical devices and generally refers to the depiction of one thing in terms of another. However, the visual metaphor differs from both a diagram and an image. That is, diagrams exhibit structures analogous to their objects, but not their substance, in contrast an image resembles its object by mimicry, 'by partaking of some of the simple qualities of the object, their substance'. [587] Whereas the metaphor, which is established by convention, draws parallels between concepts rather than between objects. [588] As a conceptual structure metaphors are

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[582] J. L. Edwards, 2009, p.224

[583] B. L. Ott, & G. Dickinson, p.398

[584] B. L. Ott, & G. Dickinson, pp.398-399

[585] P. Aczél, p.336

[586] R. N. St Clair, 'Visual Metaphor, Cultural Knowledge, and the New Rhetoric', in J. Reyhner, J. Martin, L. Lockard & W. S. Gilbert (eds.), *Learn In Beauty: Indigenous Education for a New Century*, Northern Arizona University, Flagstaff, 2000, p.85 Metaphors are statements based on some kind of analogy where two things are compared to each other. This use of language allows knowledge to be seen in a new perspective. Visual metaphor is a term that designates how visual space is organised as a means of sharing cultural and social knowledge

[587] R. N. St Clair, 'Metaphorical Blends, Recruited Frames and Metaphors across Cultures', *Intercultural Communication Studies,* Vol.11, No.3, 2002, pp.1-24, available from http://web.uri.edu/iaics/files/01-Robert-N.-St.-Clair.pdf (accessed 10/10/2015) p.6

[588] R. N. St Clair, 2002, p.7

employed to construct argument and advance understanding. In science the metaphor is used in areas such as in theory building where there is a gradual metaphorical process of segmenting knowledge. For example, the illustrative metaphor 'the atom is like a solar system' demonstrates how metaphor serves to illustrate the way in which concepts are seen and understood. According to St Clair this model:

> *[It] has a nucleus just as the sun is the solar system's nucleus. It has electrons whirling around that nucleus just as the sun has planets circling around it. With the passage of time, this global view comes to be more fully articulated, the details are filled out, and what was once a simple plan for the structuring of knowledge soon emerges as an iconic metaphor, a description picturing events in photographic detail. [589]*

In this way visual rhetoric functions as a means of practical reasoning rather than merely as a means of persuasion. St. Clair's use of the visual metaphor has emphasised the expanded description of rhetoric that is 'now concerned with epistemology as a way of knowing' in that the 'new rhetoric is used to discover and understand knowledge'. [590] The increasing prominence of images in everyday life is paralleled by the need for an expansion in understanding visual rhetoric as a field of inquiry. For this reason Ott and Dickinson identify three specific tactics for treating visual rhetoric as critical pedagogy, these include exercise visual literacy, problematize visual imagery, and contextualise visual rhetoric. [591] The aim of such strategies is to encourage an engagement with images rather than remain a passive consumer.

4.5: Summary

The increase in scholarly and critical interest in this field of inquiry has exposed several issues that are relevant to this thesis. These issues relate to the multidisciplinary nature of the topic and the context in which the debates that concern relationships between the various concepts are framed. This conceptual

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[589] R. N. St Clair, p.87
[590] R. N. St Clair, p.87
[591] B. L. Ott, & G. Dickinson, p.401

framework has attempted to demonstrate that the concepts; 'art and science', the 'image', and 'visual rhetoric' do not exist in vacuums. Historically they have been linked to and influenced by philosophical, cultural and technological developments that have often resulted in diverse societal transformations. This framework has provided the avenue in which chapters five and six explore the notion of the image-maker as rhetor whereby the image is the site in which knowledge is shaped in order to construct and transmit meaning.

Chapter 5:

Illustration & Illumination: Making Visible

5.1: Establishing Focus

5.1.1 Image-maker as Rhetor

The aim of this chapter is to address the research questions that guide this study through the conceptual frameworks established in the previous chapter. This will be accomplished by considering how images function as communicative devices in scholarly inquiry. This chapter therefore concerns the way in which images, which are constructed in the pursuit of both scientific and artistic inquiry, not only function as a system of communication, but also how this system functions differently in art than it does in science. This means that even though images are frequently utilised by both artists and scientists to present argument and construct meaning, these two disciplines have a different relationship with visual rhetoric. This is despite the notion that the borders between art and science are deemed permeable, such differences also take into account the notion that images, like knowledge, disregard boundaries.

There are various ways of producing and consuming knowledge. However in contrast to traditional concepts of knowledge, which focus on the word, this study has privileged the image; both as the mechanism for and as the product of knowledge. This is because art and science are generally presented and understood in terms of their product, and for this study the 'product' refers to the images that have resulted from artistic and scientific research. [592] For this reason this study proposes that image-makers are significant to the production of knowledge; thereby highlighting the links between image and knowledge as well as the links between

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[592] In their essay 'Art and Science as Creative Catalysts', presented at the IEEE VIS, Conference in 2013, Eleanor Gates-Stuart, Chuong Nguyen, Matt Adcock Jay Bradley, Matthew Morell and David R. Lovell argued that Science and Art are generally presented and understood in terms of their *products*,

theory and practice, and thus the links between making and thinking. Rather than subscribe to the idea of a theory-practice gap, this study adopts the Aristotelian notion that techne is a form of knowledge that involves theoretical understanding, in addition to the argument proposed by Albrecht Dürer that productive knowledge, or the knowledge of the maker, has the same authority as theoretical knowledge. [593] This study therefore suggests that because images are the product of a knowledge making process, images are therefore sites of intellectual inquiry.

Images are used to explore and interpret science in various ways. They also provide tangible evidence of an association between art and science that has had a long and extensive existence, both in practice and in the literature. These images demonstrate to a wider audience the difference between artistic knowledge and scientific knowledge, as well as the various ways in which these different forms of knowledge is communicated. This visual mode communication involves the articulation of artistic and scientific concepts in addition to an art's interrogation of scientific concepts. For both artists and scientists visual media is perceived as system of meaning-making in which the image functions to produce, express, contain and convey concepts. Contemporary scholars of both traditions are engaging with visual imagery in the recognition that the visual is a powerful and effective means of communicating information. [594] By conceptualising the image-maker as rhetor this chapter proposes that visual rhetoric, the process of visually shaping knowledge as a means to construct and transmit meaning, is deeply entrenched in art and in science. This proposal is supported by an extensive range literature showing that the practice of image-making for the purpose of communicating artistic and scientific concepts has a long history. The notion of image-maker as rhetor has been proposed by both Lucy Freedman Sandler and Kathryn Northcut who propose that images are created in order to effect a desired outcome in the viewer. [595] For these scholars the primary role of the image-maker concerns the production and communication of knowledge.

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[593] Aristotle's notion that techne is grounded in account and therefore constitutes theoretical understanding is located in R. Parry, 2008:
Albrecht Dürer's position on knowledge was argued in P. H. Smith, 2006, p.95
[594] J. Elkins, 1999, pp.4-5
[595] L. F. Sandler, 'Rhetorical strategies in the pictorial imagery if fourteenth-century manuscripts: The Case of the Bohun psalters', in M. Carruthers, (ed.), *Rhetoric Beyond Words: Delight and Persuasion in the Arts of the Middle Ages*, Cambridge University Press, Cambridge, 2010, p.99

Rhetoric, and visual rhetoric in particular, has been problematic for science because science has claims to objectivity, whereas rhetoric has long been associated with 'meaning' and 'interpretation'. However, John Lyne suggests that the task for rhetoric is to go beyond interpretative understanding, namely:

> *In guiding the creation of discourses, and not just the interpretation of existing texts, the work of rhetoric is to invent language strategies that bring about change. To address a discourse community in the role of the inquirer is actively and selectively to extend understanding by means of persuasion – by a rhetoric that lays a path from accepted beliefs to proposed ones.*[596]

Although all data, including graphs medical imaging and photographs, concern interpretation, scholars argue that artists and scientists accept different levels of interpretation. For instance, Catherine Allamel-Raffin notes that in art studies a plurality of meanings would be socially accepted, whereas natural science scholars seek a single meaning that would be acceptable to the whole scientific community.[597] Consequently, the 'unstable' characteristic of images is less concerning for art than for science because there are differences in the communicative concerns of scientists and artists. Yves Klein for example, sought to communicate his rejection of the brush and has abandonment of the pictorial through works such as the *Large Blue Anthropometry* (Fig. 8). This image, created in 1960, forms part of Klein's *Anthropometries* Series, which as Allamel-Raffin notes, were created through a technique that utilised naked female models covered with blue paint and dragged across or laid upon canvases, resulting in the models being utilised as 'living brushes'. [598] These works continue to attract multiple interpretations, ranging from a 'testimony of the survival and the immaterial permanence of the flesh' to 'an

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Lucy Freedman Sandler pointed to the rhetorical role of the creators of the pictorial imagery in the fourteenth-century manuscripts - 'the artist-as-rhetor, that is, as producer/creator/inventor of an effect of the user of the book'.
K. M. Northcut, 'The Making of Knowledge in Science: Case Studies of Paleontology Illustration', PhD Thesis, Texas Tech University, Lubbock, 2004, available from
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.475.6719&rep=rep1&type=pdf (accessed 24/02/2014) p.13
Kathryn Northcut's 'Producers as Rhetors', referred to the image-makers who produced images for the purposes of communicating paleontological knowledge.
[596] J. Lyne, 'Bio-Rhetorics', in H. W. Simons (ed.), *The Rhetorical Turn: Invention and Persuasion in the Conduct of Inquiry*, The University of Chicago Press, Chicago, 1990, p.37
[597] C. Allamel-Raffin, 'Interpreting Artworks, Interpreting Scientific Images', *Leonardo*, Vol.48, No.1, 2015, pp.76-77, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=84580a25-bcc8-4a03-9884-fa49b7f9f1b6%40sessionmgr112&vid=0&hid=101 (accessed 2/2/2016) p.76
[598] C. Allamel-Raffin, p.76

expression of the exploitation of the female body'. [599] Such works also reinforce the notion that in contrast to science, which aims at closing meaning through abductive reasoning, the aim of art is for meaning to remain open through the utilisation of analogy. [600] To this extent a work of art such as Klein's *Anthropometries* are open to multiple irreducible meanings, whereas a scientific image is concerned with definition of description. For Ken Arnold this difference is significant because science is judged by its capacity to unambiguously communicate the logic of its argument, in contrast, artists 'tend to insist that the visual products they create stand or fall on their own.' [601] From this account artworks sit more comfortably with rhetoric because rather than certainty and accountability, images are associated with multiple perspectives and interpretation.

Figure 8

The image-makers explored in this chapter belong to a tradition of image-makers who work with science. This tradition extends from artisans, whose work was significant in communicating the early scientific ideas of the natural world, to contemporary artists who document how science interacts with the natural world. This documentation includes images that portray both the actual and the possible outcomes of such interactions. The significance of visual representation to scientific inquiry is noted in the work of scholars that includes among others, Martin Kemp,

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[599] C. Allamel-Raffin, p.76
[600] C. Allamel-Raffin, p.77
[601] K. Arnold, 'Between Explanation and Inspiration: Images in Science', in S. Ede (ed.), *Strange and Charmed: Science and the Contemporary Visual Arts*, Calouste Gulbenkian Foundation, London 2000, pp.68-69

Michael lynch and Bruno Latour, Loraine Daston, Peter Galison and Caroline Jones. These works examine a range of artistic and scientific perspectives concerning the value of visual depictions of science. According to Janice Neri the conclusions reached in attempting to understand such examinations vary 'from the ultimate failure of images as a means of knowing nature to the paradoxical imbrication of science and the imagination.'[602] Luc Pauwels, for example, suggests that the value of visual representations in science is in part judged by their functionality of filling gaps in our knowledge, or facilitating knowledge building or transfer. [603] Pauwels' concerns are expressed from a science perspective, however, these concerns reflect the widely held conviction that 'knowledge production' is more generally associated with the work of the scientist than that of the artist. And, while traditional paradigms assume that the transmission of knowledge moves linearly from scientist down to artist, there is a call to investigate new models where the flow of knowledge is reciprocal and dialectical. [604] This proposal mirrors recent scholarship which demonstrates that science is just one among a range of activities characterised by the creation and use of knowledge.

This chapter will firstly provide the structure which establishes the image-maker as rhetor by outlining the concepts related to this role. This is followed with a two part examination of the role of the image-makers and their association with science. The first part concerns the artisan's role in the communication of early scientific concepts. The second part involves contemporary artists and the ways in which they are engaging with the concepts of science. This chapter concludes with a discussion concerning the image as the site of understanding and a site of intellectual engagement between art and science.

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[602] J. Neri, p.xvi
[603] L. Pauwels, 'Introduction: The Role of Visual Representation in the Production of Scientific Reality', in L. Pauwels (ed.), *Visual Cultures of Science: Rethinking Representational Practices in Knowledge Building and Science Communication*, Dartmouth College Press, Hanover, 2006, p.viii
[604] P. H. Smith cited in S. Dackerman (ed.), *Prints and the Pursuit of Knowledge in Early Modern Europe*, Harvard Art Museums, Cambridge, 2011, p.34

5.1.2 Visual Rhetoric: Making and Thinking

5.1.2 (i) Rhetoric as techne

The notion that rhetoric is a form of techne was advanced by Aristotle when the philosopher wrote that rhetoric involved practical and productive knowledge. [605] A key characteristic of Aristotle's techne is that each form of techne is a specialised type of knowledge. For example, the craft of shipbuilding is a specialised form of knowledge known only to a ship builder. According to James Herrick 'a techne must first have as its domain concerns not addressed by other arts'. [606] From this account rhetoric is a specialised form of knowledge because the domain of rhetoric, which is discovering the 'available means of persuasion', is not a function of any other art. By way of explanation the goals of a 'true art' such as rhetoric, cannot be accomplished by any other art. [607] As Aristotle put it; '[E]very other art can instruct or persuade about its own particular subject matter; for instance, medicine about what is healthy and unhealthy, geometry about the properties of magnitudes, arithmetic about numbers, and the same is true of the other arts and sciences.' [608] In this way the art of rhetoric is determined through distinctive methods and practices which according to the Aristotelian scheme of knowledge can be studied and taught. Consequently, a student of rhetoric must study the available means of persuasion, these means have been identified as the three artistic proofs or appeals. [609] It is through the discovery of these proofs that a rhetorician has the faculty to firstly understand the reasoning employed in practical decision making; then to realise that emotions are rational responses to certain types of circumstances and arguments, and finally to understand that the potential for persuasion concerns the rhetor's character and credibility. [610]

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[605] J. M. Atwill, *Rhetoric Reclaimed: Aristotle and the Liberal Arts Tradition*, Cornell University Press, Carbonale, 2009, p.x
[606] J. A. Herrick, p.75
[607] J. A. Herrick, p.75
[608] Aristotle, 1924, 1355b
[609] Aristotle*, On Rhetoric: A Theory Of Civic Discourse* (2nd edn.), trans. G. A. Kennedy, Oxford University Press, Oxford, 2007, 1356a
non-artistic proofs are meant proofs not supplied by the rhetor - laws, contracts, admissions under torture – they are useful in argument but are not part of the study of rhetoric
For Aristotle, the means of persuasion, or *pisteis,* concerns either non-artistic or *atechnic* proofs, which are pre-existing and therefore not provided by the rhetor, and artistic or *entechnic* proofs which are created by the rhetor; this means 'one must use the former and invent the latter'.
In Aristotelian rhetoric *entechnic pisteis* consist of logos, pathos, and ethos.
[610] J. A. Herrick, pp.82-84

Thus, the faculty of discovering proofs for the purpose of persuasion is the hallmark of a skilled rhetor.

The notion of rhetoric as productive knowledge that is concerned with the art of making is described through the doctrine of the 'four causes', whereby Aristotle's theory of causality provides an avenue to explain the means and rationale by which persuasion is bought into existence through the actions of a maker. [611] In the 2010 essay focusing on craft knowledge and rhetoric, Robert Johnson writes that for Aristotle the 'four causes' were representative of the whole of techne as 'it is only when the human maker can bring all these causes together, that the craftsperson possesses the appropriate techne (knowledge of the particular art) to create useful products and not only material artefacts, but discursive products, too, as in the case of rhetoric'. [612] Consequently, when one describes rhetoric as a techne, one is describing a specialised type of knowledge that involves a maker who brings into existence a product through the activity of that maker. Beyond the product itself the concept of use is an important aspect of the four causes. Johnson argues that the product is inert until it is put to use, as such 'techne and the art of making have two ends (telos)'. [613] Aristotle's theory of causality is significant to this study because this theory provides the means by which to understand the effective utilisation of the rhetorical appeals as a means of persuasion.

An examination of the use of appeals in visual rhetoric reveals many assumptions, such as the notion that scientific discourse is heavily reliant on logos as well as the idea that artists effectively utilise pathos to appeal to an audience. Yet, Kathryn Northcut suggests that:

> *[T]o privilege logos automatically would threaten to demote the*

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[611] The four causes provide an explanation of how, when, what and why knowledge is productive. According to Robert Johnson the concept of the four causes are found throughout Platonic and Aristotelian corpuses as a way to describe theories of human procedures and the making of things – the causes (aitiai) are; the efficient (arche), the material (hule), the formal (eidos), and the end or final (telos).

[612] R. R. Johnson, 'Craft Knowledge: Of Disciplinarity in Writing Studies', *College Composition and Communication,* Vol.61, No.4, 2010, pp.673-690, available from http://www.jstor.org.ezproxy.usq.edu.au/stable/pdf/27917868.pdf?acceptTC=true (accessed 20/10/2015) p.676
Aristotle explains in the Metaphysics
[The] causes are spoken of in four senses. In one of these we mean the substance, i.e., the essence (for the "why" is reducible finally to the definition, and the ultimate "why" is a cause and principle); in another the matter or substratum, in a third the source of change, and in a fourth the cause opposed to this, the purpose and the good (for this is the end of all generation and change).

[613] R. R. Johnson, p.677

invention process of the artist and promote a simplistic role for the illustration regardless of how it came to be. The risk is to suggest that the image is a rational representation of reality, objective, verifiable, and noncontroversial. . . To closely associate the work of the artist with pathos might be problematic, as the commonplaces, or topi, of science [. . .] specifically privilege unemotional handling of ideas. For example, scepticism is a value privileged in scientific discourse, rather than being seduced by ideas or interpretations. Thus the preferred way to appeal to an audience is through dialect-discussion- rather than immediate adherence to unconsidered claims. Ethos is an example that holds much promise for research about possible links between illustrations and rhetorical appeals. The degree to which an audience develops trust in the images and the arguments set forth by the images may be based on elements of the compositions, the audience's understanding of the collaborators involved in the production process. . . [614]

Here Northcut has utilised Aristotle's theory of causality to explain the complexities involved in communicating the visual concepts of paleontology. These complexities arise because the work of artists such as La Gina Fairbetter involves theoretical evaluation of both the subject and the process of image production itself. [615] Thus, the works that portrayed paleontological flora and fauna were not only a practical and productive form of knowledge that functioned to visually transmit scientific concepts, but they are also theoretical knowledge which serve to argue art's claim as a credible form of inquiry; because according to Aristotle these images as techne are grounded in theoretical understanding.

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[614] K. M. Northcut, pp.112-113
[615] K. M. Northcut, p.111

5.1.2 (ii) Rhetoric: the art of scientific inquiry

The concept of techne has been adopted by various contemporary scholars as a framework to explore rhetoric as a process of scientific inquiry. Chad Wickham for example proposed that:

> [T]he Aristotelian concept of techne, and the four causes in particular, can be used to conceptualize scientific practice as a productive technical art and thereby locate rhetoric in the actual production of artefacts, including visual inscriptions and texts, as they emerge out of scientists' complex interactions with a range of material, technical, and symbolic resources in the process of inquiry. [616]

This approach concerns both knowledge production and dissemination of that knowledge and involves scientific procedures and products as well as the visual representations of the inquiry. Wickham suggests that theorising the role of techne in these practices emphasises the technical means by which scientists intervene in the natural world as well as the representational means by which they generate meaningful accounts and thus bring-forth new findings that result in new knowledge. [617] For this study the means of representation refer to the visual images that are employed as both a process of inquiry and as a mode of representing the results of that inquiry. In Wickman's view the technical and the rhetorical begin to merge when the scientist, as the possessor of specialised knowledge, can both bring forth new findings and explain how and why that end was achieved in the light of existing knowledge. [618] In this way Aristotle's concept of techne, which concerns the creation of images that emerge as the result of scientific processes, offers the basis for locating scientific inquiry as a productive art.

Images are becoming increasingly significant to science, and although the context may vary, images primarily function as meaning-making devices in the production and representation of scientific knowledge. This is not a new practice because

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[616] C. Wickman, 'Rhetoric, Technê, and the Art of Scientific Inquiry', *Rhetoric Review*, Vol.31, No.1, 2012, pp.21-40, available from http://www-tandfonline-com.ezproxy.usq.edu.au/doi/pdf/10.1080/07350198.2012.630953 (accessed 04/06/2015) p.23
[617] C. Wickman, p.24
[618] C. Wickman, p.27

scientists have long employed visual elements such as symbols, notations, and images, so as to persuade the reader of the credibility of such research. Galileo Galilei's wash drawings of the moon, for example, were provided as evidence of his scientific observations which served to challenge the prevailing thinking of the times. According to Jeanne Fahnestock any rhetorical analysis of drawings such as Galileo's takes into account the persuasive effects of visuals since they are so important in the effectiveness of scientific arguments. [619] However, because this study aims to establish how images persuade, it is not sufficient to merely describe these images as rhetorical. This issue also concerned Charles Hill who asked 'how do representational images work to influence the beliefs, attitudes, opinions and sometimes actions of those who view them?' [620] Understanding how images function as argument is significant as it involves both the way in which persuasion occurs, which in part concerns the aforementioned four causes, as well as the epistemic value of the process of persuasion itself. Consequently, images, as the product of non-discursive practices which determine how scientific culture and meaning is reflected and communicated, need to be understood as persuasive rhetorical objects as well as epistemic processes.

Even though rhetoric has an uneasy relationship with science it has long been employed to argue the value of scientific research. For Robert Hooke rhetoric served two purposes. The philosopher utilised both verbal and visual rhetoric as a means to argue the existence of previously unknown phenomena. These strategies also served to persuade others of the worthy pursuits of natural philosophy. Hooke's 1665 *Micrographia* is believed to be the first publication to illustrate phenomena of the microscopic world. Although contemporary science is replete with visual images, Allan Chapman claims the 'tradition of visual communication in science largely begins with Hooke's *Micrographia*'. [621] In Jordynn Jack's view *Micrographia* holds also an important place in the history of scientific rhetoric, primarily because the text functions in a rhetorical framework that instructs readers how to view images in

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[619] J. Fahnestock, 'The Rhetoric of the Natural Sciences', in A. A. Lunsford, K. H. Wilson & R. A. Eberly (eds.), The SAGE Handbook of Rhetorical Studies, SAGE Publications, Thousand Oaks, 2009, p.188

[620] C. A. Hill, 'The Psychology of Rhetorical Images', in C. A. Hill & M. Helmers (eds.), *Defining Visual Rhetorics*, Lawrence Erlbaum Associates, London, 2004, e-book, Taylor & Francis e-Library 2008, p.25

[621] A. Chapman, *England's Leonardo: Robert Hooke and the Seventeenth-Century Scientific Revolution,* Institute of Physics, Bristol, 2005

accordance with an ideological or epistemic programme. [622] In other words, 'Hooke not only taught his readers how to view a new kind of image, but he also recruited potential contributors to the program of natural philosophy'. [623] In keeping with the work of Chad Wickman, the images that constituted the *Micrographia* emerged from Hooke's interactions with the microscope and as such were evidence of a new productive science. Thereby confirming the objectives of the newly formed *Royal Society of London* which, for natural philosophers, was to generate new accounts based on their own observations and experiments.[624] Such accounts were viewed by the *Society* as contributing to the generation of new empirical evidence. In addition to its rhetorical function of helping viewers see these images within cultural and epistemological context *Micrographia* functioned as a 'virtual witness' to experimental science for the *Society*. [625] Hooke brought the previously unseen and therefore unknown into existence through his actions as an image-maker. The natural philosopher also made the objects of his discoveries, such as the cellular structure of plants (Fig. 9) visible to the viewer, thereby inviting the viewer to experience the object for themselves.

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[622] J. Jack, 'A Pedagogy of Sight: Microscopic Vision in Robert Hooke's Micrographia', *Quarterly Journal of Speech*, Vol.95, No.2, 2009, pp.192-209, available from
http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=521ef4ca-4683-4bd4-abe6-409bc5779c6c%40sessionmgr198&hid=105 (accessed 09/07/2015) p.192
Common to early scientific writing. Hooke frequently advances the notion that the intricate workings of minute objects are evidence of divine creation*in order to reconcile his scientific findings with the dominant Christian Religion. p.201
[623] J. Jack, p.192
[624] J. Jack, p.194
[625] J. Jack, p.205
The term 'virtual witnessing' was coined by Stephen Shapin and Simon Shaffer in the 1985 publication *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Lif*e.
The technology of virtual witnessing involves the production in a reader's mind of such an image of an experimental scene as obviates the necessity for either direct witness or replication. Through virtual witnessing the multiplication of witnesses could be, in principle, unlimited. It was therefore the most powerful technology for constituting matters of fact. The validation of experiments, and the crediting of their outcomes as matters of fact, necessarily entailed their realization in the laboratory of the mind and the mind's eye. What was required was a technology of trust and assurance that the things had been done and done in the way claimed. p.60
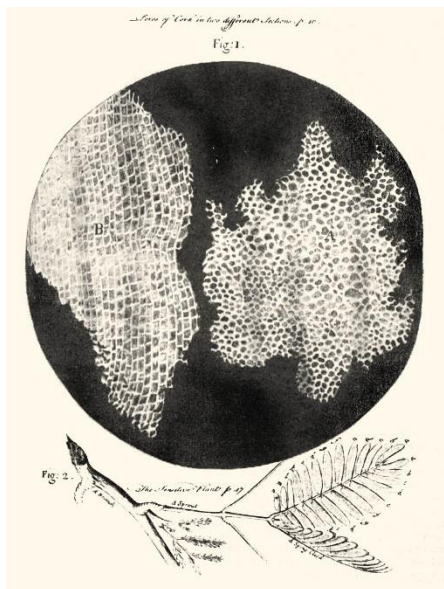
Figure 9

Micrographia accomplished its virtual witnessing through the rhetorical figure of 'enargia', or vivid description, whereby viewers were persuaded of the significance of microscopic sights against the limitations of the naked eye. [626] The concept of enargia refers to the ability to 'make things visible' and is frequently associated with the rhetorical proof, pathos. According to Ruth Webb a successful rhetor could achieve enargia through the use of mental images, in that the ability to 'place before the eyes' is a vital skill if the rhetor wishes to harnesses the power of the imagination. [627] By creating images through the assistance of the microscope Hooke was able to engage the viewers' imagination and persuade them of the existence of an inner world. Therefore, the viewers of the *Micrographia* came to accept the microscopic view as a visual truth.

5.1.2 (iii) Rhetoric: a frame for artistic inquiry

During the Renaissance there was a renewed interest in a scholastic system based in language which included rhetoric and logic. Matthew Rampley suggests this renewed interest included the expansion of rhetoric to include the visual as well as the verbal,

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[626] J. Jack, p.195
Enargia – is variously spelt *enargia/enargeia* and refers to a powerful vivid description that recreates something or someone 'before the eyes'
[627] R. Webb, *Ekphrasis, Imagination and Persuasion in Ancient Rhetorical Theory and Practice*, Ashgate, Farnham, 2009, p.88

even though the links between image and discourse has been central to the understanding of visual art since antiquity. [628] Consequently, images have long been recognised as a medium for communication. For example, from the twelfth century visual art was referred to as the 'literature of the lay people' because images functioned to disseminate biblical narratives and Christian morality to a largely illiterate congregation. [629] In this instance visual rhetoric was an effective substitute for verbal rhetoric and, rather than be considered a rhetorical process, these images were deemed a rhetorical product. As it were, the visual as a product served as multimodal speech in that it had replaced the verbal in order to produce persuasive influential messages. [630] Visual art therefore held a privileged position and its communicative power was dependent upon the rhetorical skill of the image-maker.

According Brian Vickers rhetoric offered the only complete and integrated communication system during this time.[631] Hence, theories concerning the visual arts were informed by concepts and structures from the art of rhetoric. This is noted by Glenn Ballard and Lauri Koskela who write that Alberti'*s De Pictura,* the most influential guide to criticism of the visual arts during the renaissance, is modelled on Quintilian's *Institutes of Oratory* and Cicero's *De Oratore*. [632] Alberti utilised the theories of rhetoric to argue that painting, a mechanical art, should be of equal significance to the liberal arts which during the Renaissance included mathematics. Accordingly, Raymond Quek contends that rhetoric provided the means by which visual artists attempted to elevate the status of visual forms of expression as abstracted knowledge to the point of equity with non-visual senses of knowledge. [633] Quek's essay is based on the rhetorical canon of invention however scholars, including the aforementioned Kathryn Northcut, have demonstrated that the five

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[628] M. Rampley, p.134
[629] M. Rampley, p.134
[630] P. Aczél, p.336
[631] B. Vickers, in G. Ballard & L. Koskela, 'Rhetoric and design', Presentation Paper, ICED 13: 19th International Conference on Engineering Design, Seoul, 19-22 August, 2013, pp.1-10, available from http://eprints.hud.ac.uk/25190/1/Koskelaiced.pdf (accessed 20/10/2015) p.4
[632] G. Ballard & L. Koskela, 'Rhetoric and design', Presentation Paper, *ICED 13: 19th International Conference on Engineering Design*, Seoul, 19-22 August, 2013, pp.1-10, available from http://eprints.hud.ac.uk/25190/1/Koskelaiced.pdf (accessed 20/10/2015) p.4
[633] R. Quek, 'Excellence in Execution: Disegno and the parallel of eloquence', *Working Papers on Design,* Vol.4, 2010, pp.1-19, available from https://www.herts.ac.uk/__data/assets/pdf_file/0011/12404/WPD_vol4_quek.pdf (accessed 20/10/2015) p.3

canons of rhetoric as well as Aristotle's proofs provide the means by which to challenge the notion that knowledge can only be argued verbally.

Scholars continue to draw on the terminology and strategies of rhetoric for the purposes for artistic research. Joan Mullin for instance suggests that:

> the 'canons of rhetoric' - invention, arrangement, style, memory and delivery – are a basis for examining . . . art productions, and articulate persuasive appeals that a communicator uses: logos (arrangement, placement of marks on a background), ethos (the believability of the 'author') and pathos (the emotional impact and response to the marks because of their believability).[634]

This understanding of rhetorical strategies provides the artist with the tools by which to articulate their practice as well as emphasising the artist-viewer relationship. To this extent visual rhetoric involves not only the artist's cultural perspectives but those of the viewer. A focus on the reception by viewer involves a reading of the picture that is determined by the success of the rhetorical appeals (logos, ethos, pathos), in addition to what these 'readers' bring to the piece. [635] Marguerite Helmers provides an account of viewer reception through her rhetorical unpacking of Joseph Wright of Derby's 1768 work *An Experiment on a Bird in the Air Pump*. Here, Helmers argues that 'visual images are construed not as capable of argument but as invested with the ability to offer audiences propositions', specifically '*visual rhetoric* is a frame of analysis for looking and interpreting'. [636] From this view one of the roles of rhetoric in the visual arts is to determine how the images themselves are carriers or meaning.

Described as a candlelight scene that was typical of the times, *An Experiment on a Bird in the Air Pump* (Fig. 10) depicts the advances of experimental science through figurative conventions such as metaphor and allegory which were previously reserved for historical and religious works. The persuasive power of the work depends on the effective use of the rhetorical appeals which were introduced by

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[634] J. Mullin, 'Rhetoric: Writing, Reading and Producing the Visual', in M. Biggs & H. Karlsson (eds.), *The Routledge Companion to Research in the Arts*, Routledge, London, 2011, p.158
[635] J. Mullin, p.156
[636] M. Helmers, 2008, p.64-65

Aristotle in his text *Rhetoric.* [637] In this work Wright had utilised the mechanisms of rhetoric so as to provide a platform for the development of complex visual competencies within the notions of the scientific world. Petra Aczél suggests this approach locates visual rhetoric as a procedure, which involves the notion that 'images are underlying forms of our thinking and that the pictures are created as a visual mode comprising visual logic and intelligence'. [638] Consequently, visual rhetoric as a procedure concerns the logic of seeing whereby visual thinking involves the utilisation of rhetorical practices.

Figure 10

In Wright's work the subject of science and the realism of the technique function to create what classical rhetoric would identify as an appeal to the emotions, or pathos. [639] This emotional appeal transcends Wright's own time whereby 'audience members would have seen the Author of all (God) working in and through the machine, and would have experienced the emotional response sanctioned by Edmund Burke's ideas on the sublime: the overpowering sensation of awe in the face of God's work', to a

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[637] For Aristotle there are three means of effecting persuasion, whereby 'the man who is to be in command of them must, it is clear, be able (1) to reason logically, (2) to understand human character and goodness in their various forms, and (3) to understand the emotions-that is, to name them and describe them, to know their causes and the way in which they are excited'. Aristotle*, Rhetoric*, trans. Roberts, W., R., An Electronic Classics Series Publication, available from http://www2.hn.psu.edu/faculty/jmanis/aristotl/Aristotle-Rhetoric.pdf p.9

[638] P. Aczél, p.337

[639] M. Helmers, 'Painting as Rhetorical Performance: Joseph Wright's An Experiment on a Bird in the Air Pump', *JAC: Journal of Advanced Composition*, Vol.21, No.1, 2001, pp.71-95, available from http://www.jaconlinejournal.com/archives/vol21.1/helmers-painting.pdf (accessed 30/07/2014) p.76

contemporary response in which experimentation and technology are seen as capable of mass destruction, supplanting the awe reserved for the divine with a sense of revulsion. [640] Works such as Wright's serve to illustrate the centrality of the viewer to visual rhetoric, in that viewer response is dependent upon perception and reception of the image as well the notion that the meaning of an image changes when viewed from different cultural perspectives.

As Helmers explains, 'prior knowledge and the context of viewing the object will condition perception. Reception depends not only on emotion and structures of feeling, but also on the framing devices and cultural expectations being created by the area of display'. [641] The ways of looking and interpretation therefore involve the notion of spectatorship such as concerns both the issue of context and the different types of viewer. [642] Drawing on the work of Lynne Pearce, Helmers describes two types of readers of art; the 'naïve viewer,' and the 'knowledgeable viewer'. The naïve viewer, one whose primary interest is in representational content, has the capacity to form an individual interpretation because this viewer is 'technically illiterate', whereas the 'knowledgeable' viewer who is versed in technical conventions of paintings is enslaved by interpretative explanations. [643] Such issues are important to this study because visual artists, as the documenters of cultural change, utilise rhetorical tools such as analogy and metaphor to both reflect and reinterpret science. This type of documentation occurs in areas that range from the experimentation with the physical properties of light, reflected in the imagery produced by Chris Henschke, to the preservation of human habitation in hostile environments, which is the focus of the work of Stephen Eastaugh. The work of these image-makers is discussed as part of this chapter's second inquiry concerning the methods by which artists engage with the concepts of science.

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[640] M. Helmers, 2001, p.76
[641] M. Helmers, 2008, p.84
[642] For W. J. T Mitchell, spectatorship involves all social practices of display and included both scientific and artistic modes of inquiry, 'Showing seeing: a critique of visual culture', *Journal of Visual Culture,* Vol.1, No.2, 2002, pp.165-181, available from http://www9.georgetown.edu/faculty/irvinem/theory/mitchell-showingseeing.pdf (accessed 22/02/2013) p.166
Drawing on the work of Lacan, Marita Sturken & Lisa Cartwright, relate spectatorship to the 'concept of the gaze' arguing that they remain cornerstones of visual studies because they provide a set of terms and methods by which to consider some aspects of looking practices. *Practices of Looking: An Introduction to Visual Culture*, Oxford University Press, New York, 2001, p.102
[643] M. Helmers, 2008, p.66

5.1.3 Visual Rhetoric: Strategy for Communication

Because of the complexity of contemporary communication, theorists argue that verbal modes of discourse are no longer the defining elements of literacy. Theorists are pointing to an increasing reliance on a multi-literate society whereby literacy is discussed in multiple ways. Scholars such as Ed Nagelhout are currently discussing literacy in terms of the visual, the rhetorical, and the informational. [644] Drawing on the work of scholars such as Nagelhout this study notes that in addition to the issues of meaning making and context, multiliteracy involves the notion that meaning-making is 'multimodal'. For this reason rhetors are increasingly concerned with the different literacies that concern meaning-making, and because of the centrality of the image to this study there is a focus on visual literacy.

5.1.3 (i) Visual literacy

Visual literacy expands the traditional notion of language as 'articulated sound' or 'written orality to include visual forms, which for this study concerns the images that function as artistic and scientific modes of inquiry. The term 'visual literacy' was originally coined in 1968 by John Debes to describe the ability to see, comprehend and interpret objects and symbols and to integrate them with other sensory experiences thereby using them to creatively communicate with others. [645] Contemporary scholars locate visual literacy within the broad field of 'visual studies', an umbrella term that refers to the exploration of the practices and processes involving visual objects such as the image from various disciplines. As such, visual literacy is an interdisciplinary concept that is significant to both art and science. The 'visually literate', according to Anne Bamford, have the ability to construct meaning from visual images using the critical skills of exploration, critique and reflection. [646] In this way the visually literate communicate concepts in a purposeful and meaningful way. For Bamford visual literacy is a process that encompasses all the

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[644] E. Nagelhout, 'Pre-professional practices in the technical writing classroom: Promoting multiple literacies through research', *Technical Communication Quarterly*, Vol.8, No.3, 1999, pp.285-299, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=18aae5a4-bb8f-4f8b-b3e2-9bedcffed9fb%40sessionmgr120&hid=116 (accessed 4/11/2015) p.286

[645] Unite for Sight, 'Module 3: Visual Literacy', *Online Global Health Course*, http://www.uniteforsight.org/visual-literacy/module3 (accessed 20/08/2014) Web Page

[646] A. Bamford, 2003, p.1

knowing about and responding to the visual within a particular way of knowing. [647] Consequently, visual literacy involves the interpretation and composition of meaningful visual communication. Beyond communicative and representative issues visual literacy involves an awareness of how and why images communicate meaning. Within Nagelhout's multi-faceted model of communication, visual literacy concerns the intricacies of sight-based cues and the visually constructed nature of all documents; these include 'understanding visual design as an audience issue, as principles for organisation, and as another /similar/same way to think rhetorically about their writing'. [648] Visual language then, is a complex multilayered mode of communication which for this study includes both visual rhetoric and the concept of rhetorical literacy.

5.1.3 (ii) Rhetorical literacy

Rhetorical literacy is one of the four primary literacies identified by Nagelhout as significant to the development of a multi-perspectival approach to communication. Rhetorical literacy is described by Sigrid Kelsey as the ability of an individual to meaningfully participate in and to produce discourse. [649] Noting the communicative function of rhetoric Petra Aczél suggests that visual rhetoric, as a 'subdomain of the classical discipline, endeavoured to purport rhetorical literacy, for the visual, and to provide a framework to interpret and produce visual artefacts rhetorically'. [650] To this extent a 'rhetorically literate' person would understand how a scientific illustration functions rhetorically. Thus, in keeping with Davis Williams and Michael Hazen, the visually literate have the capacity to understand the logic and transformations of discourse and assess claims made in consideration of compelling circumstances, historical traditions, new possibilities, social interests, and personal motives. [651] A central concept of rhetorical literacy is the notion that conventions are discipline specific. That is, through research, scholars realise that different disciplines have different conventions for disseminating knowledge, and different conventions for

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[647] A. Bamford, p.4
[648] E. Nagelhout, p.289
[649] S. Kelsey, *Handbook of Research on Computer Mediated Communication*, IGI Global 2008
[650] P. Aczél, p.336
[651] D. C. Williams & M. D. Hazen, *Argumentation Theory and the Rhetoric of Assent*, University of Alabama Press, Tuscaloosa, 1990, p.65

supporting arguments. [652] In this way, scholars construct a rhetorical frame in which to identify such issues as the proposed intent of the rhetor, the situational context as well as the intended audience. Scholars also point to the significance of the metaphor to rhetorical literacy. Anna Ursyn for example, proposes that visual rhetoric, 'as part of visual communication, supports one's visual literacy, visual thinking, and visual learning by enhancing metaphorical thinking, visualisation, and ability to recognise the full worth of images, artworks, and media presentations'. [653] For this study the concept of metaphor in addition to visual conventions are an essential component of visual rhetoric.

Writing in *Shaping Information: The Rhetoric of Visual Conventions* Charles Kostelnick and Michael Hassett note that visual language is structured around a wide range of conventional practices which have been shaped and normalised within specific groups of users. [654] That is, visual communication relies on conventions that are primarily based on culturally based codes, whereby disciplines such as art and science utilise specific and highly developed conventions in which to describe, inform and persuade. Kostelnick and Hassett also stress that in contrast to prevailing attitudes, which characterise visual conventions as expedient imitations, some general principals of conventional practices affirm their pervasiveness, malleability, and context-dependent nature. [655] From this view conventional practice is deemed as rhetorical. This means that image-makers utilise rhetorical judgement not just by selecting conventions based on their interpretation of the potential viewer and the situational context in which the image is to be employed, they also adapt conventions to a situation by reshaping them. [656] Therefore, the meaning making capabilities of visual language is dependent upon the cultures that sustain them as well as upon the shifting interpretation of the conventions themselves. By way of explanation, images communicate through convention which for this study involves the visual metaphor

[652] E. Nagelhout, p.289
[653] A. Ursyn, *Computational Solutions for Knowledge, Art, and Entertainment: Information Exchange Beyond Text,* IGI Global, Hershey, 2013
[654] C. Kostelnick & M. Hassett, *Shaping Information: The Rhetoric of Visual Conventions,* Southern Illinois University Press, Carbondale, 2003, p.5
[655] C. Kostelnick & M. Hassett, p.5
[656] C. Kostelnick & M. Hassett, p.5

which becomes conventionalised through repeated use. [657] The metaphor has long been associated with rhetoric and in Classical oratory it was particularly important in securing clarity of expression. Aristotle for example, wrote that 'metaphor . . . gives style, clearness, charm, and distinction as nothing else can'. [658] However for Lenora Ledwon metaphors are more than literary flourishes to embellish speech; they are cognitive tools because they assist in understanding the unfamiliar by connecting to the familiar. [659] As such, metaphors as a cognitive device, are aligned with rhetoric because they persuade the viewer to participate in new insights and consequently new understandings.

Scholars argue that the exploitation of analogy and metaphor is one point of similarity between art and science. [660] For Lynden Stone the metaphor is an essential instrument of conceptual engagement between visual art and viewer.[661] For scientists the metaphor is a means by which to explain difficult concepts. Leonardo da Vinci's drawing the *Foetus in the Uterus* (Fig. 11) for example, is illustrative of early explanations of human reproduction and depicts the uterus opened like a 'burst seed-case' to reveal the fetus. The concept is accentuated by the analogical form of the axillary sketches on the sheet. Leonardo employed the strategy of implied (metaphorical) comparison to assert that the opened uterus and the burst seedcase are not alike but the same, in order to visually present his understanding of fetal growth and development. The entire drawing, comprised of analogical sketches depicting botanical forms, is described by Martin Kemp as replete with visual analogies of a microcosmic kind, whereby botanical analogies were used as explanatory parallels between all created forms. [662]

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[657] D. Gentner & B. F. Bowdle, 'Convention, Form, and Figurative Language Processing', *Metaphor & Symbol,* Vol.16, No.3&4, 2001, p.229

[658] Aristotle in J. A. Herrick, *The History and Theory of Rhetoric* (2nd edn.), Allyn & Bacon, Boston, 2001, p.87

[659] L. Ledwon, *Drake Law Review,* Vol.6, No.1, 2015, pp.194-237, available from https://lawreviewdrake.files.wordpress.com/2015/03/lrvol63-1-ledwon.pdf (accessed 2/10/2015)p.198

[660] S. Flach & B. Arends,' Knowledge in the Arts', Presentation Talk, *Virtual Symposium : On Visual Culture and Bioscience,* 5 – 13 March, 2007, Cultural Programs of the National Academy of Sciences, Washington, pp.1-7, available from http://www.ekac.org/knowledge_in_the_arts.pdf (accessed 04/05/2014) p.7

[661] L. Stone, 'Metaphor for Abstract Concepts: Visual Art and Quantum Mechanics', Studio Research, No.2, 2014, pp.15-59, available from http://www98.griffith.edu.au/dspace/bitstream/handle/10072/64537/98523_1.pdf?sequence=1 (accessed 12/11/2015) p.14
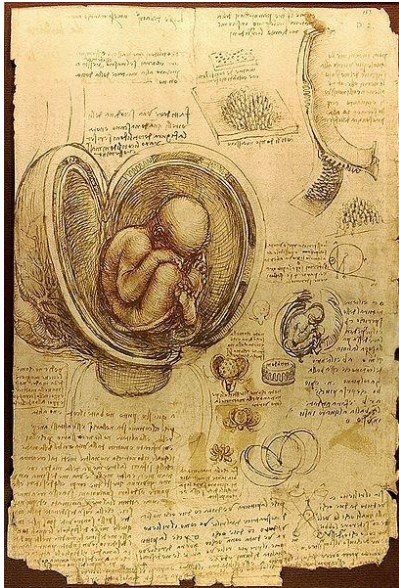
[662] M. Kemp, 2000, p.20-21

Figure 11

The Renaissance idea of the microcosm/macrocosm locates humans as a smaller representation of a larger universe. The supposed analogy between the whole and its parts, portrayed in Leonardo's drawing, 'served not only to develop a cosmology in which the reality of the individual received due attention but was also fundamental to astrology and other fields in which belief in a metaphysical relationship between man and the rest of nature is postulated'. [663] This portrayal is consistent with Robert St. Clair's notion of visual metaphor which 'designates how visual space is organized as a means of sharing cultural and social knowledge'. [664] Thus, visual metaphors provide a dominant mode of information processing function as a means of sharing cultural knowledge.

5.1.3 (iii) Communicating visual knowledge

The complexity of visual language is evident in scientific illustrations which in recent times have attracted the interest of a range of scholars including art historians and the historians of science, as well as philosophers and rhetoricians of science.

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[663] Encyclopaedia Britannica, 'Microcosm', *Philosophy*, Encyclopaedia Britannica, available from http://www.britannica.com/topic/microcosm (accessed 12/05/2013) web page
[664] R. N. St Clair, 2000, p.85

Martin Rudwick is credited with the development of the visual communication of science in his seminal text *The Emergence of a Visual Language for Geological Science, 1760–1840*. Drawing on the work of art historian William Ivins, Rudwick wrote that:

> *...prints are a means of communication, and as such the new modes of representation required new modes of perception by those who looked at them. Furthermore, the relation between the object depicted and its visual representation was never straightforward, however 'realistic' the intentions of the illustrator: artistic representation is always a visual language, which has to be learned and which changes over time.* [665]

For Rudwick the aim of the geologist and historian of science was to emphasise the role of a developing visual language in geology to the development of geology as an autonomous discipline with its own clearly defined goals and institutional structures. This new visual language drew on a variety of traditions and graphic conventions from areas that include visual art, cosmology, mineralogy, and natural history. However, Rudwick argues that representational conventions in science, while subject to change, reflect a tacit consensus of the community using them and more specifically that the emergence of a stable visual language is part of a scientific discipline's larger process of emergence. [666] Through this essay Rudwick demonstrates that each science is identified by a specific visual language, and importantly, that a link exists between visual conventions and the epistemology of that particular science. Rudwick explains that:

> *...an essential part of this complex historical process was the construction of a visual language that was appropriate to the subject-matter of the science, and which could complement verbal descriptions and theories by communicating observations and ideas that could not be expressed in words... this increasing formalization of the visual language of geology involved —and*

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[665] M. J. S. Rudwick,1976, p.177
[666] M. J. S., Rudwick, cited in J. Smith, *Charles Darwin and Victorian Visual Culture*, Cambridge University Press, 2006, Cambridge, p.35

reflects — the development of successive sets of cognitive goals.[667]

Consequently, images are more than an illustrative artefact that supports a verbal description, they are intrinsic to both the construction and communication of scientific knowledge

5.2: Artisanal Mediation of Scientific Ideas

5.2.1 Images: The Stuff of Science

Image-makers have enjoyed a long association with the production and communication of early scientific knowledge. This is because, as Jennifer Tucker argues, 'visual images are the stuff of science and an important way that science has defined itself (and has been defined or perceived by others) for hundreds of years'.[668] It is also because the 'stuff of science' was more often cultivated by artisans or artists rather by the scientist themselves. In this respect Tucker points to similarities and shared theoretical and methodological frameworks between the history of art and visual studies, and those of science studies. [669] Thereby inferring that because the image is a common ground of inquiry between art and science the history of art and the history of science are in part the history of the image itself. Just as significant for this study is the notion that images had become the basis of exchange between the distinct bodies of practical and theoretical knowledge and had thus provided a catalyst for the transformation from medieval natural philosophy to modern science. [670] For this reason the image became essential to the concretisation of abstract concepts: in that the image functions to persuade the viewer of the material existence of the phenomena depicted, in addition to providing a tangible link between thinking and making.

The significance of the relationship between the representational function of images and their role as mediators in understanding scientific concepts is evidenced by the numerous texts that extend from antiquity to the present day. However, the image did

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[667] M. J. S. Rudwick, 1976, p.177-178
[668] J. Tucker, 'The Historian, the Picture, and the Archive', *Isis*, Vol.97, No.1, 2006, pp.111-120, available from http://www.jstor.org/stable/10.1086/501104 (accessed 29/10/2012) p.114
[669] J. Tucker, 2006, p.114
[670] J. Büttner, et al, p.4

not always maintain its value as an epistemic medium. For example, during the early modern period images were a significant feature in philosophical publications that included illustrated botanical and anatomical texts. Brian Ogilvie suggests that the sixteenth century in particular was a productive time for illustrated texts as this was a time when images and words served a similar role in natural history, which was to convey a description of the object under study. [671] However, as language became more descriptive, authors began to omit images from their botanical texts because scholars of the seventeenth century had developed a precise language that conveyed more than image could. [672] Nonetheless this was not the case for all scientific texts. Drawing on the work of Ogilvie, Katherine Acheson proposes what while illustrations in botanical treatises diminished in number and importance, over the early modern period illustrations remained a key part of zoological works. [673] Such publications include Conrad Gesner's *Historiae animalium*, published between 1551 and 1558, and Edward Topsell's 1607 work *The Historie of Foure-footed Beastes*. Acheson suggests that while the illustrations of the *Historiae animalium* remained a zoological reference for the next two hundred years they were also one of the principal sources for animal images in a wide range of fine and decorative arts, across the European continent. [674] Therefore these images contributed to the critical mass of knowledge in addition to promoting collaborative research between scientists as well as between scientists and artists. [675] In this way images were significant to knowledge itself as well as to a knowledge network that included scientists and artists.

Until recently, scholarship concerning the visual rhetoric of early science has focused on the work of natural philosophers such as Leonhart Fuchs and Galileo Galilei rather than on the artisans who created many of the images that constitute the visual history of scientific achievements. For example, the 1610 astronomical treatise *Sidereus Nuncius,* also referred to as *The Starry Messenger*, is based on the Galileo's telescopic observations. As well as providing a pictorial description of the

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[671] B. W. Ogilvie, p.142
[672] B. W. Ogilvie, p.142
[673] K. Acheson, 'Gesner, Topsell, and the Purposes of Pictures in Early Modern Natural Histories', in M. C. W. Hunter (ed.), *Printed Images in Early Modern Britain: Essays in Interpretation*, Ashgate Publishing, Farnham, 2010, p.128
[674] K. Acheson, 2010, p.128
[675] K. Acheson, 2010, p.128

philosopher's 'heavenly' discoveries, the publication' served to support Galileo's scientific arguments that were constructed and presented through cinematic sequencing (Fig. 12).

Figure 12

Mario Biagioli contends that the cinematic presentations employed by Galileo function as argument rather than illustration as they do not provide an example of a known object or process. [676] Furthermore, because sequences come with the fact and not after the fact, they are part and parcel of arguments about the existence of that which they claim to depict. [677] Galileo's images have been the subject of constant academic speculation and, in addition to providing visible evidence of previously disputed astronomical phenomena, some suggest that the images were created in order to display and facilitate arguments rather than just record observations. This is in keeping with Biagioli who advances the notion that the images were created to display and facilitate Galileo's refutation of the Aristotelian concept of the incorruptibility of the heavens. [678] In this way the images served as a discursive device in addition to functioning rhetorically, that is, Galileo's scientific work was

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[676] M. Biagioli, *Galileo's Instruments of Credit: Telescopes, Images, Secrecy*, The University of Chicago Press, Chicago, 2006, p.142
[677] M. Biagioli, p.142
[678] M. Biagioli, p.142

concerned with both the particular physical problem in question as well as the perception of natural science within the contemporary intellectual environment.

The images that comprise of Leonhart Fuchs' 1542 De *Historia Stirpium* have also attracted significant scholarly scrutiny. Sachiko Kusukawa wrote that images of early science were used 'to make generalising arguments, discuss complete or ideal objects, and claim authority in matters of knowledge. [679] Although plants were identified according to general physical characteristics, images presented an opportunity for botanists to argue the accuracy of the verbal descriptions provided in their botanical atlases by visually depicting the specific characteristics of a particular specimen. Different levels of 'accuracy' existed in botanical illustrations. Leonhart Fuchs for instance, depicted only 'critical inseparable accidents' (Fig. 13) in his illustration of what is now known as a species of violet, in contrast Hans Weiditz' illustration of a similar plant portrayed 'a less than pristine state of the specimen in the hands of the artist' and included 'separable accidents' which 'compromise the effectiveness of the images in support of identifying definitions' (Fig. 14). [680]

Figure 13
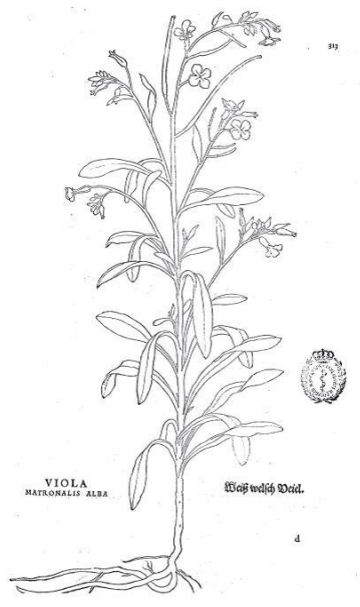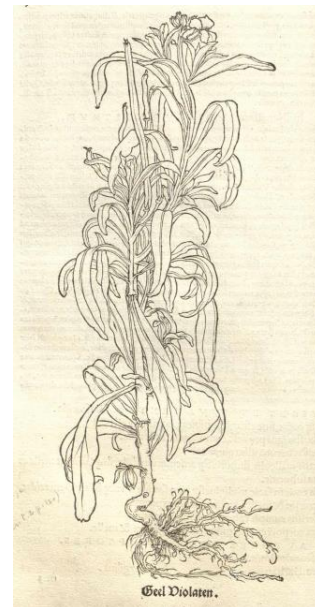
Figure 14

[679] S. Kusukawa, *Picturing the Book of Nature: Image, Text, and Argument in Sixteenth-Century Anatomy and Medical Botany*, The University of Chicago Press, Chicago, 2012, p.3
[680] J. Fahnestock, 'Forming Plants in Words and Images', *Poroi*, Vol.10, No.2, 2014, pp.1-34, available from http://ir.uiowa.edu/cgi/viewcontent.cgi?article=1194&context=poroi (accessed 3/10/2014) p.22

Drawing on the humanist rhetorical tradition promoted by Philip Melanchthon, as well as invoking Rudolf Agricola's idea of 'native accidents', Fuchs' argued that his images displayed characteristics innate to the specimen and could therefore could be used for identification. [681] That is, the images served to persuade the viewer that they correctly portrayed the plant identified by the accompanying verbal descriptions.

Even though the images themselves were deemed valuable to the presentation of scientific discoveries scholars have expressed concerns relating to the accurate representation of the specimen by image-makers. Drawing on the accounts of both Fuschs and Carolus Clusius, Janice Neri has noted that for these scholars working with artists was an ongoing struggle, 'one in which the botanist triumphs over devious, vainglorious, or incompetent artists'. [682] For Fuchs this meant that there was 'the need to supervise artist and artisans in order to prevent errors, or even worse flights of fancy that would confuse or obfuscate the viewer's understanding of the plant.' [683] According to Neri this ongoing conflict between the concerns of 'art' and the aims of 'science' had profound consequences for early modern practitioners who saw the need to reassure the reader that the values of science had prevailed over those of art. [684] Such assurances were frequently provided by the authors of philosophical publications. Robert Hooke, for example, stated in the preface of the *Micrographia* that he had presented nature with 'a sincere Hand, and a faithful Eye'. [685] In contrast to a perceived conflict between art and science some scholars locate the artisan-scientist dichotomy as continuation of a long tradition that separates making from thinking, whereas others point to an increasingly close collaborative relationship between artists and scientists. [686]

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[681] S. Kusukawa, 2012, pp.103-105
Melanchthon described plants in terms of separable and inseparable accidents
J. S. Mill, *A System of Logic: Ratiocinative and Inductive: Vol. I*
Separable accidents are those which are found, in point of fact, to be sometimes absent from the species; which are not only not necessary, but not even universal.
Inseparable accident are properties which are universal to the species but not necessarily to it.
[682] J. Neri, p.xviii
[683] J. Neri, 2011, p.xviii
[684] J. Neri, 2011, p.xviii
[685] R. Hooke, *Micrographia*, Royal Society, London, 1664, available from Internet Archive
https://ia800504.us.archive.org/5/items/mobot31753000817897/mobot31753000817897.pdf Preface [no page number]
[686] Scholars such as Pamela Smith and Pamela Long attribute this dichotomy to an Aristotelian scheme of knowledge which gave way to new ideas of knowledge during the scientific revolution.

5.2.2 Distinguishing Knowledge: Practice, Theory, and Artisanal Knowledge

5.2.2 (i) Artisans

The increased interest in the role of images in the documentation, dissemination, and preservation of early scientific knowledge has resulted in scholars such as Pamela Smith, Sachiko Kusukawa and Pamela Long, among others, turning their attention to the role of the image-makers in the development of science. Research has revealed that with few exceptions these image-makers remain unidentified. This is because the pictorial documentation of 'scientific' knowledge claims prior to the advent of tools such as the camera and the more recent processes of computerised digitalisation was customarily the responsibility of a team of workshop-based artists and craftspeople. As well as the 'workshop' Smith advances the idea that an important criterion for an artisan is manual work inculcated by an apprenticeship rather than by texts. [687] And, in contrast to the intellectual work of scholars, artisanal work was performed by hand. The term 'artisan' refers to those who had the specialised knowledge of their craft and although the term refers to a variety of skilful practitioners including weavers, sculptors, and goldsmiths, for this study 'artisan' refers to an image-maker. It is through the work of such artisans that many past 'scientific' practices and knowledges have been recorded and preserved. However, the role of the artisan was not just to make knowledge visible but to make knowledge legible. This meant that the artisan was not merely a transcriber of information from one form to another but was also an active interpreter and creator of visual forms of knowledge. Smith advances the notion that much of the visual information produced by artisans had a significant role in the rise of 'new science' and its 'new epistemologies'. [688] In this way, the artisanal skills of production provided an avenue for the development of the 'new science', which was now a 'practice' that engaged with nature rather than a set of theories.[689] This new practice belonged to a new type of philosopher 'who could

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[687] P. H. Smith, 2004, p.243
Until the onset of the industrial era artisans were the dominant producers of goods that were utilised by society. In such societies artisans were recognised as having specialist knowledge and skill. This particular knowledge was acquired through lengthy training supervised by a master, the hallmark of an apprenticeship.
[688] P. H. Smith, 2004, p.19
[689] The 'new science' or the new philosophies' refers to a science based on evidence acquired through observation and experimentation rather than based of the accumulation of theoretical knowledge

manipulate things, produce items of value, and act as an advisor to rulers', a practice that was closer 'to a practitioner or artisan of previous centuries than to a true philosopher'. [690] Consequently the methods, goals and epistemologies of artisans aligned closely with those of the new philosophy. This called for a reconsideration of the intellectual divide between the philosophers who possessed theoretical knowledge and artisans, or those with practical craft knowledge.

5.2.2 (ii) The division of knowledge

The classical scheme of knowledge

The convention of distinguishing between theory and practice represents a persistent feature of Western culture which is manifest in a hierarchy of knowledge that values the knowledge of a scientist over the knowledge of an artist. It is this hierarchy of knowledge that has shaped the frames of reference of this study which seeks to demonstrate that art like science is a legitimate way of knowing. According to Pamela Smith the divide between scholars and artisans is located within the Aristotelian scheme of knowledge 'which held, with some minor changes, up to the seventeenth century'. [691] This classical categorisation of 'craftsperson' and 'scholar' divided makers from thinkers whereby theory or episteme is distinguished from practice, which involves both praxis and techne. Pamela Long suggests that these categories of knowledge 'were hierarchically ranked: *epistemē* was at the highest level and *technē* at the lowest. In the medieval period, the liberal arts—the *trivium* (rhetoric, grammar, and logic) and the *quadrivium* (arithmetic, geometry, music, and astronomy)—were considered separate from and superior to the lower mechanical arts'. [692] Thus, until the late seventeenth century the ancient scheme of knowledge which differentiated between the work of the hand and the work of the mind prevailed in European society. The long established conceptual dichotomies of theory/practice, scholar/artisan, art/science, making/thinking, and hand/mind have

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[690] P. H. Smith, 2004, p.19
[691] P. H. Smith, 2004, p.17
[692] P. O. Long, Artisan/Practitioners and the Rise of the New Sciences, 1400–1600, Oregon State University Press, Corvallis, 2011, p.127

not only served to differentiate between so-called formal and informal knowledges but continue to reinforce the notion that knowledge equates with science.

Artisanal knowledge

Within the classical scheme of knowledge artisans were associated with practice instead of theory. And, although the practical way of knowing involved both praxis and techne, artisanal knowledge concerned techne, which was productive knowledge involving things 'made', rather than praxis or 'things done'. Smith differentiates between these two forms of practical knowledge proposing that:

> *Things done were comprised of human knowledge such as history, politics, ethics, and economics. Praxis was studied in the particular (by collection of experiences): it could not be formed into a deductive system, and was thus not as certain as theory. The other type of practice was composed of things made, or techné, that involved bodily labour. Techné had nothing to do with certainty but instead was the lowly knowledge of how to make things or produce effects, practiced by animals, slaves, and craftspeople. It was the only area of knowledge that was productive.* [693]

According to this model the practice of image-making consisted of making rather than thinking, thereby reinforcing artisanal knowledge as techne and thus bodily labour. However, Paola Bertucci and Oliver Courcelle argue that the artisanal world was a sphere of knowledge production where the ability to manipulate materials and to make things provided an intellectual foundation for the understanding of nature and its laws. [694] For artisans 'bodily labour', involving practices such as copying and drawing, was essential to making and therefore knowledge production. Knowledge production frequently involved repetition and details about the necessity for the constant replication of bodily practice was a persistent feature of artists' manuals. Michelangelo, for example, saw repetitious bodily practice as the key to knowledge

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[693] P. H. Smith, 2004, p.17
[694] P. Bertucci & O. Courcelle, 'Artisanal Knowledge, Expertise, and Patronage', *Eighteenth-Century Studies*, Vol.48, No.2, 2015, pp.159-179, available from http://history.yale.edu/sites/default/files/files/Artisanal%20Knowledge%202015.pdf (accessed 15/11/2015) p.160

when he instructed an apprentice to draw and not waste time. [695] For Albrecht Dürer art was a skill that developed through the practice of imitation. This meant that for knowledge to occur 'the apprentice must first copy after a master then after nature, resulting in a bodily storing up of experience. [696] Dürer 'emphasised that out of such bodily practice, 'art' - by which he meant a kind of knowledge that is larger than an individual's skills - comes into existence. . . these practices – transformed into art – are manifested in an object.' [697] Drawing on artists' accounts of their workshop practices, scholars have established that artisanal knowledge was constitutive of several characteristics. Smith, for example, has revealed that this knowledge was disciplined by years of practice, it was primarily empirical rather than theoretical, it was also precise, cumulative, demonstrated (visually and practically), collaborative and an example of distributed cognition and finally, artisanal knowledge resided in and was 'proven' by objects. [698] In the case of image-makers, making and knowing converged in the images that were produced through artisanal practice.

As this study demonstrates, scholars generally concur that the naturalistic works of artists, including the images created by Dürer, are the result of understanding and knowing nature through empirical modes of inquiry. This study also recognises that these modes of inquiry have in some way contributed to the wider knowledge debate. Smith points to an artisanal empiricism involving observing and representing that went beyond vision and description to a form of embodied skill and knowledge. [699] It was through this bodily knowledge that artisans were able to both 'render visible the invisible powers of nature and to extract positive knowledge from nature', thereby presenting themselves as self-aware experts on the processes and transformations of nature. [700] These claims were presented in naturalistic representations such as Dürer's 1503 work the *Large Piece of Turf*. Whereby Smith makes the point that:

> *Dürer used this position to argue (in his works of art as well as his*
> *treatises) that direct access to nature and the ability to effect*

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[695] P. H. Smith, 2007, p.41
[696] P. H. Smith, 2007, p.41
[697] P. H. Smith, 2007, p.41
[698] P. H. Smith, 2007, p.44
[699] P. H. Smith, 2006, p.95
[700] P. H. Smith, 2006, p.95

> *productive knowledge had the same authority as 'certain'*
>
> *knowledge, or 'scientia'. . . Artist/artisans such as Dürer strove to*
>
> *establish their status as observers, representers, and "knowers" of*
>
> *nature and used images to engage in a kind of theorizing about*
>
> *nature. In doing so, they articulated a body of claims about nature*
>
> *and about the sources of natural knowledge. [701]*

Dürer was arguing that artisans/artists were in possession of an enhanced way of knowing that was different from the rote manual work of a craftsperson. The artist was also arguing that this contribution to the existing body of knowledge was equal to that of a philosopher's. The notion of the 'self-aware expert' for instance, refers to the ability for an artisan to recognise their own capabilities and that their contribution to the existing ways of knowing has value. As Smith argues, it was through the 'practice' of describing nature that artisans 'helped change the view of what constitutes positive, certain knowledge.' [702] The significance of artisanal techniques of observation and documentation to the development of empirical science is well recognised in the wider knowledge debate. However, Dürer's argument concerning the equal positioning of productive and certain knowledge is particularly relevant because it mirrors the objectives of this study, which argues that art should be positioned, alongside science, as a legitimate way of knowing. Dürer's argument concerning the epistemological status of art is also significant because as an artisan, a position of cultural, social, and educational disadvantage, he was arguing against the dominant orthodoxy of the time which privileged theory over practice.

Artisanal literacy

Because of their lowly status artisans were denied formalised learning subsequently, with few exceptions, their knowledge was not documented in 'written' form. Instead, after an elementary education involving vernacular reading, writing and arithmetic, workshop apprentices undertook orally transmitted hands-on training.[703] Learning was therefore a process of imitation and doing that was 'perfected' through

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[701] P. H. Smith, 2006, p.95
[702] P. H. Smith, 2006, p.95
[703] P. O. Long, 2001, p.121

experience gained in the workshop. Consequently, the goals of artisanal instruction differed from scholastic learning. Rather than producing a 'lettered man' who could call to mind a corpus of knowledge contained in texts, 'artisanal literacy' aimed to make knowledge productive whereby artisans formulated their knowledge and processes of cognition in their works. [704] An artisanal way of knowing was therefore concerned with a 'material language' that involved the bodily manipulation of materials. In contrast, a scholar's way of knowing involved the intellectual manipulation of words. Contemporary scholars gain access to this artisanal knowledge through an interpretation of a craftsperson's materials, texts and artefacts. Pamela Smith proposed that these works exhibit epistemological claims, referred to as 'artisanal epistemology' as well as a vernacular 'science' of matter. [705] This articulation of epistemology can be found in fragmentary texts, naturalistic depictions and works of art, rather than in the books of a scholastic library.

Scholars, including Smith and Sven Dupré, propose that an advancement in artisanal literacy to include the documentation of their processes contributed to the realisation that artisans as well as scholars were able to construct knowledge. Prior to the fifteenth century learning consisted of the oral transmission of knowledge in the workshop. However, historians note that around fourteen hundred artisans 'resorted to pen and paper in a field where their fathers had been satisfied with memory and the spoken word'. [706] This change in artisanal literacy resulted in an unprecedented number of technical treatises concerning subjects that ranged from sculpture to perspective and mathematics. As stated by Birgit Fenzel these written forms of knowledge were collated by the master and included specific artistic techniques as well as formulae for mediums such as paint and resin. [707] Furthermore, in addition to the artists these publications attracted the interest of practicing alchemists and natural

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[704] P. H. Smith, 2004, p.8
[705] P. H. Smith, 2004, p.8
For Smith active knowledge involves the work of the hand – and the bodily engagement of artisans with matter, or materials, and nature represents a valuable form of cognition which she refers to as a 'vernacular' or 'artisanal epistemology'.
A consideration of this 'vernacular epistemology' involves 'forming a kind of common intellectual currency" shared by artisans, alchemists, medical practitioners, and "all practices associated with changes of state and transformations of matter, including those found in artisanal works of art and artisanal writings about art and nature. Smith, 2004, p.145
For Smith The vernacular science of matter – closely resembles knowledge related to alchemy in addition to other knowledges about 'nature'
[706] F. Lestringant in P. H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution,* The University of Chicago Press, Chicago, 2004, p.31
[707] B. Fenzel, p.78-84

philosophers. [708] For Sven Dupré this transmission of knowledge through books, drawings and objects including images, which were bought together by artists as working collections, represented the intellectualisation of the artist's profession. [709] With the emergence of the artist's treatises the transmission of artisanal knowledge had progressed from a tradition which consisted of communication from master to apprentice, to the dissemination of knowledge to a wider group of practitioners and scholars through various forms of written and pictorial media. Pamela Long suggests that the arts themselves were enhanced when artisan practitioners and humanists produced treatises on various mechanical arts. [710] Despite research revealing that benefits to the arts were primarily achieved through patronage, whereby the enhanced value of the arts reflected on the cultural aims of both the patron and the society to which they belonged, artist's publications functioned to advance ideas such as Dürer's notions of art as a knowledge discipline. Long considers these publications important for the advancement of knowledge because it was through the 'formulation of their principles in treatises, authors created potentially learned disciplines out of arts previously concerned primarily with craft production and construction'. [711] Although artisanal literacy had expanded from primarily a 'material language' to include the textual and thus the theoretical, it continued to be associated with productive knowledge. This is because artisanal/artist 'knowledge and processes of cognition' continue to be formulated in their works.

Practice, theory, and productive knowledge

A shift in literacy to include written forms had resulted in both an increased access to artisanal knowledge and an awareness of the 'usefulness' of productive knowledge. 'Useful knowledge' according to Evandro Agazzi refers to the idea that knowledge functions to 'help man to dominate Nature and to establish his reign, which would guide and advance practice rather than reflect upon Nature'. [712] Therefore, instead of the Aristotelian concept where knowledge remained eternal, certain and unchanged,

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[708] B. Fenzel, p.78-84
[709] S. Dupré, pp.1-2
[710] P. O. Long, 2001, p.245
Long notes that these books explicated in writing and in drawings, particular arts such as painting, sculpture and architecture
[711] P. O. Long, 2001, p.245
[712] E. Agazzi, *Right, Wrong and Science: The Ethical Dimensions of the Techno-scientific Enterprise*, Rodopi, Amsterdam, 2004, p.58

knowledge is transformed through productive activity which results in the construction of new knowledge. For example, an image constructed through the work of the human hand might represent not just knowledge but useful knowledge. This is because images provide the means by which to articulate new aims and methods for the study of nature. [713] A wider dissemination of artisanal practices had resulted in an increased appreciation of artisanal methodologies by scholars who found these methods useful in the search for new knowledge.[714] As Katherine Park explains, observation through direct engagement with phenomena became a scholastic requirement, particularly in relation to the properties of different plant and animal species, where knowledge could not be derived from first principles. [715] The ancient model no longer held because the production of effects and real things was required to prove the certainty of theory.[716] In contrast to a dependence on theoretical knowledge transmitted unchanged through time, this new model depended on physical evidence to support knowledge claims whereby knowledge could be confirmed through 'things done'. Science was no longer purely theoretical, it was now a practical activity and a link could be established between three areas of ancient knowledge: *episteme*, *praxis* and *techne* within the 'new philosophy'. For Pamela Smith this evolution of the system of knowledge connected the scholar with the artisan or technician. [717] This connection was evident when natural philosophers as emerging empiricists, recognised, valued and adopted the artisanal skills of observation and engagement with nature. Smith argues it was due to the actions of individuals such as artisans, through their new methods of pursuing knowledge, that a significant change in scholarly culture was achieved. [718] Therefore making and thinking, which were considered to be separate activities since the time of Aristotle, were linked in the new epistemologies.

Although the translation of techne to what is now considered 'art' is imprecise, it serves as a conceptual frame through which to argue the notion that art and science

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[713] P. H. Smith, 2006, p.83

[714] Scholars, whose education was previously dominated by reading and textual description from authors such as Aristotle and Galen, appropriated artisanal approaches of hands-on practice, instrumentation, observation and measurement

[715] K. Park, 'Observation in the Margins, 500–1500', in L. *Daston & E. Lunbeck, Histories of Scientific Observation, The University of Chicago Press, Chicago, 2011,* pp.15-16

[716] P. H. Smith, 2004, p.17

[717] P. H. Smith, 2004, p.19

[718] P. H. Smith, 2004,p.18

both function through making and thinking. The concept of 'technique' for example, has long been linked with making and consequently is generally dissociated from thinking. The term generally refers to both the way in which a particular task is performed and the capacity of a person to perform such a task. Because it is through specific techniques that knowledge is made concrete, technique is considered the hallmark of a skilled artisan. [719] But while technique is essentially the competent application of know-how obtained through the accumulation and transmission of concrete experience, Evandro Agazzi claims that it is not supported by knowing *why* such procedures are especially efficacious. [720] According to this view technique involves 'knowing how' whereas techne, or the art of making, has the capacity to demonstrate 'knowing why'. However Agazzi proposes this 'invention of the why' or the introduction of a theoretical demand into the domain of practice and doing resulted in 'efficient knowing', or techne, which is the 'efficient action that knows the *reason*s for its efficiency and is based upon them'. [721] Agazzi's proposal is significant to understanding the position of art in the theory-practice debate because from this view techne goes beyond mere technique, or 'how', to a practical form of knowledge grounded in knowing 'why'. As previously noted, techne is an empirical form of knowledge by virtue of the modes of inquiry, thus observation and documentation of nature includes issues of cause and effect. For Agazzi the idea of techne as a theoretically grounded form of practical knowledge became apparent when the contemplative and disinterested conception of knowledge allied with the notion of useful knowledge. [722] This notion functioned to advance the idea that knowledge must be put into the service of practice. In the case of science knowledge now needed to be useful because the solution to concrete problems concerned the use of available theoretical and practical knowledge [723] For example, the theoretical and

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[719] N. Winder, 'Educating the children in the mode-2 revolution', in B. Tress, G. Tress, G. Fry, G. & P. Opdam, (eds.), *From Landscape Research to Landscape Planning: Aspects of Integration, Education and Application*, Springer, Dordrecht, 2006, p.208
[720] E. Agazzi, p.56
[721] E. Agazzi, p.56
[722] E. Agazzi, p.58
A. Pérez-Ramos in S. Kusukawa, 'Bacon's Classification to Knowledge', in M. Peltonen, (ed.)*The Cambridge Companion to Bacon,* Cambridge University Press, Cambridge, 1996, p.38
For Aristotle, the ideal knowledge consisted of the disinterested contemplation of the world, - Francis Bacon discredited this ideal and replaced it with a new emphasis on controlling and manipulating nature
Bacon was an exponent of the "Maker's knowledge tradition' which poses an intimate an intimate relationship between objects of cognition and objects of construction, and regards knowing as a kind of making or as a capacity to make.
[723] E. Agazzi, p.59

practical knowledge of geometry was involved in planning and constructing devices, such as artillery, that related to the unstable politics of the time. In the case of art useful knowledge primarily focused on materials and 'technique'.

Even though artists supported an erasure of the epistemological hierarchy between theory and practice, scholars have argued that in their works making was favoured over thinking. Michael Baxandall noted the significance of technique to fifteenth-century artists, when he proposed that for these artists intellectual concepts are one thing but and crass practice is something else. [724] These sentiments were related to the practicalities of business as well as the desire to produce a credible work. Theorists, including Alberti and Petrarch, argued for the skilful application of materials because one paid for a picture under these same two headings, matter and skill, material and labour. [725] Similarly, art collectives such as the *Société des Arts* advocated for the integration of practical and theoretical knowledge. But, as Paola Bertucci and Oliver Courcelle argue, the *Society* shared an epistemology that artisans had articulated in mechanical treatises centuries earlier that privileged practice over theory. [726] This consideration is exemplified in the *Discours Admirables*, the 1580 publication of the lectures given by French artisan and engineer Bernard Palissy, whereby the author 'unabashedly attacked the value of erudition in the search for the secrets of nature, praising instead an approach based on learning by doing'. [727] However, rather than view artisanal/artist knowledge in terms of distinct and separate concepts labelled 'practice' and 'theory', there has been a reconsideration of these concepts.

Although it is useful to distinguish between theory and practice, Smith argues that research has shown that artisanal knowledge does not consist of mindlessly followed recipes and rules, but carefully-thought out technology. [728] Smith's argument serves to demonstrate that the conceptual dichotomies of theory/practice and scholar/artisan were a consequence of the prevailing notions of knowledge as well as the modes by

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[724] M. Baxandall, *Painting and Experience in Fifteenth Century Italy: A primer in the social history of pictorial style* (2nd edn.), Oxford University press, Oxford, 1988, p.16
[725] M. Baxandall, 1988, p.16
[726] P. Bertucci & O. Courcelle, p.165
[727] P. Bertucci & O. Courcelle, p.165
[728] P. H. Smith, 2004, pp.6-7

which knowledge was presented and transmitted. However, other than instruction in drawing, linear perspective and anatomy, there is little evidence to suggest that 'art practice' existed as a coherent body of knowledge. For this reason scholars are considering differing notions of knowledge as well as reconsidering the dichotomous concepts of theory and practice. According to Caroline van Eck any inquiries concerning theory and practice in art should be considered within wider social and cultural issues. [729] Van Eck is referring to the prevalence of Humanist theory in the art academies whereby scholars, such as Leon Battista Alberti, applied the principles of rhetoric to their work. Consequently, theories and terms used for academic discussions of the visual arts, such as concepts, categories and principles, were based in rhetoric. [730] While the association between art and rhetoric involved the adoption of rhetorical language and theories it also concerns community engagement, because rhetoric traditionally offered training in persuasive communication.

5.3: Artists' Engaging with the Concepts of Science

5.3.1 Art and Science: Engaging rather than Representing

Artists have long exploited the concepts of science to make work. This claim is supported by the various images portraying scientific topics as well as the work of scholars including Martin Kemp, Barbara Maria Stafford, Siân Ede, and Stephen Wilson. According to Wilson the increasing interest in artistic research by scholars from fields such as science relates to understanding how art might contribute to knowledge as well as the relevance of these contributions. [731] In contrast, artists have demonstrated the numerous ways in which to explore the possibilities of science. Wilson lists three such approaches: the first approach concerns the 'artist as consumer', in which the tools of science are employed to create new art forms; the second approach sees the 'artist as analyst' or 'interpreter' whereby the function of the artist is to critique and reveal the developments of science, and last, the 'artist as participator', this is where artists develop their own research agendas and undertake

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[729] C. van Eck, 'Rhetorical Categories in the Academy', in P. Smith & C. Wilde (eds.), *A companion to Art Theory*, Blackwell Publishing, Oxford, 2002, p.105
[730] C. van Eck, p.105
[731] S. Wilson, 2007, p.1

their own investigations. [732] Hence, the concepts by which artists construct meaning and advance understanding have both similarities to, and differences from, the practices of past image-makers. The contemporary role of rhetor for example, extends beyond persuasion to involve understanding. Understanding also includes Sonja Foss' and Cindy Griffin's notion of invitational rhetoric whereby images, as a form of communication, present an opportunity for the viewer to see the world from the maker's perspective. [733] This means that images constructed through artistic inquiry would function to generate understanding among viewers with different perspectives rather than attempt to persuade viewers of a particular view. For this reason artists and scientists, as part of a viewing audience, would each derive different meanings from an image such as Joseph Wright of Derby's *An Experiment on a Bird in the Air Pump*.

Other than eschew the traditional notions of rhetoric, whereby change rather than understanding was the aim of the rhetor, contemporary artists are no longer perceived to be in the service of science. Rather than fulfil a utilitarian function, which in keeping with the ancient concept of techne seemingly required limited scholarly investment, artists' now 'have the freedom to play, subvert science and interrogate it in ways that practicing scientists cannot without questions being raised about their integrity or, indeed, their capacity as scientists'.[734] Such examples of contemporary engagement include Cubism's interrogation of physics and Op art's engagement with the science of perception and optics. This suggests artists enjoy an openly intellectual connection with their work that occurs within a scientific milieu. Therefore instead of visually interpreting and representing concepts for science, artists are connecting with science in a meaningful way for the purpose of visually communicating their concepts to a wider world.

Although artists continue to connect with science through various media, including music, theatre and literature, Siân Ede proposes that these engagements primarily

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[732] S. Wilson, 2007, p.1
[733] S. K. Foss, 2009, pp.569-570
[734] J. Kieniewicz, 'On Scientific Imagery, Art, and Science', *At the Interface: Where art and science meet*, PLOS Blogs, [web blog] September 27, 2012, available from http://blogs.plos.org/attheinterface/2012/09/27/on-scientific-imagery-art-and-science/ (accessed 10/09/2014) web page

occur through the visual arts.[735] This observation has led Ede to speculate on why visual artists, who communicate in perversely abstract ways and whose vision is resolutely individual, are attracted to science. What does this involvement with the 'most rational and reductionist of activities, one whose *raison d'être* [sic] is its materialism, its strictly agreed protocols, its faith in facts 'mean for the visual arts world?' [736] Ede's concerns are in part addressed by Brett Wilson, Barbara Hawking, and Stuart Sim who argue that, rather than 'rigid certainties', science is considering alternative frameworks in which the objective/subjective axis has been replaced by a contemplative approach based on Bayesian constructs. [737] In this way we make sense of the world through broader constructs and accept multiple and alternative concepts of reality. The authors also suggest that artists are drawn to science's rich subject matter and methodological productivity as well as the opportunity to explore human questions in a different way from their initial training as artists. [738] For most scholars, rather than alienate these two forms of inquiry, it is more productive for society to acknowledge that although art and science have different notions of knowledge there are many parallels in both forms of research. The 'culture of experiment' for example, exists in both forms of research, that is:

> *Studios and laboratories are both places of discovery and curiosity; where new conceptual structures and investigative methods are explored; where mastery of craft, tacit knowledge and expert judgement play important roles; where new metaphors can suggest previously unexplored directions and illuminate unexpected consequences; where articulation and communication of hunches, suspicions and 'what-ifs' are central; where teasing obliquely glimpsed possibilities into working artefacts can be decisive; and where carefully crafting work in progress towards a*

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[735] S. Ede, 2000, p.19
[736] S. Ede, 2000, p.19
[737] S. Ede, 2000, p.19
[738] B. Wilson, B. Hawkins, B., & S. Sim, 'A Transdisciplinary Approach to Art and Science Research: Permeable Research Frameworks', *The International Journal of the Arts in Society: Annual Review*, Vol.7, 2013, available from http://placeinternational.org/project_dialogue/papers/A%20transdisciplinary%20approach_fullpaper.pdf (accessed 08/08/2014) p.42
Bayesian Methods - For example Mark E. Glickman and David A. van Dyk argue that there are competing schools of thought in statics, for example the Bayesian constructs involve the concepts of subjectivity, i.e. expressed in degrees of belief. Whereas the classical approach involves hypothesis testing and confidence intervals as two of the main modes of inference

state of inspection, exhibition and judgement by fellow

professionals, sponsors and the wider public is a strong driving

force. [739]

From this account it is important to note that artists do not only work as sole practitioners in studios but are also conducting, and participating in 'interdisciplinary and collaborative' research in 'science laboratories'. Thus, the issues voiced by the aforestated authors have engendered the wider art-science debate. These issues also reflect the issues addressed in this study which focuses on the visual images produced through art's engagement with science. Such concerns relate to the acceptance of differing concepts of knowledge and the wider implications for the validity of visual communication of concepts across disciplines.

5.3.2 Boundary-work

In contrast to past practices, contemporary research is increasingly complex because it frequently involves perspectives from more than one discipline. Current research therefore results in various forms of inquiry each of which is identified according to the differing levels of integration between constituent disciplines. For instance, integrative relationships between art and science are described as either collaborative, transdisciplinary, cross-disciplinary, interdisciplinary or multidisciplinary. Although these terms are frequently used to describe research that involves more than one discipline, there is confusion over what these terms actually mean. The description provided by Andy Sumner and Michael Tribe therefore serves to clarify these terms that are frequently used interchangeably. For example:

. . . cross-disciplinarity is a generic term meaning any kind of

mixing of disciplines. Multi-disciplinarity entails researchers in

teams conducting research from their own disciplinary viewpoint

and where the team as a whole includes researchers from a number

of disciplines. Interdisciplinarity is a step further towards

integration, rather than the co-existence of different disciplines (the

disciplines are still discernible but some level of deeper integration

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[739] B. Wilson, et al, p.42

> *is evident). Individuals within teams seek to integrate concepts and*
> *methodologies and the individual researchers are based primarily*
> *in one discipline but will have familiarity with at least a second*
> *discipline. Trans-disciplinarity relates to complete integration of*
> *two or more disciplines with the possibility of forming a new*
> *discipline.*[740]

The significance of clarifying these concepts lay in communicating and understanding the insights that result from the various forms of research. The Wellcome Trust's *Sciart* programme was presented as a collaborative model which functions on the concept of bringing artists and scientists together to do something new which could not be achieved without interacting with each other, in that each must enter the other's territory, whereas other programmes aim to facilitate artistic research in scientific environments. [741] The *Artists in Labs* Project is one such programme which 'promotes sustainable collaboration between artists and scientists of all disciplines', and these 'long-term interdisciplinary and cross-border collaborations provide artists with an opportunity to critically engage with the sciences and their experimental and aesthetic dimensions'. [742] Interdisciplinarity and collaboration therefore involve a range of research practices that necessitates exchanging knowledges as well as research topics, methods and technologies. Consequently, this study will employ these terms interchangeably to refer to those artists whose research engages with a scientific environment.

Although no single description of either collaboration or interdisciplinarity exists this study has adopted the notion of 'boundary-work' whereby artistic research entails crossing disciplinary boundaries in order to suggest different approaches to research and challenge accepted ways perceiving and knowing. [743] The notion of artist's

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[740]A. Sumner & M. Tribe, 'Development Studies and Cross-Disciplinarity: Research at the Social Science–Physical Science Interface', *Journal of International Development*, Vol.20, No.6, 2008, pp.751-767, available from https://www.ids.ac.uk/files/dmfile/DevelopmentStudiesandCrossDisciplinarityResearchattheSocialSciencePhysicalScienceInterface.pdf (accessed 21/09/2014) p.753

[741] Expert Observer, in P. Glinkowski, & A. Bamford, *Insight and Exchange: An Evaluation of the Wellcome Trust's Sciart Programme*, Wellcome Trust, London, 2009, available from http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_grants/documents/web_document/wtx057228.pdf p.85

[742] Artists in Labs 'Artists in Labs: Web Site', Institute for Cultural Studies in the Arts, Zurich, available from http://www.artistsinlabs.ch/en/ (accessed 15/10/2015) web page

[743] The term 'boundary work' was attributed to Thomas Gieryn who used it to refer to the problem of delineation of scientific knowledge and non-scientific knowledge. Boundary-work was also used by Henk Borgdorff to refer to artistic research that is undertaken in the borderland between the art world and the academic world.

crossing boundaries of recognised media in order to create art was attributed to Fluxus artist Dick Higgins when he described the concept of intermedia. [744] However, rather than crossing the boundaries of media, artists including the Cubists, crossed disciplinary boundaries to explore the concepts contained in the 'new sciences'. Such explorations, focusing on perspective and the representations of reality, resulted in the multiple perspectival images that are most commonly associated with the Cubist painters including Pablo Picasso and Georges Braque. The validity of perspective had already been questioned by Paul Cézanne, however, art historian Linda Dalrymple Henderson suggests that the Cubist painters saw the existence of a fourth dimension as justifying their rejection of three-dimensional Renaissance perspective. [745] As a consequence, these images functioned to both represent new ways of seeing and reject the traditional modes of representation. It is widely acknowledged that much of the work of artists such as Picasso and Braque was based on their understanding of non-Euclidean geometry. Henderson informs us that this 'provided visual parallels and the theoretical justification for a pictorial space based in tactile and motor sensations', that is, 'the pictorial space of Cubism is to be born of the artist's tactile and motor spaces of Poincaré. [746] In turn, a Cubist painting should excite these same sensations of the mind of one who views it, thus serving as "a sensitive passage between two subjective spaces"'. [747] For Henderson, Jean Metzinger's 1910 *Nude* (Fig. 15) 'with its shaded overlapping facets and interpenetration of figures and space' closely approaches the four-dimensional geometry of Esprit Jouffret. [748] For this study these works illustrate the way in which the artist's research into the world of mathematics and physics was utilised in order to portray his understanding of 'reality' in his works.

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[744] H. Higgins, in D. Higgins, 'Intermedia', reprinted with an Appendix by H. Higgins, *Leonardo*, Vol.34, No.1, 2001, pp.49-54, available from https://muse.jhu.edu/journals/leonardo/v034/34.1higgins.pdf (accessed 20/11/2015)] Higgins later acknowledged that 'intermedia' appeared in the works of Samuel Taylor Coleridge in 1812 in exactly its contemporary sense—to define work which fall conceptually between media that are already known, pp.53-54

[745] L. D. Henderson, 2013, p.184
According to Henderson the relationship between Cubism and the new geometries was complex, involving visual as well as philosophical aspects of the fourth dimension and non-Euclidean geometry, as they were understood in the early years in the twentieth century.

[746] L. D. Henderson, 2013, p.188

[747] L. D. Henderson, 2013, p.187
Henderson has quoted 'a sensitive passage between two subjective spaces' from Gleizes and Metzinger *Du Cubisme*, [p.18]

[748] L. D. Henderson, 2013, p.188
Jouffret's *perspective cavaliére* serves to illustrate Poincaré method, presenting a fusion of the successive views of a four dimensional object which result from the mental picture of its rotation in the mind of the geometer. [Jouffret's drawings served to popularised the work of mathematician/physicist/philosopher Henri Poincaré]

Figure 15

Images such as Metzinger's *Nude* serve to support Cubism's challenge to the conventional ways of representing the world and their argument for different ways of seeing and the portrayal of a conceptual approach to reality. Therefore, by applying the concepts advanced by Jordynn Jack, Cubism functioned as a rhetorical structure because it acted to instruct readers how to view its images in accordance with an epistemic programme that involved the artist's way of depicting this 'new' reality. An 'imperceptible reality' according to Henderson, was the fourth-dimension, 'the popular idea that the three dimensional world of perception was merely a section of a truer four-dimensional realm, a higher reality to be discovered by sensitive artists'.[749] Additionally, and in agreement with both Jack and Chad Wickman, the images constructed through Cubism's interpretation of the new geometries were the evidence of a new productive art. This new 'productive' art is generated through interdisciplinary research whereby the 'new reality', depicted in form and space, was produced by the image-maker to be placed before the eyes of the viewer so that they might experience it for themselves. Conforming to the notions advanced by Stephen Wilson, Cubism explored the possibilities of science through its tools and concepts

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[749] L. D. Henderson, 'X-Rays and the Quest for the Invisible Reality in the Art of Kupka, Duchamp, and the Cubists', *Art Journal*, Vol.47, No.4, 1988, p.323

which in turn resulted in new art forms such as the oft-cited multi perspectival images that are associated with the movement.

5.3.3 Interdisciplinary rather than Integrative Practice

The interest in art-science linkages has resulted in questions regarding the concept of a 'third culture' created through the merger of art and science. This contentious proposal was posed by science historian Arthur I. Miller, the moderator of a panel of bioartists at the 2011 exhibition *Merging Art and Science to Make a Revolutionary New Art Movement.* Participating artists, including Oron Catts, were very clear in their view that that the domains of art and science should remain separate entities even if they are cross-fertilising each other. [750] Consequently, rather than totally integrating art and science and forming one discipline, many of the approaches that concern 'art and science' research reflect an interdisciplinary focus. The aforementioned *Artists in Labs* project for example, promotes collaborative research between artists and scientists. In contrast to science oriented projects such as the Arts and Genomics Centre's *New Representational Spaces Programme*, the *Artists in Labs* project is an 'art focused' mode of inquiry. An art centred programme involves the placement of artists within a scientific environment whereby there is a focus on opening 'up new forms of knowledge' and 'educate artists and designers in disciplines outside their usual cultural borders'. [751] Thus these programmes involve research across well-established permeable boundaries. Concerning the notion that these are long and much used pathways, Siân Ede makes the point 'that it would be difficult to find examples since the modern period, of occasions when artists have not in some way, become involved in science, even if unconsciously or tangentially.' [752] For artists then, science serves as a valuable research site in itself as well as providing the opportunity to work 'collaboratively' with the practitioners of that site.

According to the founder of the *Artists-in-Labs* project Jill Scott, the success of these projects depends on shared languages and shared goals; that is to say, if the goal is

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[750] Blog Author 'Science and art – Talking about a new movement', *SciArtsci WordPress* [web blog] 11 July 2011, available from http://sciartsci.wordpress.com/2011/07/11/science-and-art-making-a-new-art-movement/ (accessed 17/09/2014) web page

[751] S. Schade, 'Forward: A Project Situated in the Field of Cultural and Visual Analysis', in J. Scott (ed.), *Artists in Labs: Processes of Inquiry*, Springer Wien, New York, 2006, p.4

[752] S. Ede, 2000, pp.17-18

the creation of hybrid forms that transcend the disciplinary limits of any given field, then the means of articulating and conveying the meaning and significance of the forms of interdisciplinary creation is required. [753] To this extent research that concerns both art and science involves a mutual understanding of complex processes of inquiry as well as the product of that inquiry, which for this study primarily concerns the images that are generated by image-makers through their engagement with science. This consideration remains even though different goals, criteria for success, and approaches to practice exist for specific disciplines. Scientist and Executive Director of the Leonardo Publications Roger Malina makes the point that working *outside* of a discipline might involve conceptual risk but might also result in unexpected outcomes. [754] Malina goes on to explain that in order to reframe or explore crucial developments *within* a discipline individual practitioners draw upon a wide variety of sources of inspiration, methodology, validation and experience across disciplinary boundaries. [755] Accordingly, many disciplines utilise interdisciplinary ways of knowing for the purposes of advancing disciplinary knowledge. To this extent researchers such as Paul Grobstein argue that contemporary science itself is the product of collective interactions among 'entities'. [756] Whereas art is frequently described as an inherently interdisciplinary practice. The Columbia University School of the Art for instance, functions on the concept of interdisciplinarity, whereby 'artists have the experience of such fluidity, to observe how others construct and conceptualize the range of possibilities available to them. Even if they ultimately return to their initial form, their approach will be different'. [757] Irrespective of the different views concerning interdisciplinary research, most authors concur that the significance of any interaction between art and science lies in an increased level of respect and understanding of the other's culture and system of knowledge.

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[753] J. Scott, 2006, p.13

[754] R. Malina, 'Welcoming Uncertainty: The Strong Case for Coupling the Contemporary Arts to Science and Technology', in J. Scott (ed.), *Artists in Labs: Processes of Inquiry*, Springer Wien, New York, 2006, p.15

[755] R. Malina, 2006, p.15

[756] P. Grobstein, 'Interdisciplinarity, Transdisciplinarity, and Beyond: The Brain, Story Sharing, and Social Organization', *Journal of Research Practice*, Vol.3, No.2, Article M21, 2007, pp.1-22, available from http://jrp.icaap.org/index.php/jrp/article/view/98/148 (accessed 10/05/2013) p.4

[757] A. Gibbons, 'Anticipation of the Coming Year: Questionnaire', The Columbia University School of the Art, 2014, pp.66-75, available from http://arts.columbia.edu/files/soa/content/VA/66-75-Summer_Issue_questionnaire.pdf (accessed 12/10/2014) p.68

In addition to culturally focused programmes such as the *Artists-in-Labs* project, academic and Government Fellowships also provide opportunities for a collaborative relationship between art and science. For some institutions the purpose of a Fellowship, in addition to interdisciplinary research, is the communication of the institutions concept and goals. The primary objective of the *Australian Antarctic Arts Fellowship* for example is to communicate the work of the Antarctic Division through the perspective of participating artists such Stephen Eastaugh. The programme also aims to 'nurture the production of excellent and significant works of art and interpretation by professionals in the creative arts, humanities and social sciences'. [758] The Antarctic Arts Fellowship is thus described as an opportunity that enables those with a non-science focus, such as creative artists, to experience Antarctica first-hand so that they may communicate this unique experience and understanding to the wider community. [759] Stephen Eastaugh communicated these aspects of his many residencies in Antarctica through works such as *Big beautiful dead place / Rafting sea ice* and (Fig. 16) and *Husky Ghost Town [Buchta Tichaja, Franz Josef Lands]* (Fig. 17). These images formed part of the 2012 exhibition *An Awfully Beautiful Place: The Antarctic Art of Stephen Eastaugh* which functions to reflect the artist's critical engagement with the remote location as well as the historical significance of the project.
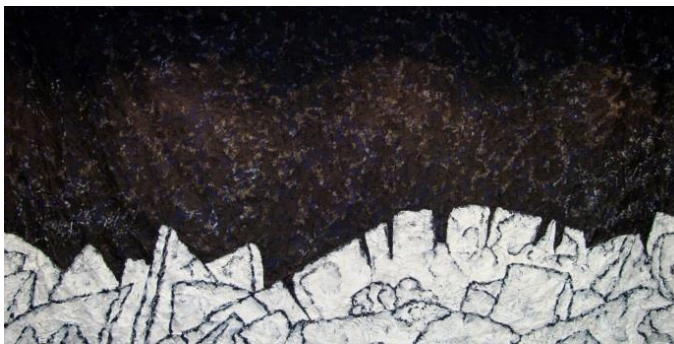

Figure 16

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[758] Australian Antarctic Division, 'Australian Antarctic Arts Fellowship', Department of the Environment, Australian Government, available from http://www.antarctica.gov.au/about-antarctica/antarctic-arts-fellowship (accessed 12/09/2014) web page
[759] Australian Antarctic Division, web page

Figure 17

The exhibition marked one hundred years of Australian Antarctic expeditions; consequently the work plays a vital role communicating the significance of scientific expeditions over time. This particular point is emphasised by Antarctic Division Director Tony Fleming in the forward of the Exhibition Catalogue, where he writes that the body of work the artist 'has produced from his experience, communicates an understanding, a connection, and an acknowledgement of history. His work plays a vital part in the effort to communicate to the world the importance of Antarctica, and the work we do there.' [760] For Fleming, Eastaugh's work functions to persuade the exhibition audience of the Division's role in the Antarctic. Specifically these images, through the artist's experiences, understandings, and connections, are an invitation for viewers to understand that Antarctica is not only a significant Australian scientific laboratory but as a 'wild untamed land' it has international importance. Thereby reflecting the Aristotelian concept of the four causes whereby persuasion is bought into existence by the actions of the maker. According to this concept, it was only through the artist's experience, understanding and connection to the location that such 'useful products' are created. Even though the work does not directly communicate scientific activity, Eastaugh expresses the hope that by providing access to the images the public might gain insights into Antarctica. [761] From this

[760] T. Fleming, 'Forward', Exhibition Catalogue, *An Awfully Beautiful Place: The Antarctic Art of Stephen Eastaugh*, Carnegie Gallery, Hobart, 7 June - 1 July 2012, p.3, available from
http://www.antarctica.gov.au/__data/assets/pdf_file/0004/142897/Stephen-Eastaugh-art-catalog.pdf (accessed 19/09/2014) p.3
[761] S. Eastaugh, 'A.I.R on Ice', *Art Monthly Australia*, Vol.220, 2009, pp.49-51, available from
http://www.stepheneastaugh.com.au/baggage-2009-AIR_on_Ice.pdf (accessed 20/09/2014) p.51

perspective art would seem to be in the service of science, because the images were constructed so as to invite viewers to first understand and perhaps be persuaded of the significance of the knowledge acquired through scientific research.

However, rather than a scientific project, Eastaugh describes his residencies as 'elements of fresh stimulus and raw data- exciting, unpredictable and in-your-face', and his work as an exploration of the visual world which then requires navigating 'through ideas to create new, two, three or four dimensional spaces'. [762] Thereby suggesting an interdisciplinary perspective to an art focused programme whereby the artist reveals the work of science in Antarctica. In order to achieve an understanding of science's culture and system of knowledge Eastaugh participated in scientific research which consisted of routine tasks such as collection of climate-related data and wildlife monitoring with remote sensors. [763] In contrast the field-trips, which consisted of information gathering through photography, sketching, and preliminary paintings, were the foundations of his artistic research. These trips are described as a 'visual gluttony' that have 'given me some fat ideas, which must now be wrestled into shape back in the polar studio at Davis Base'. [764] For Eastaugh the fellowship consisted of two separate but interrelated journeys. For example:

> *The first is the obvious thrill of collecting and translating visual data into art. This is the external trip of an artist moving through the wild climate and alien ice-scape gathering views and ideas and working in the studio; of physically getting to the studio, being there and creating. The second trip is internal as I swim through the tricky terrain of coping and isolation . . . Of course there is the great deal of Antarctic camaraderie, exhilaration, freedom. . . Both trips so far are going well. 765*

Such accounts serve to highlight the different intellectual challenges involved in producing art in Antarctica than would be experienced in an 'art environment'. For

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[762] S. Eastaugh, 2009, p.51

[763] A. Crawford, 'Antarctica's icy calling', Article, Fairfax Digital, 6 December 2003, available from http://www.theage.com.au/articles/2003/12/03/1070351649178.html?from=storyrhs (accessed 21/9/2014) web page

[764] S. Eastaugh in A. Crawford, 'Antarctica's icy calling', Article, Fairfax Digital, 6 December 2003, available from http://www.theage.com.au/articles/2003/12/03/1070351649178.html?from=storyrhs (accessed 21/9/2014) web page

[765] S. Eastaugh, 2009, p.49

Exhibition Curator Fernando do Campo this type of programme presents a theoretical and conceptual challenge concerning the geographic and artistic placing of practice that requires a thorough process of unpacking. [766] This suggests that the context, in particular site-specificity, is significant to reading these images. Eastaugh work is primarily suited to a gallery context, but according to do Campo 'its reading cannot be separated from site'. [767] Consequently, when discussing these Antarctic images 'the viewer cannot separate the work from an Antarctic-specific (site-specific) reading, at the same time the work remains within a more conventional art-object/viewer canon that is not readily associated with site-specificity' [768] The significance of Eastaugh's work therefore lies in the context in which the images were conceptualised and created rather than the context in which they are viewed. The curator also points to the notion of invention, whereby the artist is the explorer, the researcher, and the inquisitor. [769] From this concept human knowledge of Antarctica emerges through Eastaugh's conceptual relationship to site and materiality and is manifest in the imagery that portrays the transient nature of habitation as well as the remoteness of the continent.

5.3.4 The Transfer of Knowledge

Research has shown the engagements between art and science constitute different perspectives and separate ways of knowing, and for such relationships to achieve a degree of success some sharing of ideas and ideals is necessary. A realisation that is emphasised in Robert Pepperell's oft-cited argument: 'If we are to find a reliable way of integrating knowledge between science and art, then the intellectual traffic must pass in more than one direction'. [770] Pepperell was referring to the inadequate and incomplete transfer of knowledge between researchers whereby limited understanding by one discipline of another's system of knowledge results. The term 'knowledge transfer' may apply to translation, exchange, utilization, implementation,

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[766] F. do Campo,' keeping the right distance', Curatorial Essay, Exhibition Catalogue, *An Awfully Beautiful Place: The Antarctic Art of Stephen Eastaugh*, Carnegie Gallery, Hobart, 7 June - 1 July 2012, pp.10-13, available from http://www.antarctica.gov.au/__data/assets/pdf_file/0004/142897/Stephen-Eastaugh-art-catalog.pdf (accessed 19/09/2014) p.10

[767] F. do Campo, p.11

[768] F. do Campo, p.11

[769] F. do Campo, p.11

[770] R. Pepperell, 'Einstein Picasso: Space, Time, and the Beauty that Causes Havoc' & 'Inner Vision: An Exploration of Art and the Brain', Review Article, Leonardo Reviews, May 2003, available from http://www.leonardo.info/reviews/may2003/Einstein_pepperell.html (accessed 17/09/2014) web page

diffusion, distribution, management; as well as many combinations such as 'research transfer', 'research utilization', or 'knowledge utilization'. [771] Because this study is concerned with the 'intellectual traffic' between art and science and the issues of visual representation, knowledge transfer involves the process of exchanging or transmitting various forms of knowledge among researchers and across disciplines. And as this study argues, images, as an area of commonality between art and science, provide an avenue for knowledge transfer across disciplines. Even though the methods of conveying knowledge to ensure its availability for users have changed since paleolithic societies depicted their concepts of the world onto cave walls, the notion of knowledge transfer across disciplines remains problematic for some scholars. The process of transmission for example, is dependent on knowledge type, which implies that some have access to important truths that need to be learned, accepted, adopted and implemented by others. [772] However, the benefits of sharing knowledge across diverse disciplines such as art and science is documented in the work of many scholars. Jill Scott for instance, argues that sharing ideologies is a solid base for innovation, production, distribution and socio-cultural potential. [773] Adding further that exchanges in skills and knowledge are becoming evident as artists are beginning to understand scientific methodologies and scientists are starting to value the aesthetic and communicative skills of artists. [774] In addition to gaining a broader understanding of science, sharing concepts and methods across disciplines has enabled artists to critically evaluate their own practice.

The recent work of Chris Henschke is illustrative of a multidirectional flow of information and knowledge. The artist's experiments with light and technology, for example, are realised through the imagery produced as the result of collaborative research at the *Australian Synchrotron*. [775] Henschke's residencies at *the Australian*

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[771] P. J. Graham, 'Knowledge Transfer in Theory and Practice: A Guide to the Literature', Report, 2008, available from https://www.academia.edu/1962622/Knowledge_Transfer_in_Theory_and_Practice_A_Guide_to_the_Literature (accessed 21/09/2014)

[772] B. Head, 'From knowledge transfer to knowledge sharing? Towards better links between research, policy and practice', in G. Bammer (ed.), *Bridging the 'Know-Do' gap: Knowledge brokering to improve child wellbeing*, ANU E Press, Canberra 2010, p.266
H. M. Collins, The Structure of Knowledge', *Social Research*, Vol.60, No.1, 1993, pp.95-116, categorised knowledge as embrained, embodied, encultured, embedded and encoded.

[773] J. Scott, 2006, p.24

[774] J. Scott, 2006, p.24

[775] The Australian Synchrotron, opened in 2007, houses a 3GeV third-generation circular synchrotron that accelerates electrons to almost the speed of light. As the electrons are deflected through magnetic fields they create narrow beams of extremely

Synchrotron through the Arts Victoria and the Australian Network for Art and Technology provided an opportunity for the artist interact with experimental scientists who work with light. According to Henschke these experiences and experiments serve to illuminate his personal methodology and provide insights into the nature of scientific research. [776] Significantly, Henschke proposes that artists should engage with scientists at an informed and critical level, because such dialogue not only gives scientists a different perspective on their research and methods, it also increases their understanding and appreciation of artistic processes.[777] Equally important to free flowing intellectual traffic is the capacity to learn about each other's processes and knowledge. In highlighting this issue, Jill Scott suggests that it is the responsibility of the artist to acquire robust scientific knowledge prior to attempting any collaborative relationship with science. [778] In keeping with authors such as Scott, as well as Charles Kostelnick and Michael Hassett, 'robust knowledge' involves the specific properties of scientific communication including the visual conventions used in communicating disciplinary concepts, as well as a high level of understanding in relation to different terminology including the metaphors used to explain scientific activity. [779] For Henschke this type of communication was particularly challenging, primarily because the *Synchrotron* represented a high level of theoretical and technical complexity involving a wide range of scientific disciplines with specific visual conventions and methodologies. However, one area of commonality was the use of digital technologies and methods by which the sciences visualise data, additionally many of the processes in contemporary media art share many properties with those of scientific research. [780] To this extent the data

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bright light, which is channelled down beamlines to experimental workstations where it is used for research. Synchrotron light is advancing research and development in fields as diverse as the biosciences, medicine, the environmental sciences, agriculture, minerals exploration, engineering, forensics and the development of advance materials.

[776] C. Henschke, 'Colliding Light', in M. Rosengren, & C. Kennedy, (eds.) *SPECTRA: Images And Data In Art/Science: The currency of images in the studio and the laboratory*, Australian Network for Art and Technology (ANAT), Adelaide, 2014, pp.32-36, available from http://www.anat.org.au/wp-content/uploads/2014/05/SPECTRA-book-FINAL-low-res.pdf p.35

[777] C Henschke, 'Aspects of the Art/Science Equation – Media Art Meets High Energy physics', in K. Cleland, L. Fischer, & R. Harley, (eds.) *Proceedings of the 19th International Symposium of Electronic Art,* ISEA, 2013, Sydney, 2013, pp.1-4, available from http://ses.library.usyd.edu.au/bitstream/2123/9633/1/aspectsartscience.pdf (accessed 22/09/2014) p.4

[778] J. Scott, 2006, p.26

[779] Kostelnick and Hassett, argue that discourse communities such as specific disciplines construct and codify conventions, consequently visual language is best studied in relation to the discourse communities in which it thrives and develop, p.230
 According to Scott, metaphor is important in physics, for example, when PSI scientists explained how their cosmic-ray detector could detect and measure muon particles, they used the metaphor of a dinner plate to describe how 60 muons cover its surface every second

[780] C. Henschke, 'Communicating across the specialization barriers…' *AIR Residency: Australian Synchrotron* [web blog], posted 1/11/2007, available from http://henschke.anat.org.au/?p=19 (accessed 12/08/2014) web page

screen provided a site whereby artists and scientists could visually represent their concepts. And so, the tools utilised in data analysis and representation also provided an avenue to produce art, and 'although the results are very different, the shared elements and methods point to a fundamental form of visualization common to both disciplines'. [781] Rather than a lack of communication between the two cultures, Henschke's experimental interdisciplinary images serve to indicate that the 'intellectual traffic' did travel in both ways. This is evident in Henschke's final experiment at the *Synchrotron*, which was developed through collaborative research with Synchrotron accelerator physicists Martin Spencer and Mark Boland, and with the help of Dr Andreas Wilde, at Dresden's *Fraunhofer Institute for Integrated Circuits*. This experiment, described as a 'relationship between sound, sight and matter', involved complex sound frequencies inaudible to the human ear that were transformed into data formats and later utilised to construct images such as *Smaller Frequencies* (Fig. 18). [782]
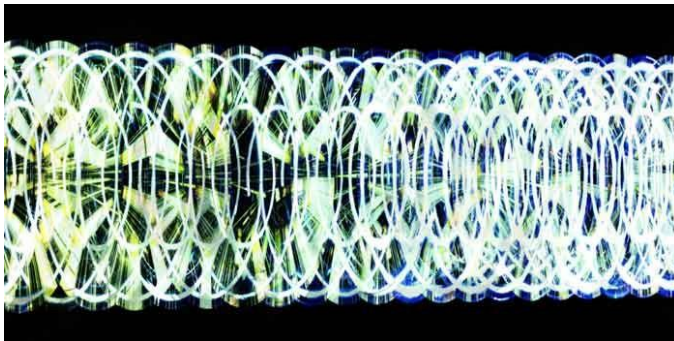

Figure 18

By adapting the scientific methodology of experimentation and data collection to investigate materials and materiality, Chris Henschke's work involves the processes of digital media, which brings together different aspects of the practices of science in order to produce art. The artist acknowledges that it was through the development of these techniques that the formal and conceptual elements of the synchrotron were brought together in various combinations, often with unexpected results, some of

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[781] C. Henschke, 2007, web page
[782] C. Henschke, 'The final experiment', AIR Residency: Australian Synchrotron [web blog], posted 22/12/2007, available from http://henschke.anat.org.au/?s=pich (accessed 12/08/2014) web page

which the artist referred to as 'accelerator expressionism'. [783] This combination of energy, invisible fields, image and sound manipulation processes results in experimental images such as the previously mentioned *Smaller Frequencies* as well as *Infra-red experiment* (Fig. 19) and *The New Sun* (Fig. 20).
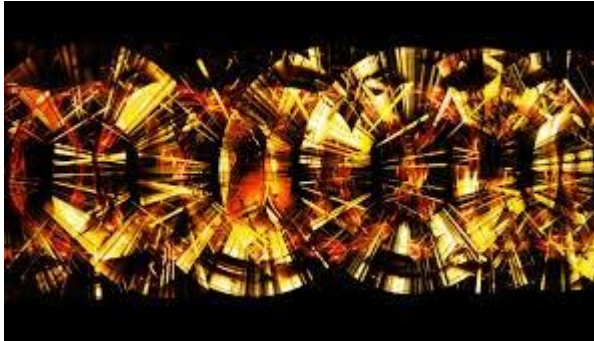

Figure 19

Figure 20

Even though Henschke's images function to make the invisible visible they were primarily concerned with bringing art before the eye of the viewer. Rather than utilise technology for the purposes of making previously invisible phenomena visible, Henschke creates artworks by using the 'invisible' phenomena itself, thereby evoking Paul Klee's oft-cited dictum; Art does not reproduce the visible, but rather makes visible. [784] In this way Henschke's images function to provide new insights into the research activities of both art and science, in addition to challenging the

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[783] C Henschke, 2013, p.2
[784] Klee's dictum was the opening statement in his 1920 essay *Creative Credo*.

scientific understanding, and ownership of the phenomena manifested through high energy experiments. [785] The art/science residency thus provides a site in which to compare and contrast the different methodologies of art and science. Henschke demonstrates that through the development of collaborative experiments using 'hands-on' and emergent methodology correlations do exist between art and science.[786] One such cross-disciplinary correlation includes the use of collage and montage. Noting that collage has a role even in the most precise of disciplines, Henschke makes the point that:

> *The physicist David Bohm championed 'the importance of "mental play" in connecting seemingly disparate phenomena or ideas in scientific research, he described the state of mind in developing new ideas in science as being a 'poetic equating of very different things [in which there is] a kind of tension or vibration in the mind, a high state of energy'.* [787]

Although Henschke continues to emphasise the interdisciplinary approach to his work this utilisation of scientific methodology highlights the views held by artist Jon McCormack who argues that rather than be a 'handmaiden' to science, art needs to evolve out of its reputed triviality and take on science's inquiry into life, death and the form of the universe as well as raise awareness of the implications of fields such as biotechnology and information science. [788] While Henschke's work 'takes on' science's inquiries, it also acknowledges a long tradition concerning the transfer of knowledge and methods between art and science, whereby artists develop their own agenda and undertake their own investigations. That this tradition has proven particularly productive for artists is evident in the work of artists such as the previously mentioned Jean Metzinger and more recently in the work Stephen Eastaugh. Although knowledge sharing is central to the success of Henschke's work, the art/science residency also functions to argue the existence of a link between

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[785] C. Henschke, 'High Energy Art Experiments', Abstract, *Energies in the Arts Conference,* 13–15 August 2015, Sydney, available from http://www.niea.unsw.edu.au/sites/default/files/150630_EnergiesConf_A4_Web_V2-4.pdf (accessed 20/10/2015) p.4

[786] C Henschke, 2013, p.1

[787] C. Henschke, 2014, p.35

[788] J. McCormack cited in O. Richardson, 'Worlds collide or collude? Science and art, at heart, share a sense of wonder', Sydney Morning Herald, article, posted 16/7/2012, available http://www.smh.com.au/entertainment/art-and-design/worlds-collide-or-collude-science-and-art-at-heart-share-a-sense-of-wonder-20120715-22411.html (accessed 20/10/2015) web page

media art and experimental physics. [789] Thus, as rhetor the artist was not only prepared to put forward his works and experiences gained through the process of knowledge sharing that the residency afforded, but in this role the artist also evokes the authority of historical and philosophical scholars, such as Karl Popper and Ernest Gombrich, in order to lend credibility to the argument that connections exist between art and science.

5.4: Images: Sites of Engagement

This study argues that in contrast to the traditional notions of knowledge whereby the verbal is privileged over the visual, images have a significant role in intellectual discourse, and as a site of commonality between art and science images provide an avenue for art's claim as form of inquiry. This claim is realised through the works and treatises of image-makers such as Albrecht Dürer as well as through the more recent images constructed through artist's engagement with science. Works such as Chris Henschke's experimental montages, that combine audio and visual material, provide an effective framework in which to advance the argument that art is an intellectual form of inquiry. The works produced by artists such as Dürer and Henschke demonstrate that an image is not a homogenous entity, but encompasses heterogeneity in a variety of forms and in various domains of inquiry. In this way the description of the image continues to evolve to include a 'new media' in which images transcend tangible materiality to include transient works that may involve some degree of interactivity.

In addition to representing multiple ways of knowing through interdisciplinary practice these images provide an avenue for the visual communication of concepts across disciplines. Art and science are different paradigms that share formal and abstract properties and that interdisciplinary experimentation, such as the images produced at the Synchrotron, act to reveal the existence of deep connections between the disciplines, which can propel both into new areas of research and discovery. [790] For Dürer this communication of concepts also involved a collaborative process

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[789] C Henschke, 2013, p.4
[790] C. Henschke, 2014, p.36

across knowledge domains whereby knowledge, or certainty, was based on first-hand experience of nature which was expressed by realistic representation. [791] This first-hand experience was primarily dependent upon the practices of visual observation, which was essentially the domain of the artisan rather than the philosopher. The work of Henschke and Dürer is indicative of a tradition of image-makers who have positioned their work, produced through an engagement with the natural world, as argument that the productive knowledge of the artist constitutes a form of knowledge because it is grounded in theory. This position was the focus of Dürer's many treatises in which the artist stated that treatises on sculpture and painting 'could no longer be limited to supplying generally accepted patterns and recipes but had to equip the artist for his individual struggle with reality. [792] Along these lines image-makers continue to shape knowledge in order to communicate their reality to a wider world.

The 1503 drawing *Large Piece of Turf* (Fig. 21) by Albrecht Dürer continues to attract the attention of a range of scholars from various disciplines. For this study the drawing represented both a site of understanding and a site that combines making and thinking and therefore a site intellectual engagement. In keeping with the objectives of this chapter, which functions as a framework in which to argue that art is a legitimate form of knowledge by highlighting the relationship between art and science through visual rhetoric, *Large Piece of Turf* serves to illustrate the different claims to knowledge of art and science as well as the validity of images as sites of knowledge production and communication.

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[791] P. H. Smith, 2006, p.95

[792] A. Dürer, in E. Panofsky, *The Life and Art of Albrecht Dürer* (3rd edn.), Princeton University Press, New Jersey, 1967, p.243

Figure 21

Also referred to as the *Great Piece of Turf* , the drawing, a seemingly random group of wild plants, is described by Pamela Smith as one of Dürer's most famous nature studies in which the artist created a new type of nature study '- in its depiction from ground level, in its lack of framing (in which it resembles a landscape)'. [793] For Karen Reeds the drawing represents the missing link between the naturalistically rendered plants in the religious paintings of the fifteenth century and the naturalistically rendered plants in the mid-sixteenth-century herbals. [794] By comparing the drawing with the illustrations of botanical treatises by natural philosophers Hans Weiditz and Otto Brunfels, Reeds suggests that Dürer 'somehow granted himself permission to draw natural objects as portraits rather than symbols' that 'had to signify something more portentous', that was soon adopted by fellow artists. [795] Reed has thus suggested that 'Durer has, in short, invented a new subject for the artist: nature studied for its own sake'. [796] According to these views the *Large*

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[793] P. H. Smith, 2004, Gallery following p.152/Plate 12

[794] K. Reeds, 'Review: Fritz Koreny, Albrecht Dürer and the Animal and Plant Studies of the Renaissance', *Isis*, Vol.81, No.4, 1990, pp.766-768 available from

http://www.jstor.org.ezproxy.usq.edu.au/stable/pdf/233851.pdf?acceptTC=true&jpdConfirm=true (accessed 21/10/2015) p.768

[795] K. Reeds, p.768

[796] K. Reeds, p.767

Piece of Turf provides the vehicle by which to argue for a change in the status of the artist as well as effect a change in artistic practice. In line with the notions of twentieth and twenty-first-century artists such as Pablo Picasso and Stephen Eastaugh, Dürer's engagement with nature had provided new ways to conceptualise reality and new ways of creating images. Conforming to the Renaissance ideal that the work of art is the direct and faithful representation of a natural object; Dürer argued that 'the more accurately one approaches nature by way of imitation, the better and more artistic thy work becomes.' [797] In agreement with Smith this suggests Dürer's theoretical claims are demonstrated in his treatises as well as through his works of art.

The *Large Piece of Turf* demonstrates a close study and rendering of the natural world, the result of careful observation and theorizing about nature. The careful rendering of nature involves the technique of 'hyperrealism', which according to Sachiko Kusukawa emphasises key features by 'selecting out potential optical confusions'. [798] Dürer's work is highly regarded for its accurate depiction of nature and the utilisation of hyperrealism afforded pictorial simplicity. As Karen Reeds observed, the 'botanical clarity of the scene is enhanced by what is not there: Dürer has tidied away the usual litter of dead grasses, leaves, and moss'. [799] In the *Large Piece of Turf* hyperrealism functions as a rhetorical device in which to convince the viewer that nature exists according to underlying principles and patterns. Through his work, Dürer articulates his knowledge about nature, which according to the artist, had the same authority as 'certain knowledge' or *scientia.* [800] To this extent the *Large Piece of Turf* represents the site of intellectual engagement whereby the artist not only demonstrates his engagement with nature, but also demonstrates his engagement with the prevailing theories of art. The work also functions rhetorically by demonstrating that productive knowledge is equal to theoretical knowledge. In this way the *Large Piece of Turf* is representative of the objectives of this chapter, primarily because this image not only represents a five hundred year tradition of

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[797] A. Dürer, 1967, p.243
[798] P. H. Smith, 2006, p.95
[799] K. Reeds, p.768
[800] K. Reeds, p.768

artists' visual engagement with science, but like Chris Henschke's *Smaller Frequencies* and Jean Metzinger's *Nude*, the *Large Piece of Turf* challenges the traditional concepts of knowledge by inviting the viewer to understand that different concepts of knowledge exist and that art's way of knowing has as Dürer stated, the same authority as science.

This chapter has demonstrated that image-makers have a long functioned to communicate complex concepts to viewers in various contexts. As rhetor, the image-maker has traditionally shaped information in order to construct knowledge and transmit that knowledge in a meaningful way. The concept of image-maker as the shaper of knowledge contrasts with the long held distinction between making and thinking. However as this chapter has shown the links between making and thinking have been established since Aristotle argued that techne is a form of knowledge that involves understanding. These links have been maintained through the work of the early artisan whose claim to knowledge is demonstrated in the visual images in which nature was portrayed as they saw it. More recently artists have reinforced the notion that art is primarily a knowledge discipline by shaping the way in which scientific concepts are communicated to the wider world.

Chapter 6:

Impression & Perception: An Invitation to See

6.1: Establishing Meaning

6.1.1 Images: Rhetorical Sites

The previous chapter established the image-maker as rhetor, whereby artisans and artists were concerned with the process of visually shaping knowledge in order to communicate artistic and scientific concepts. By demonstrating that rhetoric is an intellectual strategy that involves the representational means by which scholars bring forth new findings and thus new knowledge, chapter five also serves to illustrate the links between the theoretical and the practical and productive forms of knowledge. [801] This chapter extends on the work of the previous chapter by focusing on the image-makers' relationship with the human body, as well as with other forms of inquiry that include the life sciences. The tangible evidence of this association are the images that function to create meaning and advance understanding of the complexities that concern the body. Images of the body have existed in various forms since prehistoric times, and both the images and the body itself have long been the subject of speculation, myth and extensive study. Such consideration has attracted scholars from both the arts and the sciences; which throughout history has sought to explain the exterior of the human form as well as its inner structures and functions. For art, the human form is considered to be one of the most enduring themes and more recently the body itself was recognised as a medium in which artists created their work. [802] The body has also proven to be a continuous site of research for science, primarily to advance the knowledge of human structure and function and to identify the position of humans in a wider world.

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[801] C. Wickman, p.24

[802] A. Pakes, 'Original Embodied Knowledge: the epistemology of the new in dance practice as research', *Research in Dance Education*, Vol.4, No.2, 2003, pp.127-149, available from http://www.tandfonline.com.ezproxy.usq.edu.au/doi/pdf/10.1080/1464789032000130354 (accessed 08/05/2014) p.141

The body then is a site of inquiry across disciplines, but significant to this study are the images that provide an avenue for, and are the result of, these inquiries. These images demonstrate the various ways in which image-makers reflect upon and interpret the concepts inherent in these forms of inquiry. These investigations are concerned with what is directly visible as well as that what is seen by the 'mind's eye', and range from early forms of 'medical' research to an idealised idea of beauty of the human form to more recent issues that depict the societal consequences, as well as possibilities of science. Consequently, these images involve an interdisciplinary mode of research in which image-makers challenge the traditional concept of knowledge as primarily verbal, linear and science focused. These images also provide a framework in which to argue the significance of the image as mode of inquiry as well as art's claim as a knowledge discipline. This study presents art and science as rhetorical disciplines because both employ images as a means by which to persuade and influence. Taking into account the notion of the image-maker as rhetor, chapter six proposes that images are rhetorical sites in which knowledge is shaped as a means to construct and present meaning. Firstly, this chapter will provide a framework in which to present images as a rhetorical strategy of significance to scholars by outlining the complexities involved in interdisciplinary modes of inquiry. This is followed by a discussion on the images concerning anatomical knowledge whereby the dissected body is mined for information in order to produce knowledge. The chapter then considers the works that present the living body as a site of interdisciplinary engagement. The chapter concludes by illustrating how concepts are communicated visually in art and in science.

6.1.2 Borrowing: A Long Tradition

The images explored in this chapter are evidence of the visual arts' long tradition of borrowing from science, a custom which persists to the present day, as well as sciences' practice of utilising images for the production and communication of concepts. The notion of borrowing or reusing existing concepts and elements is a well-established practice in visual art and these strategies were utilised by artists such as Pablo Picasso, Marcel Duchamp and Barbara Kruger. For Duchamp and Kruger borrowing concerned the concepts of originality. While Duchamp challenged

the conventional ideas of originality, Kruger was 'keen to deny the notion of originality', believing that, in 'borrowing existing imagery or elements of imagery, they are re-contextualising or *appropriating* the original imagery, allowing the viewer to renegotiate the meaning of the original in a different, more relevant, or more current context'. [803] Although many of Picasso's images are in part the result of his engagement with science, the artist's work is also evidence of his appropriation of concepts from other forms of knowledge. Thus, in addition to the issues of originality, authenticity and authorship, Picasso's use of appropriation was usually associated with his borrowings from the history of art. [804] For example, the oft-cited *Les Demoiselles d'Avignon*, not only marks a break with the 'traditional' notions of perspective, but it is widely acknowledged by art historians that Picasso referenced traditional African carvings in order to paint the stylised figures that constitute the 1907 work. Appropriation in art therefore concerns references to history and culture in addition to references to science.

Other than the appropriation of an 'artisanal epistemology', which involved the craftsperson's materials as well as the artisanal techniques of observation and documentation during the early modern period by the natural philosophers, little information relating to science borrowing from art exists. This is in contrast to a profusion of publications relating to the various ways in which art has appropriated topics and methodologies from science. The paucity of published documentation concerning this issue suggests either a lack of exposure or suboptimal communication by the scientific community. However as part of the *Science in Culture Project* a team of interdisciplinary researchers at the University of Reading, attempted to resolve the question, 'What, if anything, can science learn from the humanities?' in the 2012 scoping study *The Value of the Literary and Historical Study of Biology to Biologists*. [805] The aim of the study was to establish whether

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[803] H. A. Rowe, 'Appropriation in Contemporary Art', *Student Pulse* Vol.3, No.6, 2011, available from http://www.studentpulse.com/articles/546/appropriation-in-contemporary-art (accessed 21/11/2015) on-line journal, web page
[804] T. A. Burgard, 'Picasso and Appropriation', *The Art Bulletin*, Vol.73, No.3, 1991, pp.479-494, available from http://web.a.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=4d0a09d9-7eec-4688-95e4-026db4e7421f%40sessionmgr4005&hid=4209 (accessed 04/10/2014) p.479
[805] N. Battey, 'The value of the Literary and Historical study of Biology to Biologists: a scoping study', *Cultivating Common Ground: Biology and the Humanities: University of Reading* [web blog], available from http://blogs.reading.ac.uk/cultivating-common-ground/2012/10/18/the-value-of-the-literary-and-historical-study-of-biology-to-biologists-a-scoping-study/ (accessed 24/11/2014) web page

work on biology within the humanities was of value to practicing biologists through an exploration of 'how working scientists perceive and respond to humanities scholarship which takes science as its subject of study'. [806] Rather than 'borrowing' concepts and methodology, the study focused on the benefits of collaborative communication and interdisciplinary engagement. Although the research findings concerning the research question were inconclusive it was noted while there remained some obstacles to interdisciplinary research. These obstacles include issues such as entrenched research cultures and the perception that the humanities are committed to a constructivist anti-realism which denies the possibility of objective knowledge, there was however a 'strong sense that both research and teaching in biology could benefit from more engagement with the humanities; and a perception that both humanities and biology students would gain from being taught alongside one another.' [807] The scientists' located their research within a framework of interdisciplinarity rather than within the concept of science learning or 'borrowing' from the humanities. Consequently, the phenomenon of borrowing is a complex issue involving various approaches including interdisciplinarity. Rather than focus on sciences' problematic relationship with borrowing, this study is concerned with an interdisciplinary mode of inquiry in which borrowing refers to the notion that knowledge is transmitted, transferred, adopted and implemented through the practice of sharing among disciplines.

6.1.3 Argument, Persuasion, and an Invitation to Understand

Scholars, including Caroline van Eck and David Summers, have observed that philosophers, such as Leon Battista Alberti, borrowed from rhetoric when they employed Humanist theories to establish theories of art during the Renaissance. According to Summers the critical attitudes of Renaissance writers, both of painting and poetry, were defined by the tradition of rhetoric. [808] And so rhetoric, which was a language based system, provided the framework for early theorists in which to define

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[806] University of Reading, *The value of the Literary and Historical study of Biology to Biologists: a scoping study*, University of Reading: Arts & Humanities Research Council, 2012, available from www.esrc.ac.uk/.../a5be4721-aec6-4ab0-a9fc-9a0a510bd116 (accessed 27/03/2013) p.7
[807] University of Reading, p.44
[808] D. Summers, in C. Goldstein, 'Rhetoric and Art History in the Italian Renaissance and Baroque', *The Art Bulletin*, Vol.73, No.4 1991, pp.641-652, available from https://jelenatodorovic.files.wordpress.com/2010/09/goldstein-rhetoric-and-art-history1.pdf (accessed 25/01/2015) p.642

and critically evaluate visual art. [809] For artists rhetoric was the craft of communication involving the construction, transmission and interpretation of meaning through the employment of various devices. The visual metaphor, for example, has been widely recognised by artists as a valuable rhetorical strategy. Mireia Ferrer Álvarez alludes to the extensive use of metaphor in *Vanitas* paintings which function to remind the viewer of the transience of life. [810] In these works artists drew on iconic devices such as funerary masks, skeletal forms and decaying fruit, as well as dissection scenes in order to give meaning to pain and suffering and the inevitability of death. For Stephen Kellert interdisciplinary borrowing involving rhetoric draws attention to the functions rhetoric serves in academic inquiry. The persuasive function for instance, might be illustrated by questions such as, 'What are the borrowers trying to accomplish? How are they using knowledge from the physical sciences to get something done?', and to consider 'discursive resources that can be mobilized for certain goals' as well as 'techniques, specifically arguments, that are used to secure agreement among people'. [811] These questions serve as a guide in which to consider the *Vanitas* of the late nineteenth century such as Enrique Simonet Lombardo's 1890 painting *And she had a heart! (Anatomy of the Heart)* (Fig. 22). The work combines anatomical research with artistic production and depicts a dissection scene in which an anatomist is holding in his hand the heart of a young woman, supposably a prostitute, who committed suicide.

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[809] C. Goldstein, 'Rhetoric and Art History in the Italian Renaissance and Baroque', *The Art Bulletin,* Vol.73, No.4 1991, pp.641-652, available from https://jelenatodorovic.files.wordpress.com/2010/09/goldstein-rhetoric-and-art-history1.pdf (accessed 25/01/2015) p.643

[810] M. F. Álvarez, 'The Dramatisation of Death in the Second Half of the 19th Century. The Paris Morgue and Anatomy Painting', in Petö, A. & Schrijvers, K. (eds.), Faces of death: visualising history, Thematic Work Group 4: Work, Gender and Society IV, Plus-Pisa University Press, Pisa, 2009, pp.163-187, http://www.cliohres.net/books4/4/07.pdf (accessed 20/02/2013) p.170

[811] S. H. Kellert, *Borrowed Knowledge: Chaos Theory and the Challenge of Learning across Disciplines*, The University of Chicago Press, Chicago, 2008, p.58

Figure 22

Álvarez explains that *Vanitas* paintings involve what is referred to as 'moralising anatomies' which are representations with a moral and contemplative theme in addition to the scientific and artistic content. [812] These works contrast with what is referred to as the *anatomia sensibile*, these are the representations of the human body that were painted as the result of observation and anatomic study, a practice which was not exclusive to science but was one of the great concerns of Renaissance painters. [813] Consequently, the image *And she had a heart! (Anatomy of the Heart)* offers a correct study of the human body in addition to moral and philosophical contemplation. Álvarez suggests the moral and philosophical reminders were not limited to the metaphor of woman as the source of nature and the discovery of truth represented by the female body, but also portrayed humanity's concern for the major issues of life and death. [814] These concerns are alluded to through the reproduction of Hamlet's gesture of staring at a skull and pronouncing the famous phrase 'to be or not to be, that is the question'. [815] In this way the work mirrors the artistic practice of portraying death within the embedded dialogue of cultural practices, and to this extent Álvarez argues the image is a clear example of how symbolism reinterpreted the anatomical subject. [816] Borrowing from rhetoric in this case involves the *use* of symbolism, rather than symbolism itself, in order to persuade the viewer of the

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[812] M. F. Álvarez, p.170
[813] M. F. Álvarez, p.170
[814] M. F. Álvarez, p.183
[815] M. F. Álvarez, p.183
[816] M. F. Álvarez, p.181
The cultural practices of death during nineteenth-century Paris included the dramatization of public spaces, such as hospitals and morgues, into socializing spaces.

existence of important questions concerning life and death as well as the significance of an emerging science to answer these questions. As a constant leitmotif, Álvarez claims 'the representation of death formed a mirror in which society's virtues and vices were reflected; the antinomy of a society in which life and death, perdition and redemption defined the contradictions of the positivist crises'. [817] Thus the image serves to argue that society's response to death is a reflection of other societal practices of the time. Vanessa Schwartz refers to such works as 'spectacular realities' of urban culture, in that:

> *The visual representation of reality as spectacle in late nineteenth century Paris created a common culture and a sense of shared experiences through which people might begin to imagine themselves as participating in a metropolitan culture because they had visual evidence that such a shared world, of which they were a part, existed.* [818]

For Álvarez works such as *And she had a heart! (Anatomy of the Heart)* also function as a conceptual route in which to understand that 'Paris was the stage, *les parisiens* the protagonists, and the plot: reality'.[819] Moreover it is only after travelling this route that we can understand how a building such as the Morgue, a place which signified death, could become a place for socialising, 'a container for the reality of modern life, a focus of social attraction, a mirror in which society contemplated death and disgrace as part of the general spectacle of life'.[820] From a perspective of invitational rhetoric Enrique Simonet Lombardo's work would read as an invitation to understand death within the social context of nineteenth-century Paris's culture of the sceptical.

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[817] M. F. Álvarez, p.182
During the last decades of the 19th century Symbolism was an art movement representing the changes that fin de siècle society was witnessing. The style coexisted with realism and naturalism. Symbolism had its roots in the depths of the romantic credo and inherited the latter's predilection for the vast universes of the irrational and unknown, and its penchant for mysticism and decadence. Death reappeared in artistic imagery as the most appealing subject for representation.
Among the various ways in which death was represented by symbolism, the myth of the young woman drowned and recovered from the waters of a river becomes one of the most recurrent topics for literature and art.
[818] V. R., Schwartz, *Spectacular Realities: Early Mass Culture in Fin-de-Siècle Paris,* University of California Press, Berkeley, 1998, p.6
[819] M. F. Álvarez, p.166
[820] M. F. Álvarez, p.166

6.1.4 Context: Sites of Meaning-Making

The relationship between meaning-making and interpretation generally refers to the context in which an image is viewed. [821] Images such as Leonardo's anatomical images invite various interpretations which arise because although these are images of science they are predominantly viewed in a museum of art where they attract a wide viewing public with different perspectives. Thus Leonardo's images derive meaning through the context of display. Lawrence Prelli explains that 'the meanings manifest rhetorically through display are functions of particular, situated resolutions of the dynamic between revealing and concealing. Put directly, whatever is revealed through display simultaneously conceals alternative possibilities'. [822] Furthermore, whatever is made manifest is the culmination of selective processes that constrain the possible meanings available to those who encounter them. [823] Therefore, despite the notion that meanings can be conflicting, multiple and open-ended, the image-maker, or the curator in the case of the aforementioned images, has a significant role in the interpretation of images. Consequently, in addition to the context of construction the context of viewing, or the situation in which persuasion or understanding might occur, is a significant factor in the interpretation of images.

The notion of managing interpretation through the selection of the viewing context concerns strategies such as interpretative planning. Interpretative planning is described as a deliberate and systematic process that involves planning interpretative initiatives for the purpose of facilitating meaningful and effective experiences for visitors, learning institutions, and communities. [824] Britain's Tate Museum describes such plans, which include wall texts and captions, a booklet and a multimedia tour, as 'Tools to Understand' [825] However, the need for such tools ranges from the

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[821] Meaning-making variously refers to [1] the process by which situations and phenomena are interpreted through prior knowledge of situations and experiences [2] the ability to understand [3] promotion of deep understanding

[822] L. J. Prelli, 'Rhetorics of Display: An Introduction', in L. J. Prelli (ed.), *Rhetorics of Display,* University of South Carolina Press, Columbia, 2006, p.2

[823] L. J. Prelli, 2006, p.2

[824] M. Wells, B. Butler & J. Koke, *Interpretive Planning for Museums: Integrating Visitor Perspectives in Decision Making*, Left Coast Press, Walnut Creek, 2013, p.157

[825] M. Scott & R. Meijer, 'Tools to Understand: An Evaluation of the Interpretation Material used in Tate Modern's Rothko Exhibition', *Tate Papers,* No.11, Spring 2009, available from http://www.tate.org.uk/research/publications/tate-papers/11/tools-to-understand-an-evaluation-of-the-interpretation-material-used-in-tate-moderns-rothko-exhibition (accessed 12/12/2015) web page
The Tools were designed for both the inexperienced visitor who had little contextual knowledge of the exhibition as well as the experienced visitor who were not as dependent upon the Tools because of the existence of their contextual knowledge

unexperienced exhibition visitor, who had little contextual knowledge of the exhibited works, to the experienced visitor who had little use for the tools. This is because experienced viewers have enough cultural capital to interpret what they encounter for themselves. [826] To this extent the 'tools of understanding' provide the means by which curators influence context and thus the meaning of an exhibition display. According to Marguerite Helmers the meaning of a work relies on perception, which involves prior knowledge, and the context of viewing, and reception, which is dependent on emotion and structures of feeling created by the work. [827] For Helmers the site of viewing is a site of immense power because of its capacity to mediate the reception of a work. [828] For this study the site of viewing is also a site for meaning-making to the extent that sites such as museums provide both access to and context for intellectual engagement with images that concern both artistic and scientific enquiry. Helmers also makes the point that the context in which the artwork is interpreted is neither ahistorical not value-free, but is instead, 'located in particular beliefs that take place in specific cultural moments'.[829] The notion of a value-laden, rather than the idea of a value-free, system of knowledge is consistent with an interpretative approach to meaning-making which includes the ways in which images construct argument and create meaning. [830]

6.1.5 Presentation of Inquiry: Systems of Display

6.1.5 [i] Bodies of display

The image-maker's long engagement with the life sciences is evidenced by a wide range of works that range from the portrayal of macroscopic anatomical structures to the microscopic discoveries and genetic concepts. For this reason the consideration of the body as the site of intellectual inquiry involves an engagement with the living

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[826] M. Scott & R. Meijer, web page
[827] M. Helmers, 2008, p.84
[828] M. Helmers, 2008, p.78
This concept is also addressed Niamh Brennan in the 2013 essay 'Social Art and New Institutionalism. Examining how the Art Institutions have responded to socially-engaged and participatory art practices'
[829] M. Helmers, 2001, p.89
[830] Most scholars have rejected the notion of an objective value-free inquiry. Denis Phillips, 1990 argues that observation is always theory laden
D. C. Phillips, Subjectivity and objectivity: An objective inquiry', in E. W. Eisner (ed.), *Qualitative Inquiry in Education: The Continuing Debate*, Teachers College Press, New York, 1990, p.25
John Ratcliffe who wrote that most researchers are aware that all data are theory, method and measure dependant where facts are determined by the theories and methods that generate their collection, 'indeed methods create the facts' J. Ratcliffe in D. C. Phillips, p.25

organism in addition to an opportunity to acquire knowledge from the dead. This consideration also exemplifies a sustained dialogue between art and science which in turn advances the notion that these images represent both artistic and scientific forms of inquiry. Consistent with the notion that context provides meaning, the context in which images are displayed is generally dependent on their disciplinary orientation. However in this instance, anatomical drawings present a paradox because they are created for the purposes of both scientific and artistic inquiry. During his career Peter Paul Rubens produced a wide range of anatomical drawings. According to Domenico Laurenza écorché drawings such as Rubens' Anatomical *Studies* (Fig. 23) suggests that the artist's research extended beyond drawing live models and statues to copying the works of others, a practice encouraged by masters such as Leonardo. [831] Many of Rubens' works, including the previously mentioned Anatomical *Studies*, form part of the J. Paul Getty Museum's Open Content Program whereby such images are archived in digital format, making them freely available to share without permission or restriction. In contrast to Rubens' artistic research, Henry Carter's anatomical illustrations are the basis of Henry Grey's 1858 publication *Anatomy, descriptive and surgical*. [832] Carter's images are the product of anatomical research gained through human dissection. And, for Martin Kemp Carter's drawings (Fig. 24) are descriptive and functional and therefore 'useful for the aspiring surgeon and clinician'.[833]

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[831] D. Laurenza, p.41

[832] The title was later changed to Grey's Anatomy. Because of the clarity and usefulness if the illustrations Grey's seminal text was considered a milestone in the history of medicine.

[833] M. Kemp, 'Style and non-style in anatomical illustration: From Renaissance Humanism to Henry Gray', *Journal of Anatomy,* Vol.216, No.2, 2010, pp.192–208, available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2815942/pdf/joa0216-0192.pdf (accessed 21/10/2012) p.205

Figure 23

Figure 24

This contrasts with the function of many of the 'great anatomical atlases' which, according to Carin Berkowitz, served to establish an anatomist's reputation and develop a legacy. [834] Consequently, anatomists established an authorial voice through their atlases because they employed styles of illustration that were responsive to the grand traditions in which the anatomists wanted to be placed. [835] The plates of Andreas Vesalius's *De Humani corporis Fabrica*, for example, portrayed the Renaissance ideal of human beauty, whereas Henry Carter's illustrations are noted for their 'plainness' and functionality, which, according to Kemp, were created within the context of increasing institutionalisation of medical teaching. [836] Despite the differences in what Kemp refers to as 'style', the images that constitute Vesalius's *De Humani corporis Fabrica* and Grey's anatomical publication were created with in a context of scientific research.

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[834] C. Berkowitz, 'The Illustrious Anatomist: Authorship, Patronage, and Illustrative Style in Anatomy Folios, 1700–1840', *Bulletin of the History of Medicine,* Vol.89, No.2, 2015, pp.171-208, available from http://www.chemheritage.org/Downloads/Staff-and-Scholars/berkowitz-illustrious-anatomist.pdf (accessed 5/12/2015) p.205
[835] C. Berkowitz, 2015, p.205
[836] M. Kemp, 2010, p.205

6.1.5 [ii] Exhibiting science

In antiquity a museum was an institution devoted to the encouragement of literature and learning, and as such, the museum served as a centre for scholars and poets. [837] Today universities are charged with the promotion of learning while the museum or gallery is devoted to the preservation of artefacts. However, challenges to this idea argue that the museum remains a site of knowledge construction and meaning making. The notion that contemporary exhibitions are sites of experimentation is advanced by Paul Basu and Sharon Macdonald who argue that, rather than merely a means of 'the display and dissemination of already existing, preformulated knowledges', exhibitionary practice is also an experimental practice.[838] Accordingly, the science museum might be considered as a type of laboratory or a space of knowledge-generation. The association of exhibition to knowledge is consistent with the oft-cited notion that science aims to 'make visible the invisible' whereby exhibitionary practice is linked to the public demonstration of scientific experiments. For Basu and Macdonald this practice demonstrates a break from the Aristotelian epistemologies based on doctrine and the authority of accepted truths to experiment-based empirical science which entailed 'a making visible of the processes by which scientific knowledge was established'. [839] Joseph Wright of Derby captured these ideas of an experimental science in the 1768 work *An Experiment on a Bird in the Air Pump*. The air pump was developed by Robert Boyle and was widely employed to demonstrate scientific concepts and authenticate claims to knowledge. For Boyle the public exhibitions provided the means by which the production of knowledge was not only demonstrated but witnessed.[840] Consequently, to display knowledge-generating procedures was to lend authority to such knowledge.

In addition to the dissemination of information and knowledge between the disciplines, society itself has engaged with the works and discoveries that relate to

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[837] H. Osborne, 'Museums and Their Functions', *Journal of Aesthetic Education*, Vol.19, No.2, 1985, pp.41-51, available from http://isites.harvard.edu/fs/docs/icb.topic1025195.files/Introduction/Osborne%201985%20Museums%20and%20their%20functions.pdf (accessed 18/03/2014) pp.43-44

[838] P. Basu & S. Macdonald, 'Introduction: Introduction: Experiments in Exhibition, Ethnography', in S. Macdonald & P. Basu (eds.), *Exhibition Experiments*, Blackwell Publishing, Malden, 2007, p.2

[839] P. Basu & S. Macdonald, p.3-5

[840] S. Shapin, 'History of science and its sociological reconstructions', *History of Science,* Vol.20, 1982, pp.157-211, available from http://nrs.harvard.edu/urn-3:HUL.InstRepos:3353814 (accessed 26/03/2013) p.482

knowledge. Medical museums, which began as a collecting activity by anatomists and teaching physicians primarily for pedagogical purposes, provided an opportunity for the interested public to explore the vast collections of historical artefacts that range from preserved specimens and wax anatomical models to medical equipment and illustrated anatomical texts. Barbara Maria Stafford traces the practice of collecting and display of 'old polymathic jumble' from the private cabinet of curiosities to public displays which 'required the interpretation of experts'.[841] For this reason museum 'curators' sought strategies that would enable scholarly collections to become meaningful in a social environment. Stafford suggests that such strategies involved discovering methods in which to stimulate visitor participation, whereby the transaction 'was to be entertaining and educational since specimens could pleasingly modify the visitor's expectations and associations'. [842] These strategies of display, which involved the taxonomic presentation of specimens as well as the transfer of those specimens from drawers to glass jars and cabinets so as to facilitate access, also functioned as a communicative device between the museum and the viewer. This mode of presentation has frequently been linked to changes in the dissemination of knowledge. Carin Berkowitz informs us that late eighteenth-century institutions such as The Great Windmill Street Anatomy School and Museum initially served as sites of instruction and learning for medical practitioners, whereby knowledge in anatomy was made, embodied and disseminated through a system of visual displays. [843] These displays included anatomical images and preserved specimens which were 'used in pedagogical contexts, contexts that were also the sites of anatomical research. [844] This system, in which knowledge was visually demonstrated and disseminated, later functioned to disseminate information about scientific discoveries to an engaged public. As such, museums were a site where cultural values, scientific and historical knowledge and public memory can be meaningfully and democratically engaged. [845] In contrast to contemporary museums,

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[841] B. M. Stafford, *Visual Analogy: Consciousness as the Art of Connecting*, The MIT Press, Cambridge 1999, p.255
[842] B. M. Stafford, 1999, p.258
[843] C. Berkowitz, 2012, p.2
[844] C. Berkowitz, 2012, p.2
[845] G. J. Schneider-Bateman, 'Why the Museum? The Disciplinary and Interdisciplinary Value of Gross's Exhibit Analyses', *Poroi,* Vol.10, No.2, 2014, pp.1-11, available from http://ir.uiowa.edu/cgi/viewcontent.cgi?article=1190&context=poro i (accessed 20/10/2015) p.1

which encourage a more interactive engagement through touch, earlier museum encounters were limited to visual displays that discouraged any form of contact.

6.1.5 [iii] Ways of seeing: museums of art

The modern day concept of the exhibition, as the principle mode of presentation of artefacts, is most evident within art museums or satellite spaces of display within the artworld. [846] In the 2005 publication *Thinking about Exhibitions* Reesa Greenberg, Bruce Ferguson and Sandy Nairne explain that, in addition to the medium through which most art has become known, the exhibition has become the 'primary site of exchange in the political economy of art, where significance is constructed, maintained and occasionally deconstructed'. [847] Furthermore, as part spectacle, part socio-historical event, part structuring device, exhibitions establish and administer the cultural meanings of art. [848] Consequently, museums are viewed as institutions of power and rhetoric. Bruce Ferguson explains the notions of power and rhetoric by proposing that museums are 'contemporary forms of traditional rhetoric; complex expressions of persuasion through complex transmissions of voice and image', through which 'wholesale conversion of its audiences to sets of prescribed values to alter social relations' occurs. [849] From this account the museum is a constructed environment whereby meaning is constructed and interpreted within a framework of rhetoric.

The visual artists 'custom of exploring scientific concepts for the purpose of creating art provides an avenue to explore the links between museums of science and museums of art. Biological specimens for instance, are not only housed in museums of science but also feature in displays of art. Such examples include Helen Chadwick's *Unnatural Selection*, a body of work that was the focus of the 1996 exhibition *Stilled Lives*. Chadwick's work was informed through her residency at the Assisted Conception Unit at London's Kings College Hospital and involved an

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[846] N. Curley, 'Exhibition', *Theories of Media,* The University of Chicago, Winter 2007, available from http://csmt.uchicago.edu/glossary2004/exhibition.htm (accessed 12/12/2015) web page

[847] R. Greenberg, B. W. Ferguson & S. Nairne, 'Introduction', in B. W. Ferguson, R. Greenberg & S. Nairne (eds.), *Thinking About Exhibitions*, Routledge, London, 2005, p.1

[848] R. Greenberg, et al, 2005, p.1

[849] B. W. Ferguson, 'Exhibition Rhetorics: Material speech and utter sense', in B. W. Ferguson, R. Greenberg & S. Nairne (eds.), *Thinking About Exhibitions*, Routledge, London, 2005, p.128

engagement with discarded embryonic products.[850] For Andrea Duncan this engagement is best described through the metaphoric titles of the exhibition pieces, as such, '*Opal's* (Fig. 25) associations conjure the jewel-like surfaces of the dividing cells, while *Monstrance*, with its religious reference to the display of the body of Christ during Mass, touches upon grief and upon those lost lives which had almost become something or someone.'[851] (Fig. 26)

Figure 25

Figure 26

The presentation, involving the taxonomic display of the photographed embryos mounted on large plexiglass sculptures of jewellery, reflect those of the natural history museum. Thus, it is through the concept of specimen collection, preservation and display that *Stilled Lives* retained its connections to the science laboratory. This association with scientific displays was described by Suzanne Anker and Sarah Franklin as the '*natural history museum aesthetic*', which serves to foreground artistic productions in an effort to create settings in which specimens are restaged. [852] Chadwick's work functions to highlight the relationship between bioethics and the role of technology in human reproduction. However, the strategies of display also

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[850] K. O'Riordan, p.86

[851] A. Duncan, 'Inside – Outside – Permutation: Science and the Body in Contemporary Art', in S. Ede (ed.), *Strange and Charmed: Science and the Contemporary Visual Arts*, Calouste Gulbenkian Foundation, London 2000, p.153

[852] S. Anker & S. Franklin, 'Specimens as Spectacles: Reframing Fetal Remains', *Social Text*, Vol.29, No.1, 2011, pp. 103-125, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=2&sid=5e8e2e5f-078d-4ca2-b6f9-20508387f078%40sessionmgr113&hid=128 (accessed12/12/2015) p.110

draw attention to the relationship between art and science. For instance, the context of display enabled the viewer to 'see' this relationship by noting the parallels between the presentation of works of art and the presentation of biological and botanical specimens.

The notion that an exhibition provides an opportunity to 'see' is advanced by Svetlana Alpers who suggests that museums are a 'way of seeing', whereby the way of seeing is reliant upon the 'museum effect' which acts to transform objects into works of art by isolating these objects and creating a situation of visual interest. [853] The term the 'museum effect' was coined by André Malraux to refer to the effect whereby the placement of the object within the museum creates its significance and validity. [854] The 'museum effect' continues to be associated with power and influence, which at times has attracted differing levels of controversy. This concept is primarily associated with curators, however, scholars have argued that artists have long embraced the 'museum effect' through their own strategies of collection. James Putnam suggests this tradition of collecting is integral to an artists working method whereby these images and objects are collected for use as research and as a working medium, the studio thus becomes a storage area where ideas and materials are evaluated and classified for incorporation into works of art. [855] Within a framework of bioart, Putnam's argument, that museums are formal constructions that have an aesthetic and conceptual significance to the viewer, lends credibility to Svetlana Alpers' notion that the museum is a way of seeing. [856] This is because bioart, which according to Ingeborg Reichle is art from the laboratory, invites 'looking' from viewers of different perspectives. [857] It is also because the museum, through its strategies of display would transform a bioart exhibit into something of visual interest which has an aesthetic and conceptual significance both artists and

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[853] S. Alpers, 1991, pp.25-26

[854] V. Casey, 'The Museum Effect', Presentation Paper, ICHIM 03: The Seventh International Cultural Heritage Informatics Meeting, Le Louvre, Paris September 2003, available from http://www.valcasey.com/thesis/thesis_effect.html (accessed 12/07/2015) web page

[855] J. Putnam, 'The Museum Effect', in M. Ryan, *The Museum Effect, Exhibition Catalogue*, 14 May-28 June 2009, Lake Macquarie City Art Gallery, 2009, preview available from http://peteratkins.com.au/library/file/Preview%20of%20%E2%80%9CMuseum%20Effect%201.jpg%E2%80%9D.pdf (accessed 12/12/2015) p.7

[856] J. Putnam, p.7

[857] Ingle Reichle argued that much bioart literally comes out of the laboratory *Art in the Age of Technoscience: Genetic Engineering, Robotics, and Artificial Life in Contemporary Art*, trans. C. Custance, Springer-Verlag/Wien, New York, 2009, p.ix

scientist.[858] Thus, the capacity of the museum to create visual interest is dependent on the viewers' capacity to cultivate a 'way of seeing' as much as the museum's ability to confer significance and thus meaning.

6.1.5 [iv] The body as spectacle

In addition to a site of artistic and scientific inquiry, the anatomical body is also considered to be a source of entertainment. Anatomy lessons for instance, became a public spectacle during the Renaissance when the public was invited to witness for themselves the process of dissection. Although these events attracted the interest and curiosity of a lay audience, José van Dijck argues that anatomists saw these occasions as an opportunity to both establish their reputation and command respect and awe. [859] Aside from the epistemological value, the occasion therefore served to raise the profile of the anatomist. To this extent the drama of the occasion afforded the anatomist the means by which to persuade the audience, which consisted of a public gallery as well as students and other anatomists, of the magnitude of his skills and knowledge. This meant that it was the occasion rather than the dissection that became the spectacle, or the means of persuasion. Consequently, the rhetorical spectacle is conditioned by an engaged audience. However, Guy Debord argues that the spectacle demands a passive audience because this type of performance presents itself as a vast inaccessible reality that can never be questioned. [860] For Debord the spectacle represented a form of enslavement, whereas for others spectacles are dynamic constructions of reality. These reconstructions of reality are exemplified in Salvador Dali' 1929 surrealist image *Lugubrious Game* (Fig. 27), which references so called deviant sexual practices. Although the work was 'shockable' for the time, Robert Hughes claimed that such works would be less provoking when viewed in 'the context of a less sexually frank time', such as today. [861]

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[858] S. Alpers, 1991, P.25/ J. Putnam, p.7
[859] J. van Dijck, *The Transparent Body: A Cultural Analysis of Medical Imaging*, University of Washington Press, Seattle, 2005, p.134
[860] G. Debord, *The Society of the Spectacle*, trans. K. Knabb, Rebel Press, London, 2004, p.9
[861] R. Hughes, *The Shock of the New*, Alfred A. Knopf [ebook],New York, 2013, digital p.338
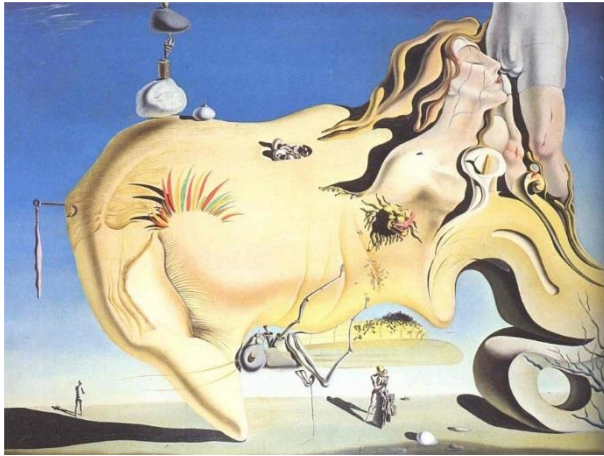
Figure 27

Other experimental works, including the 'decontextualized' found objects were considered provocative because they were placed in an art setting and were therefore designated art. Thomas Farrell argued that 'what is essential to the spectacle is not so much the fact that real things are replaced by images as it is that the materials of our experience are rearranged, so that natural impulse and use are subordinated to a choreographed audience "aesthesis"', the pleasure of witnessing: sight'. [862] From these accounts interpreting the spectacle involves issues such as society's assumption of normality and the cognitive significance of the spectacle. According to Farrell a spectacle becomes a form of knowledge insofar as it presents us with something new to know.[863] This novelty involves creating sites for dialogue and interpretation and therefore transforming preconceptions about the nature of art and science.

The notion of spectacle is frequently applied to Gunther von Hagens' travelling anatomical exhibitions *Body Worlds*. Consisting of preserved human bodies and body parts, the exhibition has been variously described as a 'blurring between science and spectacle', 'aesthetic anatomy', an opportunity for 'self-understanding' as well as a mode of interdisciplinary inquiry, therefore an opportunity to 'learn

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[862] T. B. Farrell, 'Media Rhetoric as Social Drama: The Winter Olympics of 1984', *Critical Studies in Mass Communication*, Vol.6, No.2, 1989, pp.158-182, available from
http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=3&sid=d9611e14-7124-4185-89d7-e7eab30d0d5b%40sessionmgr110&hid=118 (accessed12/10/2015) p.160
[863] T. B. Farrell, p.161

something new'. The plastinated cadavers, such as those referred to as 'skin man', have not only referenced previous anatomical 'masters' including Juan Valverde de Hamusco (Fig. 28), but the exhibition represents an apparent mirroring of the entertainment aspect of the early anatomical theatres. For example, the preserved plastinated bodies have attracted large international viewings thereby suggesting society's continued fascination of the anatomical body. For this study the appeal of Body Worlds, purported to be at the intersection of science, medicine and art, is best understood from an historical perspective. This means that in addition to a collaborative venture between art and science, anatomical practices and representations have historically been seen to be both instructive and entertaining.
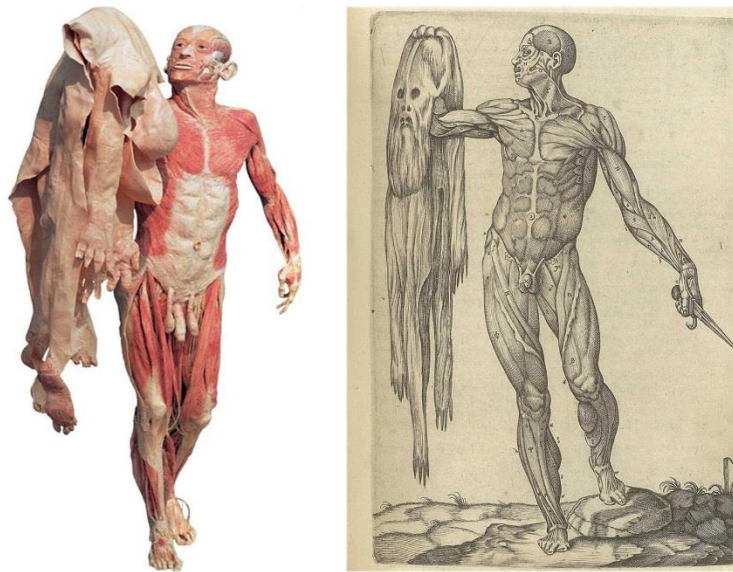
Figure 28

According to José van Dijck the plastinated cadavers fit the long standing scientific tradition of body production as well as the artistic conventions of anatomical representation.[864] In a contemporary context the display of bodies has attracted various responses, ranging from the controversial exhibition of 'real' human cadavers, to questions concerning the exhibition's disciplinary orientation. The 'media', for example, raised concerns about the Exhibition's supposed scientific

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[864] J. van Dijck, p.43

goals as well as the intention to display art objects. [865] For Elizabeth Stephens the exhibition's contextualisation within the history of anatomy and the Renaissance tradition of écorché emphasized the epistemic aim while de-emphasising its commercial, spectacular elements. [866] Von Hagens' representations were originally framed within the commercial and the spectacular, but through the process of re-contextualisation the works are associated with education and science. For instance, the works which are also referred to as palatinates, originally exhibited in convention centres and publicised as 'anatomical art' or 'event anatomy', metamorphosed as 'science' available only in science museums. Consequently, the exhibition was no longer an enticing but dubious form of entertainment, but has been reframed as a celebration of enlightenment and scientific progress. [867] However, in contrast to the anatomical museums that are based in the tradition of collecting and instruction, and as such are reputed sites of science and credibility, von Hagen's displays follow the tradition of the spectacle. This notion is in part based on Stephens' analysis of the responses to *Body Worlds*. Despite numerous reports of 'unease' by viewers concerning the display, Stephens' points to the increasing popularity of the palatinates. [868] Which is perhaps an indication that the success of von Hagens' experiment is partly due to a paradoxical 'fascination with the grotesque'. This type of response is described by Lorraine Daston and Katharine Park as a 'pleasurable wonder', or 'the wonder of the connoisseur, so familiar with a multiplicity of extraordinary phenomena that he knew which truly deserved his amazement', furthermore this wonder was 'a finely graduated register of response that only the best-informed and the most philosophically sophisticated could deploy'. [869] The rhetoric of the spectacle is significant to this study because scientists and artists have long exploited the concepts of drama and shock in order to engage with viewers. This is important because visually striking displays, such as von Hagen's *Body Worlds*

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[865]J. van Dijck, p.43

[866] E. Stephens, 'Inventing the Bodily Interior: Écorché Figures in Early Modern Anatomy and von Hagens' Body Worlds', Social Semiotics, Vol.17, No.3, 2007, pp.313-326, available from http://www.tandfonline.com.ezproxy.usq.edu.au/doi/pdf/10.1080/10350330701448611 (accessed 09/09/2013) p.313

[867] L. Schulte-Sasse, in E. Stephens, Inventing the Bodily Interior: Écorché Figures in Early Modern Anatomy and von Hagens' Body Worlds', Social Semiotics, Vol.17, No.3, 2007, pp.313-326, available from http://www.tandfonline.com.ezproxy.usq.edu.au/doi/pdf/10.1080/10350330701448611 (accessed 09/09/2013) p. 314

[868] E. Stephens, 2007, p.322

[869] L. Daston & K. Park, *Wonders and the Order of Nature 1150-1750*, Zone Books, New York, 1998, 167 According to Albertus Magnus. Pleasure, like wonder, was for students not philosophers, p.116

and Duchamp's *Readymades,* disrupt what is perceived to be 'normal' and thus present to the viewer an opportunity to view the 'world' without established conventions and therefore learn something new.

6.1.5 [v] The recontextualised body

The extended use of the biological body is not just concerned with the dead. Artists such as Orlan and Stelarc use science in order to recontextualise the body as a medium for art. [870] Stelarc's art of the body explores alternate, intimate and involuntary interfaces of the body through the use of medical instruments, prosthetics, robotics, virtual reality systems, the Internet and biotechnology. Stelarc's experimental processes have been variously described as taking art to a new level or alternatively breaching an array of ethical considerations. These experiments are deemed to be problematic because, as Ryszard Kluszczyński claims, they challenge universally accepted boundaries, conventions and notions. [871] This strategy of locating the aberrant in an art setting was utilised by Marcel Duchamp and other Dada artists who questioned the long held assumptions about art, such as the conventional ideas of originality and the aesthetic contemplation of ordinary life. Through the concept of recontextualization 'found objects' of industrial production, such as Duchamp's urinal, were placed within an atypical setting and thus designated as art. [872] The aim, according to Robert Hughes, was to provoke a calculated sense of the bizarre through the shock of confronting normalcy in a foreign context. [873] For Elizabeth Stephens these performances might be contextualised within the history of early scientific cultures of wonder where the 'monster' is not always an object of fear and anxiety. [874] These were the popular exhibits that portrayed human anomalies such as bearded women, giants, dwarfs and conjoined twins as monstrosities. Such 'monsters' were frequently a source of fascination or wonder, a sensation which

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[870] R. W. Kluszczyński, 'NeMe: Orlan, Stelarc and the Art of the Virtual Body', *NeMe Texts*, 15 September 2013, available from http://www.neme.org/1609/the-art-of-the-virtual-body (accessed 10/10/2014) web page

[871] R. W. Kluszczyński, web page

[872] T. B. Farrell, p.160

[873] R. Hughes cited in T. B. Farrell, 'Media Rhetoric as Social Drama: The Winter Olympics of 1984', *Critical Studies in Mass Communication*, Vol.6, No. 2, 1989, pp.158-182, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?vid=3&sid=d9611e14-7124-4185-89d7-e7eab30d0d5b%40sessionmgr110&hid=118 (accessed12/10/2015) p.160

[874] E. Stephens, 'Wonder Machines: The Strange Science of Stelarc', Conference Paper, The Science of Stelarc, Curtin University, 19 June, 2013, pp.1-12, available from https://www.academia.edu/attachments/31438700/download_file?st=MTQxMjg5NDAwMywxNzUuNDUuMTQ2LjEwMiw4MzE5NDc2&s=work_strip (accessed 10/10/2014) p.9

elicits mixed feelings of 'reverence, pleasure, approbation'.[875] As an 'anomaly' Stelarc's work functions reveal the strangeness of new experiences and new forms of knowledge. [876] In keeping with these accounts the issues of the recontextualised body also reflect those of the spectacle whereby the artist's embodied encounters with the technological might be considered as an invitation for us to experience the wonder and strangeness of the artist's experiments.

6.2: Witnessing Life: Showing Knowledge

6.2.1 Anatomy: Useful Knowledge

The vast array of imagery revealing the structures of the body is testimony of society's continuing fascination with the anatomical body. These images exist in institutions of science as well as intuitions of art, however, art and science no longer monopolise the study of the body because technological advances have broadened access to information resulting in a broad appeal of the now ubiquitous phenomenon. [877] Anatomy has been described as the foundation of medicine and during the Renaissance anatomical knowledge was an essential component of an artist's education. Anatomy is frequently described as a visual subject because anatomy is a form of knowledge that can only be mastered through observation, and made meaningful through visual artefacts such as images. Consequently, anatomical knowledge becomes useful knowledge through image-making practices.

The evidence supporting the notion of very early interest in the human body exists in the parietal schematic and expressive representations of the body, such as the clearly depicted anatomical structures of the female external genitalia on the cave walls at Chauvet (Fig. 29) and in the schematic carvings at La Ferrassie (Fig. 30). The presence of these images suggests that the body has been meaningful in some way

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[875] L. Daston & K. Park in E. Stephens, 'Wonder Machines: The Strange Science of Stelarc', Conference Paper, *The Science of Stelarc*, Curtin University, 19 June, 2013, pp.1-12, available from https://www.academia.edu/attachments/31438700/download_file?st=MTQxMjg5NDAwMywxNzUuNDUuMTQ2LjEwMiw4MzE5NDc2&s=work_strip (accessed 10/10/2014) p.9
[876] E. Stephens, 2013, p.11
[877] Access to images of the body is available through anatomical imaging sites and online access to museums such as London's Tate Museum. Anatomical images also appear in a range of media - including advertising media

since the earliest times, even though the function and relevancy of paleolithic parietal 'art' has been the topic of academic debate.

Figure 29

Figure 30

It is unknown whether these images served a ritualistic or shamanistic purpose but for Gillian Morriss-Kay the paintings involve intention and perception, in that, painting 'with a conscious aim to portray symbolic content for communication with the viewer is inherent in the work of mature artists, in which category I include the artists of Lascaux and Chauvet.' [878] This suggests that images were recognised as a vehicle for the presentation and dissemination of knowledge from Palaeolithic times. Anatomical images have been a useful resource for art and for science thus emphasising the significance of the image as a site of intellectual inquiry for both disciplines. Fundamental to this study is the context in which to frame the construction of anatomical knowledge and the interpretation and presentation of that knowledge by image-makers. This is demonstrated through the inclusion of references to the historical and cultural modes of anatomical research. In this way this study acknowledges both the long tradition of art's engagement with anatomy in which many image-makers were informed by their own anatomical knowledge

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[878] G. M. Morriss-Kay, 'The evolution of human artistic creativity', *Journal of Anatomy*, Vol.216, No.2, 2010, pp.158–176, available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2815939/ (accessed 20/02/2013) p.171

gained through various forms of interdisciplinary research, as well as the significance of the anatomical body to both artistic and scientific research.

6.2.2 Bodies of Knowledge

6.2.2 [i] Interpreting anatomy

Many areas of knowledge contribute to an understanding of the human body, and although the most critical concepts are embodied in the biological sciences of anatomy and physiology, art has also played a significant role in anatomical research. Various definitions and descriptions of anatomy exist but anatomy is generally described as the study, classification and description of the structures of the body, and for this study anatomy also includes an examination of the relationships between the various parts of the body. In contrast, physiology, which is also referred to as functional anatomy, concerns the functioning of the body and how the parts of the body function to sustain life. Anatomical study involves gross anatomy, which concerns the structures that can be seen with the naked eye, and microscopic anatomy or histology which concerns those structures too small to be examined without the use of optical instruments, such as the microscope. [879] For this study anatomical knowledge is also described as useful knowledge because such knowledge functions to guide and advance scientific and artistic practice. This type of knowledge is useful to scientists and to artists because theoretical models of anatomy as well as the artistic interpretations of the body are to varying degrees dependent upon a knowledge of anatomy. To fully appreciate the usefulness of a particular type of knowledge Joel Mokyr suggests that it is essential to identify the evolution and therefore the underlying concepts of that knowledge.[880] For this study it is beneficial to follow the path of previous forms of anatomical experimentation so as to fully appreciate the conceptual models such as the visual arguments relating to assisted conception that artists like Helen Chadwick employ in their work. Consequently, this study includes an account of early dissection practices that has

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[879] E. N. Mareb, *Human Anatomy and Physiology*, Benjamin/Cummings Publishing Company Redwood City, 1989, p.5
[880] J. Mokyr, 'Useful Knowledge as an Evolving System: the view from Economic history', Conference Paper, *The Economy as an Evolving System*, Santa Fe, November 16-18, 2001, pp.1-43, available from http://faculty.wcas.northwestern.edu/~jmokyr/Arrowfest.PDF (accessed 04/08/2015) p.9-11

resulted in a system of visual displays created through collaborative artistic and scientific inquiry.

Science has long been categorised according to its function, thus science might be described as either normative or descriptive. Although this classification is considered problematic because no form of inquiry is purely descriptive or purely normative, George Sabine's definitions in the 1912 essay *Descriptive and Normative Sciences* provide general understanding of the terms. According to Sabine the aim of descriptive science is to describe and measure reality through observable sciences such as biology and physics; descriptive science states 'what is', whereas a normative inquiry states 'what ought to be'. [881] 'What ought to be' generally reflects the theories and beliefs of a given society and these beliefs change in context and through time. For example, objectivity is often considered as an ideal for scientific inquiry, as a good reason for valuing scientific knowledge, and as the basis of the authority of science in society.[882] Attempts to explain the problematic normative-descriptive dichotomy range from Aristotle's distinction between theoretical and practical knowledge and in Immanuel Kant' categories of knowledge to Hilary Putnam's argument that as the 'last dogma of empiricism' the insistence that facts and values have nothing to do with each other has spawned many unworkable philosophies of science. [883] Scholars argue that each form of inquiry *should* inform the other, however, the fact-value conflict remains problematic in some forms of inquiry, most notably in relation to value judgements and decision making. [884] For example, interpretations of descriptive and normative dimensions of inquiry has played a significant role in the long history of anatomy, ranging from the ancient practice of vivisection when experiments were conducted on the living without regard to their humanity, to the ethical considerations of biotechnology. This relationship between ethics and scientific progress has attracted the interest of visual artists, most notably Patricia Piccinini who investigated and portrayed the potential

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[881] G. H. Sabine, 'Descriptive and Normative Sciences', *The Philosophical Review*, Vol.21, No.4, 1912, pp.433-450, available from http://www.jstor.org/stable/pdfplus/2177252.pdf?acceptTC=true (accessed 09/11/2014) p.450

[882] J. Reiss & J. Sprenger, 'Scientific Objectivity', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*, 2014, available from http://plato.stanford.edu/cgi-bin/encyclopedia/archinfo.cgi?entry=scientific-objectivity (accessed 12/12/2014)

[883] H. Putnam, in R. Harris, 'A Summary Critique of The Fact/Value Dichotomy', Essay, 2005, pp.1-25, available from http://www.virtualsalt.com/int/factvalue.pdf (accessed 20/12/2015) p.18

[884] R. Harris, 'A Summary Critique of The Fact/Value Dichotomy', Essay, 2005, pp.1-25, available from http://www.virtualsalt.com/int/factvalue.pdf (accessed 20/12/2015) p.13

impacts of 'normative elements' of experimental science. Piccinini's work is described by Donna Haraway as 'premised on bioscientific practices of manipulation and alteration of living beings, of creating "new worlds" if "only" in art', whereby ethics is 'not about right response to a radically exterior/ized other, but about responsibility and accountability for the lively relationalities of becoming of which we are a part'. [885] Piccinini's work variously referred to as 'confronting and ambiguous', 'tender', 'grotesque and beautiful', provides a framework in which to interpret the multiple possibilities of bio-scientific engineering including 'what is' as well as 'what ought to be'.

6.2.2 (ii) Anatomy: emblematic knowledge

Anatomical knowledge is recognised as the hallmark of many scientific disciplines, specifically medicine. John McLachlan and Debra Patten point out that while anatomy is integral to medical education, the teaching of anatomy has perhaps the longest history of any component of formalised medical education.[886] The term anatomy, derived from the Greek word *anatémnein* means to 'cut apart' or 'dissect' and it was through the practice of dissection that scholars originally accessed the interior or the body for the purpose of gaining knowledge. Although knowledge was the goal of dissection, the process itself has evolved from a task performed by a lowly illiterate barber/surgeon to a procedure demonstrated by a learned scientist. And so exploration of the bodily interior through dissection has been a persistent feature of medical education since the early Renaissance, and participation in this process is viewed by medical educators as the most universally defining feature of a medical graduate. [887] The value of dissection as both a form of scientific research and a teaching tool is currently the topic of debate in many academic institutions. Some scholars suggest that anatomy's status as a science has diminished because it can no

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[885] D. Haraway,' Speculative Fabulations for Technoculture's Generations: Taking Care of Unexpected Country', originally published *(Tender) Creature: Exhibition Catalogue,* Artium, 2007 available from http://www.patriciapiccinini.net/writing/30/250/102 (accessed 15/12/2015) web page

[886] J. G. McLachlan & D. Patten, 'Anatomy teaching: ghosts of the past, present and future', *Medical Education*, Vol.40, 2006, pp.243–253, available from http://faculty.ksu.edu.sa/hisham/Documents/Medical%20Education/English/Medical%20Education/193.pdf (accessed 14/09/2013) p.243

[887] G. S. Dyer & M. E. Thorndike, 'Quidne mortui vivos docent? The evolving purpose of human dissection in medical education', *Academic Medicine*, Vol.75, No.10, 2000, pp.969–79, available from http://journals.lww.com/academicmedicine/Fulltext/2000/10000/Quidne_Mortui_Vivos_Docent__The_Evolving_Purpose.8.aspx# (accessed 1/10/2014) p.969

longer be considered to be a research-led discipline.[888] Technological innovations have stimulated debate on the role of dissection as a teaching tool in recent times whereby scholars, including José van Dijck, have suggested that digital anatomy, such as that provided through the *Visible Human Project* may provide an alternative to the human cadaver which is perishable, expensive, and presents a potential health risk due to the possible presence of disease. [889] In this way the issue of dissection, based on tradition versus innovation, presents a paradoxical argument for science. However, the dissection of cadavers for the purposes of medical inquiry and as an epistemic tool has persisted through a myriad of philosophical and cultural changes. Many scholars therefore believe dissection is, and will continue to be, an important tool in the anatomy laboratory, while also noting that changes will continue to evolve as new teaching technologies are developed. [890] Appropriately, the knowledge gained through traditional practices, that included image-making as well as dissection will eventually provide new modes of acquiring and disseminating knowledge, these new modes also include processes such as digital image displays.

6.2.2 (iii) Interior knowledge: dissection

Ancient practices

The dissection of human cadavers for medical purposes has a long history. The practice of dissection for the pursuit of knowledge was believed to have occurred before recorded history. However, the first systematic dissection of human bodies is attributed to Erasistratus and Herophilus, Greek physicians working in Alexandria in the third century.[891] These physicians are credited with the advancement of knowledge of the interior of the human body thereby establishing anatomy as a

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[888] J. G. McLachlan & D. Patten, p.244

These claims are based on the nature of anatomy and conventional definition of science which focus on a proven hypothesis and statements of conditional probability. Thus, in addition to the unlikelihood of the discovery of new gross anatomical structures, contributing factors to anatomy's altered status include the evolution of new fields of research into new disciplines. p.244

The research disciplines of histology and embryology, for example, were previously studied within the anatomical sciences, but have developed as separate disciplines through specific goals and methodologies.

[889] J. van Dijck, p.119

The aim of the Visible Human Project is to provide detailed digital images of the human body for the purposes of research

[890] R. E. Elizondo-Omaña, S. Guzmán-López & M. De Los Angeles García-Rodríguez 'Dissection as a Teaching Tool: Past, Present, and Future', *The Anatomical Record*, Vol.285B, No.1, 2005, pp.11-15, available from http://onlinelibrary.wiley.com/doi/10.1002/ar.b.20070/pdf (accessed 1/10/2014) p.14

[891] H. von Staden, 'The Discovery of the Body: Human Dissection and its Cultural Context in Ancient Greece', *The Yale Journal of Biology and Medicine*, Vol.65, No.3, 1992, pp.223-241, available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2589595/pdf/yjbm00051-0069.pdf (accessed 29/09/2014) p.223

scientific field of inquiry. Adrian Wills observed that such practices were largely abandoned after the deaths of the physicians. [892] It is widely speculated that the majority of writings of Erasistratus and Herophilus were lost when the library at Alexandra was destroyed by fire. For Wills this loss, and the expulsion of the Alexandrian intelligentsia from Egypt, exacerbated the demise of rationalistic practice and the rise in empiricism which had a detrimental effect on the advancement of anatomical knowledge. [893] A systematic mode of scientific research and medical instruction was reintroduced by the anatomist Mondino De' Luzzi at Bologna during the fourteenth century. Importantly medicine was no longer the scholastic discipline that relied on ancient texts for information, it was now associated with practical knowledge that was acquired through the activities of the hand. [894] Mondino's 1316 *Anathomia corporis humani* was the first European anatomical text produced since classical antiquity that was based on the dissection of human cadaver. [895] The anatomist performed dissections for teaching purposes and the *Anathomia* was a detailed description of this scientific process, whereby the text functioned to persuade scholars that anatomy was descriptive science. This compendium is primarily an instructional book containing no images, only text that tightly adheres to Galenic anatomical understanding. [896] Galenic understanding refers to the authority of the teachings of Galen, the Greek scholar and physician who practiced in Rome during the second century. In addition to its epistemic function dissection was an event that portrayed the many of norms of Renaissance culture.[897] These norms included the previously mentioned spectacle associated with anatomical dissection as well as utilisation of the bodies of executed criminals for the advancement of knowledge.

It is widely reported that Galen never performed a human dissection and rather than obtain his knowledge from human cadavers the scholar's conclusions were based on

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[892] A. Wills, 'Herophilus, Erasistratus, and the birth of neuroscience', *The Lancet*, Vol.354, No.9191, 1999, pp.1719-1720, available from http://web.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=f7136a38-ae27-453f-a4aa-7296e6c4df9a%40sessionmgr13&vid=6&hid=9 (accessed 05/06/2013) p.1720

[893] A. Wills, p.1720

[894] R. French, p.85

[895] R. French, p.113

[896] D. Laurenza, p.7

[897] Brought to Life Museum, 'Using the Dead', *Wellcome Trust: Science Museum's History of Medicine*, available from http://www.sciencemuseum.org.uk/broughttolife/themes/understandingthebody/dead.aspx (accessed 12/06/2013) web page

the study of animals. However, his writings have had a far-reaching impact on the practice and study of medicine. [898] For example, Mondino's *Anathomia* remained the standard manual for students for over two hundred years, thereby aiding in the transmission of flawed anatomical knowledge. This form of knowledge was demonstrated through public anatomy lessons which permitted differing levels of interplay between anatomist, students and an audience. Public dissections were long valued as a cultural event and Maud Gleason argues that for Galen they represented the opportunity in which to present the body as a world of knowledge to be mapped, specifically by Galen himself, by revealing the function of the structures normally hidden beneath the previously intact skin. [899] Furthermore Galen's demonstrations not only had a scientific and teleological function they also functioned within a complex cultural system, fusing intellectual competition with performance. [900] To this extent Galen's anatomical demonstrations, which involved animal vivisection, served to compel scholars to recognise his intellectual and technical supremacy. In addition to the employment of the rhetorical tradition, which emphasised the homology between animals and humans in order to argue a unitary view of nature, Gleason argues that Galen's rhetorical practices involved a complex discourse about power articulated through the body. [901] Alongside the fascination of the spectacle dissection served to demonstrate the power of revealing knowledge and the potential of such knowledge to control nature.

Dissection and myth

Although Mondino de' Liuzzi is credited with the revival of anatomical investigation through dissection and the *Anathomia corporis humani* constitutes the first documentary evidence of this activity, it is highly probable that dissection was practiced by physicians and surgeons before this time. [902] The myth that cutting into dead bodies rarely happened before Mondino public dissections at Bologna has been

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[898] D. Laurenza, p.6

[899] M. W. Gleason, 'Shock and awe: the performance dimension of Galen's anatomy demonstrations', in C. Gill, T. Whitmarsh & J. Wilkins (eds.), *Galen and the World of Knowledge*, Cambridge University Press, Cambridge, 2009, p.86

[900] M. W. Gleason, p.86

[901] M. W. Gleason, p.113

[902] D. Jacquart, 'Medical scholasticism', in M. D. Gremek & B. Fatini (eds.), *Western Medical Thought from Antiquity to the Middle Ages,* trans. A. Shugaar, Harvard University Press, Cambridge, 1998, p.225
Mondino's text the *Anathomia corporis humani* is frequently referred to as the *Anathomia* in scholarly articles

rejected by James Walsh and Katharine Park. Walsh argues that the notions of a prohibition of human dissection by the Catholic Church are based on misinterpreted ecclesiastical documents. [903] Research shows that dissections were known to occur for the advancement of knowledge in Italian universities during the thirteenth century. Archival documents note that in 1231 the Emperor of the Holy Roman Empire, Frederick 11, granted permission for the dissection of human bodies to occur in medical schools for the advancement of medical knowledge, in particular anatomical knowledge. [904] Dissections, also referred to as anatomies, became part of the formal academic curriculum at both Bologna and Padua. This myth of 'illegal' dissections has been perpetuated through a reading of artworks such as those referred to as 'the anatomies' whereby the anatomist is depicted conducting a dissection by candle light. Sachiko Kusukawa informs us that medical students learned about plants in the summer and attended dissections in the winter when the cooler temperatures delayed the deterioration of body tissues. [905] For this reason the dissection scene illuminated by a single light source, such as J.H. Hasselhorst's 1864 work *Lucae und die Sektion der schönen Frankfurterin*, (Fig. 31) functions through dramatic appeal and enlightenment through the production of new knowledge, however the work portrayed the actual context of scientific dissection practices prior to reliable preservation technologies.

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[903] J. J. Walsh, *The popes and science : the history of papal relations to science during the middle ages down to our own time* (1911), Fordham University Press, New York, 1915, pdf accessed from Portal Conservador http://portalconservador.com/livros/James-Joseph-Walsh-The-Popes-and-Science.pdf p.31
According to Walsh *The Bull De Sepulturis of Boniface VIII*, a decree issued in 1300, clearly does not refer to dissection or the study of anatomy but instead is concerned with burials, that is, the custom of 'barbarously' rendering the bodies of the dead to bones for efficient transportation to their home country for burial. Walsh goes on to say that this custom concerned the vast numbers of nobility who died great distances from their homes during the crusades and the method of preparing the bones for transport was considered by the Church to be a barbarous act.
[904] A. Mavrodi & G. Paraskevas, 'Mondino de Luzzi: a luminous figure in the darkness of the Middle Ages', *Croatian Medical Journal*, Vol.55, No.1, 2014, pp.50-53, available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3944418/pdf/CroatMedJ_55_0050.pdf (accessed 04/10/2014) p.51
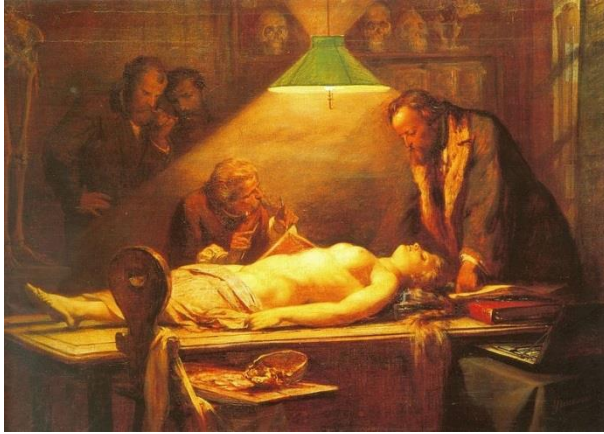[905] S. Kusukawa, 2012, p.1

Figure 31

Transmitting knowledge

Because of a paucity of formal documentation little is known about the practice of dissection for epistemic purposes prior to 1300. In addition to the aforementioned permission to dissect at the medical school, dissection, similar to other forms of teaching, is thought to have occurred in private homes. This form of instruction was a well-established custom involving the master and a small group of disciples, it was also a relatively informal and frequently undocumented form of instruction. [906] During this time the dissemination of knowledge was ritualistic and hierarchical, from the master to the student, often through intermediaries. According to Marko Monteiro the centre of this spectacle was less the body than the cathedra, where the professor was socially and culturally the focal point. [907] In this way 'revealing the knowledge contained in the classic works (such as those of Galenus) was the principle goal, with the body used as an empirical example – less relevant than the classical knowledge transmitted by the professor'. [908] The title page of early printed editions of Mondino de' Liuzzi's *Anathomia* (Fig. 32) provides an example the mode

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[906] K. Park, 'The Criminal and the Saintly Body: Autopsy and Dissection in Renaissance Italy', *Renaissance Quarterly*, Vol.47, No.1, 1994, pp.1-33, available from www.jstor.org.ezproxy.usq.edu.au/stable/pdfplus/2863109.pdf (accessed 12/09/2013) p.7

[907] M. Monteiro, 'The digital anatomy theatre: scientific practices for representing the body', *História, Ciências, Saúde-Manguinhos*, Vol.18, No.3, 2011, pp.1-19, available from http://www.scielo.br/pdf/hcsm/v18n3/en_03.pdf (accessed 15/08/2013) p.3

[908] M. Monteiro, p.3

The author uses the Latin form of Galen - *Galenus*

of knowledge dissemination that existed during this time. [909] According to Luke Wilson:

> *The hierarchy of functions is very clear, with the professor elevated and elaborately framed, the ostensor in academic garb but clearly of peripheral importance, and the surgeon differentiate from professors and students alike by his clothing. The cadaver, represented horizontally relative to the frame of the picture, does not really participate in the vertically differentiated hierarchy at all. The purpose of the anatomy is the verification or demonstration of the text, and so the centre of focus is the professor. The horizontal body remains inert in this scheme; unremarkable and as yet unopened, it is no more than a secondary focus of attention. That it is unopened suggests, too, that what this illustration aims to capture is the anatomy as an initial and static scene rather than as an ongoing process arrested at a particular moment. [910]*
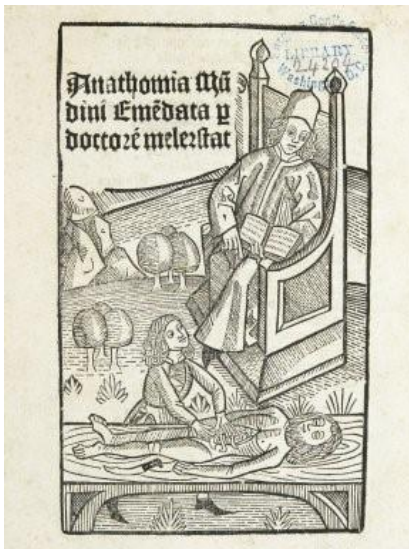

Figure 32

This image depicts a hierarchically structured transmission of knowledge based on the authority of Galen's text. Galen's anatomical theories had been accepted as the highest authority in medicine since the fourth century, and José van Dijck argues that the writings were read ex cathedra by a professor or lector while an ostensor pointed to the organs in the body laid open on the table. [911] Furthermore, the 'actual dissection was left to relatively unimportant menials, dissectors who were considerably lower in status than the lector or ostensor because the demonstration of body parts played a minor, purely ornamental role.' [912] The educational value of such practices was deemed to be limited. This is because the goal was not to add to the existing body of knowledge concerning human anatomy but to help scholars understand and remember the texts in which that knowledge was enclosed. [913] Accordingly, during the fourteenth and fifteenth centuries dissections functioned to instruct not investigate, and to this extent anatomy was a static discipline. Katherine Park argues that there is little to suggest that anatomy functioned as an arena of research, instead dissections served as a pedagogical tool. [914] In this context dissections functioned like an extension of anatomical illustration.

The reintroduction of human dissection is recognised by many scholars as a significant milestone in the history of both medical and anatomical education. For Nancy Siraisi this practice provides evidence of a commitment on the part of some *medici* that first-hand experience as well as theoretical understanding in the interior of the human body was an essential component of medical knowledge. [915] Although Mondino de' Liuzzi perpetuated many of the errors contained in Galen's writings his anatomical treatise is recognised as the first modern work on anatomy. This is primarily because through his practice Mondino emphasized the centrality of dissection to the knowledge of anatomy. Due to this endorsement the anatomies

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[911] J. Van Dijck, p.121
[912] J. Van Dijck, p.121
[913] K. Park, 1994, p.14
[914] K. Park, 1994, p.14
[915] N. G. Siraisi, *Medieval & Early Renaissance Medicine: An Introduction to Knowledge and Practice*, The University of Chicago Press, Chicago, 1990, p.88
The concept of knowledge acquisition through direct experience is attributed to Aristotle when the philosopher, by extension the concept of autopsia, meaning knowledge of the subject through direct observation, or 'from my own eyes' had become an endorsement of validity and authority for early natural philosophers.

eventually became a well-established method of learning about the body throughout the Renaissance universities.

It is widely acknowledged that the observation of the parts of the bodily interior through the dissected corpse in the anatomy theatre has been a hallmark of a medical education since the beginning of the fourteenth century. For John McLachlan and Debra Patten it is useful to distinguish between the observation of dissection, which is the mainstay of Renaissance teaching through the anatomy theatre, and active dissection performed by the scholars themselves. [916] This is because this latter form of investigation 'came to be seen as the modern way and observation was relegated to a second class activity'.[917] These accounts in part contradict the argument advanced by scholars, including Pamela Smith, in which the process of knowledge formation involved thinking and making and was based in activities such as observation which together with documentation was identified as the scientific method.

6.2.3 The Illustrated Anatomy: Visual Knowledge

6.2.3 [i] Preserving knowledge

Throughout history bodies have been preserved for cultural and research purposes through a variety of complex processes. Yet despite a problematic history, images remain the most frequently used method of preserving the body. This notion was advanced by Benjamin Rifkin when the art historian described the illustrated anatomy as a site where:

> [T]he body is laid bare inside and out in pictures that work in
> several realms. They are science in subject, illustration in
> usefulness, but art in their potential emotional impact. Spawned in
> the ancient union of art and medicine and fears of mortality, these
> books transform the pathology of death into art concerning the
> force of life. [918]

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[916] J. G. McLachlan & D. Patten, p.244
[917] J. G. McLachlan & D. Patten, p.244
[918] B. A. Rifkin, 'The Art of Anatomy', in B. A. Rifkin, M. J. Ackerman & J. Folkenberg, *Human Anatomy: Depicting the Body from the Renaissance to Today*, Themes & Hudson, London, 2006, p.7

Accordingly, these images served to represent the different aims of artistic and scientific research. According to Rifkin the 'doctor studies the body to improve its fate; the artist to improve its spirit', the images however are one way in which to preserve and commemorate the body's finite tenure. [919] For this study these books, that contained images of the dead and whose purpose was to preserve life, also represent a link between art and science.

The practice of disseminating knowledge about the body through visual methods is thought to have originated during the Renaissance when image-makers created images in order to represent the external and internal structures of the body. These images were based on knowledge that was primarily acquired through observing and in some cases participating in dissection processes, thereby initiating an association between artists and anatomists that was rich and enduring. This association is portrayed through a plethora of imagery, illustrations, and works that are not just useful to science but are also aligned with the Western concept of art. Consequently, the body and the resulting images provide a site of intellectual inquiry across disciplines. According to this study the 'illustrated anatomy' is a common ground of inquiry because it is a site in which both artistic and scientific research is documented and presented. For scholars the 'illustrated anatomy' has been an invaluable reference tool for the scholars of both art and science since the early Renaissance. In addition to the original intended use as an epistemological tool for scholars of medicine, early anatomists including Andreas Vesalius recognised the usefulness of anatomical knowledge to artistic research. Martin Kemp pointed to the value of the *De humani corporis fabrica* to artistic research when he argued that there is evidence to suggest that Vesalius' 1543 publication retained its hold as a source book for artists until the early nineteenth century. [920] Anatomists also recognised that the knowledge of the image-maker was essential for the articulation of their discoveries. A consideration offered by Sharon Lacey who suggested that because of the increased emphasis on direct observation in the sciences and the arts, the role of skilled draughtsmen to present this revolutionary view of the natural

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[919] B. A. Rifkin, p.7
[920] M. Kemp, 1970, p.288

world became crucial. [921] For Pamela Smith the knowledge-making processes that concerned the practice of the new philosophy paralleled the 'methods, goals, and episteme of art'. [922] This suggests that in contrast to an activity that involved theoretical contemplation among philosophers, science now recognised the usefulness of other epistemologies. Significantly for this study the previously held distinction between theoretical knowledge and the artisanal practice of observation emphasised the legitimacy of art's way of knowing, and because observation became the criteria for knowledge development art could rightfully be positioned alongside science as an authoritative form of inquiry.

6.2.3 [ii] The flayed figure

Écorché

The visual representations of the body are conventionally depicted in three forms, those with the skin intact, the flayed body, referred to as écorchés, and the skeletal illustrations. An écorché is generally defined as a representation of a human or animal body from which the skin has been removed to reveal the underlying musculature. The term écorché was popularised during the nineteenth-century in the French Academies of art such as the *Ecole des Beaux-Arts* when écorché studies were undertaken by art students as a form of anatomical research. [923] This form of representation originated during the Renaissance principally as a tool for teaching anatomy and is most commonly identified with the images in anatomical reference books. But Roslynne Wilson has suggested that the model of the flayed figure originated in the artist's studio rather than the dissection theatres of Renaissance medicine. [924] The workshop scene in Agostino Veneziano's 1531 engraving *The Academy of Baccio Bandinelli* (Fig. 33) for instance, portrays artists employing écorchés as tools for drawing research.

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[921] S. Lacey, 'Artistic Influences on Andreas Vesalius's 'De humani corporis fabrica libri septem' and Its Influence on the Arts in the Sixteenth and Seventeenth Centuries', Doctus Artiflex, [web blog] 31 May, 2012, available from http://sharonlacey.wordpress.com/2012/05/31/artistic-influences-on-andreas-vesaliuss-de-humani-corporis-fabrica-libri-septem-and-its-influence-on-the-arts-in-the-sixteenth-and-seventeenth-centuries/ (accessed 20/09/2013) web page
[922] P. H. Smith, 2004, p.19
[923] M. Clarke, *The Concise Oxford Dictionary of Art Terms*, OUP Oxford, Oxford, 2010, p.85
[924] R. V. Wilson, 'The Écorché Model and Pre-Vesalian Medical Illustration', *Caduceus: a Museum Journal for The Health Sciences*, Vol.8, No.2, 1992, pp.1-22, E-book and text archive available from Internet Archive http://ia600606.us.archive.org/9/items/caduceusmuse821992unse/caduceusmuse821992unse.pdf (accessed 20/08/2013) p.1

Figure 33

Écorché studies also function to provide visual evidence that artists engage in some way with the anatomical body. It is widely known that Leonardo da Vinci performed dissections and many of the artist's detailed drawings, such as the schematic representation of the arm and shoulder (Fig. 34), were based on the artist's anatomical investigations.

Figure 34

Described as strictly 'anatomical-artistic' the work presents the shoulder through several rotating views which functions to display the various muscles as well as the

direction of the muscular fasciculi. Because Leonardo had applied the theories of mechanics to anatomical function, the drawing serve to demonstrate the application of the artist's knowledge of mechanics as well as his knowledge of the anatomical structures of the arm. This drawing also serves to demonstrate Leon Battista Alberti's theories concerning the significance of anatomical study in an artist's training. Alberti advised the artist when preparing to paint a portrait of a man, 'to first visualize their bony insides . . . then attach tendons and muscles in their place and finally clothe the bones and muscles with flesh and skin'. [925] According to Alberti's theories, artists must become familiar with human anatomy in order to be proficient with the Renaissance ideal of representation. Research shows that Leonardo's investigations of the human body were in keeping with this notion of accurate and faithful representation. The drawing also indicates the artist's adherence to the concept of knowledge as a practical and productive form of inquiry based on observation.

Convention of the living dead

The écorché images of Andreas Vesalius' *De Humani Corporis Fabrica* concerned the oft-cited 'muscle men' which are portrayed as a living artefact often walking through picturesque landscapes. For Deanna Petherbridge and Ludmilla Jordanova the practice of representing the anatomical subject as alive is one of the most persistent tropes within the rich and varied field of 'art and anatomy'. [926] These tropes were employed by Vesalius in the aforementioned *De Humani Corporis Fabrica* which is also referred to as the *Fabrica*. This convention of the 'living dead' is exemplified in the *Seventh Plate of the Muscles* which features a figure glancing over a shoulder as the flesh falls away exposing muscles, ligaments and tendons. The *Fabrica* contained more than two hundred woodcut illustrations, including the 'muscle men', which were commissioned by Vesalius to provide a visual documentation of his research into the structure of the human body. The images of the *Fabrica*, as well as images from other anatomical atlases, have attracted the

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[925] L. B. Alberti, in D. Shanks, 'Muscularity and the Western Medical Tradition', *Hirundo: The McGill Journal of Classical Studies,* Vol.2, 2002, pp.58 -81, available from https://secureweb.mcgill.ca/classics/sites/mcgill.ca.classics/files/2002-06.pdf (accessed 25/09/2013) p.59

[926] D. Petherbridge & L. J. Jordanova, *The Quick and the Dead: Artists and Anatomy*, University of California Press, Berkeley, 1997, p.27

interest of a wide range of scholars including historians of art and historians of science. Thus, these images have long been a common area of inquiry across the disciplines of both art and science. Because Vesalius employed images to construct argument and create meaning the *Fabrica* involves a rhetorical approach to the advancement of knowledge. Martin Kemp referred to Vesalius' particular use of visual rhetoric as the 'rhetoric of reality', noting that Vesalius embodied all the existing varieties of the 'rhetoric of reality' into a wonderfully functioning and complex whole.[927] This rhetoric of reality is initiated on the title page and is maintained throughout the atlas. The title page of the *Fabrica* 'sets the anatomist in the context of the great historia', but the underlying message is the anatomist descending from the professional throne to conduct the dissection with his own hands (Fig. 35). [928] This is despite images portraying the figures as complicit in their own dissection, a concept sustained by the muscle men as they perform their 'myological striptease 'and 'the tone of the accompanying notes talks the spectator through the various procedures in much the same way as Vesalius must have done in the dissecting room.' [929] (Fig. 36)

Figure 35
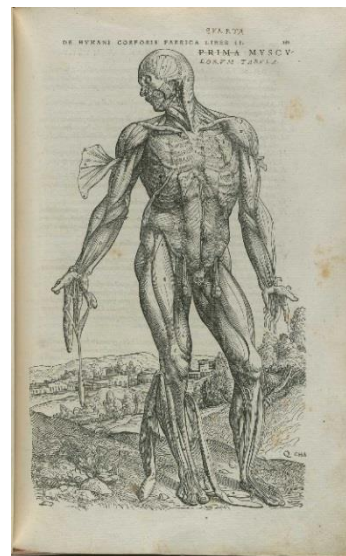
Figure 36

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[927] M. Kemp, 'Vision and Visualisation in the Illustration of Anatomy and Astronomy from Leonardo to Galileo', in G. Freeland & A. Corones (eds.), *1543 and All That: Image and Word, Change and Continuity in the Proto-Scientific Revolution*, Springer Science + Business Media, Dordrecht, 2000, p.25
The rhetoric reality is the use of recognisable visual signals of uncompromising naturalism to convince the viewer that the forms are portrayed from life, p.19
[928] M. Kemp, 2000, p.25
The great historia concerns the 'house of the soul, as Plato has it' is explored in a all'antica temple or theatrum of anatomy
[929] M. Kemp, 2000, p.26

The concept of living anatomy, in which the flayed figure was rendered as a living form, is a distinctive feature of many of Leonardo da Vinci's anatomical studies. And, after the *Fabrica* was published this characteristic became the standard by which anatomical knowledge was presented. In keeping with Jenifer Tucker, the convention of the 'living dead' became the stuff of anatomy and thus an important way in which the science defined itself. [930] This stuff of science also involves borrowing from art and elements of Italian landscape, ancient statuary, and signs of human emotion, are present in Andreas Vesalius' images. In the *Domain of Images* James Elkins argues that:

> *So many conventions of fine art have been brought over into anatomic illustration that the only major formal difference between the two is that medical illustrators were routinely granted license to portray aspects of death, sexuality, and the inside of the body that were proscribed for fine artists. In the twentieth century these distinctions have collapsed, and artists from Joseph Beuys to Arnulf Rainer and Hermann Nitsch make free use of medical images and scenes of the body's interior.* [931]

Martin Kemp and Marina Wallace note that many of the images that constitute the great atlases were created by image-makers who, for the most part, were trained as and continue to identify as artists. [932] The images of the *Fabrica* for example, are attributed to Jan Stephan van Calcar an artist working in Titian's studio, as such; these images are frequently claimed by art as well as science. Similar to Elkins, Kemp and Wallace note that the dissolution of these tidy boundaries of categorisation is also of concern to the world of art itself. [933] Even though many artists have moved away from representational art the écorché remains a significant epistemic device for various image-making practices.

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[930] J. Tucker, p.114
[931] J. Elkins, 1999, p.8
[932] M. Kemp & M. Wallace, p.11
[933] M. Kemp & M. Wallace, pp.11-13

Knowledge/death dichotomy

In contrast to current medical illustration, which functions within the narrow scope of science, Andreas Vesalius' images are understood within the wider context of cultural meaning as well as conforming to the existing scientific conventions. [934] Within this context the écorché represents the dichotomous relationship between knowledge and death whereby knowledge could only be produced through the destruction of the body. The image of a flayed figure therefore presents tangible proof of knowledge acquired through the destruction of its source. For José van Dijck the systematic dissembling of the physical body results in an entirely new body, that is, the body of knowledge. [935] According to Katherine Waldby medical science itself developed out of a productive encounter with death, in that anatomical dissection involves the mining of death to increase the value and productivity of life. [936] This productive encounter has long been associated with violence. The convention of the complicit corpse is therefore culturally significant because it serves to separate the reality of violence from the 'body' as a source of knowledge. As Elizabeth Stephens explains;

> *The convention of depicting écorché figures as passive, bloodless and alive provides a way to generalise anatomical knowledge and to distance it from the specificity of the impoverished, decomposing bodies from which it was derived. In this way, the anatomical realism of these figures was contextualised within a series of artistic conventions that serve to disavow the real dissected body on which it was modelled.[937]*

Stephens goes on to argue that this disconnect between the clean écorché and the actual 'bloody' body parallels a disengagement found in Gunther von Hagens' palatinates, whose preservation transforms decomposing corpses into static artworks. [938] This distance is also maintained through the notion of relinquishment or gifting one's body, a notion reflected in the complicit corpse, for the advancement of

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[934] M. Kemp & M. Wallace, p.11
[935] J. Van Dijck, pp.118- 119
[936] K. Waldby, *The Visible Human Project: Informatic bodies and posthuman medicine*, Routledge London, 2004, p.142
[937] E. Stephens, 2007, p.318
[938] E. Stephens, 2007, p.318

knowledge. Thus, the strategies of 'living anatomy' and voluntary donation of the body, not only reproduces the successful approach employed by anatomists such Vesalius but according to Stephens, it also addresses concerns related to ethics and the sourcing of material. [939] Therefore the body, recontextualised as a gift rather than a resource, functions to dissociate the écorché from a violent death, and the convention of the 'living dead' locates the flayed figure with in a context of knowledge production rather than violence. Within this context the body is perceived to have a higher purpose through death.

6.3: Picturing Life: Shaping Ideas

6.3.1 Living anatomy: boundary-work

The proliferation of images portraying the complexities of a functioning body is evidence that knowledge construction is not restricted to a productive encounter with the dead, the living also contribute to the knowledge debate. Living anatomy is broadly described as the science that studies the functions of the living organism. Although living anatomy generally refers to the study of the body with the skin intact it also concerns a technological engagement with the body ranging from surgical procedures and imaging techniques to pathological investigations. Traditionally this form of research 'belonged' to science, but as Stephen Wilson has noted, many artists are engaging with the diverse field of biological research. [940] In contrast to their predecessors, who attempted to capture not only what was directly before the eye but what was 'seen' with the mind's eye, artists are now employing advanced technology, which was previously available only to science, to create their works. These tools have enabled artists to move beyond the directly visible to the micro structures that inhabit science's biotheoretical space. As a result of these explorations, artists have created new art forms as well as new ways of expression. For example, Eduardo Kac's inquiries into the transgenic produced the 'GFP Bunny' Alba. More recently, artists such as Anna Dumitriu have disregarded disciplinary

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[939] E. Stephens, 2007, p.318
[940] S. Wilson, 2007, p.1

boundaries in order to create art through research with living organisms and biotechnological processes.

6.3.1 [i] Biologically informed art

Bio-Art refers to an art practice where artists, through the use of technology, engage with living organisms, which include biological tissue and bacteria, in order to produce art. In addition to a form of practice bio-art describes a form of art itself. Specifically, 'bioart' describes 'the variety of artforms that use as their medium and/or inspiration, biotechnology, genetics, ecology, plants, animals and other life-forms, be they living, semi-living or artificial'. [941] Descriptions of what constitutes bio-art vary; for example the scope of bio-art is considered by some to be limited to 'living forms' while others take a wider perspective and include imagery that includes medical and biological research. Nor is the history of bioart one of a neat linear progressive narrative. *Tissue Culture & Art Project* founders Ionat Zurr and Oron Catts argue that such a notion has been adopted by scholars who find the multiplicity of sources, concerns, motivations, backgrounds, and references of biological art complex, opting instead for a seemingly coherent, yet simplistic, narrative to explain the somewhat abrupt appearance of biological art. [942] Also problematic is the use of the umbrella term 'bioart'. This is because it clusters discrete modes of practice under a unifying banner, and according to Zurr and Catts a forced fitting of a common history and lineage is inappropriate, in as much as bio-art 'is far from being a cohesive movement with a common origin.' [943]

Despite being a contested term there is a general consensus that 'bio-art' is an interdisciplinary form of artistic research that both interrogates science and integrates scientific knowledge. Suzanne Anker argues that this nexus between the visual arts and the biological sciences is consistent with current discourses about art as a form

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[941] A. Young, 'Bio Art Seminar - Art 895', Department of Art, Ohio State University, available from http://artandtech.o su.edu/895/ http://www.artrious.com/Exhibition.html (accessed 14/10/2014) web page
[942] O. Catts & I. Zurr, 'The Ethics of Experiential Engagement with the Manipulation of Life', in B. da Costa & K. Philip, (eds.), *Tactical Biopolitics: Art, Activism, and Technoscience*, The MIT Press Cambridge, Massachusetts, 2008, p.134 The Tissue Culture & Art Project (initiated in 1996), is an on-going research and development project into the use of tissue technologies as a medium for artistic expression. http://www.tca.uwa.edu.au/atGlance/galnceMainFrames.html
[943] O. Catts & I. Zurr, p.135

of research and knowledge production. [944] For Anker the debate is framed within Brian Degger's concepts of 'speculative research' as a platform for researching and developing interactive, social, and biological artworks, and Linda Candy's notion that the creative artefact is the basis of a contribution for new knowledge. [945] Consequently, the practices and concepts that encompass 'bio-art' involve an interaction between insight and imagination. Similar to other art-science relationships this type of engagement questions whether artists' are practicing as scientists or are artists employing scientific knowledges and methods to construct art? These questions are of concern to Ingeborg Reichle, who in keeping with the notions advanced by Jill Scott notes the benefits of moving from the studio into the laboratory; firstly the shift has provided the arts with a variety of new materials as a means of artistic expression, and secondly it has also enabled artists to acquire new epistemologies and research practices. [946] In this way artists are employing scientific knowledge and methodologies as a medium for the purposes of creating works of art.

The phrase 'bio art' was first coined in 1997 by artist Eduardo Kac in relation to his work *Time Capsule*. [947] However, Kac pointed makes the point that Edward Steichen was the first modern artist to create new organisms through both traditional and artificial methods, to exhibit the organisms themselves in a museum, and to state that genetics is an art medium.[948] Even though Steichen's flowers were purported to be the first genetically manipulated life forms to be exhibited as works of art, biologically produced images were previously exhibited in 1933 by Alexander Fleming. The scientist's 'germ paintings' (Fig. 37) were produced from bacteria grown on paper prepared with a culture medium and were exhibited at St Mary's Hospital Medical School in London. [949] Although Fleming was an amateur artist the

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[944] S. Anker, 'Culturing Life: From The Laboratory to the Studio', in S. Krimsky & J. Gruber (eds.), *Biotechnology in Our Lives: What Modern Genetics Can Tell You about Assisted Reproduction, Human Behaviour, and Personalized Medicine, and Much More*, Skyhorse Publishing, New York, 2013, p.417
[945] B. Degger & L. Candy, cited in S. Anker, 'Culturing Life: From The Laboratory to the Studio', in S. Krimsky & J. Gruber (eds.), *Biotechnology in Our Lives: What Modern Genetics Can Tell You about Assisted Reproduction, Human Behaviour, and Personalized Medicine, and Much More*, Skyhorse Publishing, New York, 2013, p.417
[946] I. Reichle, 'Speculative Biology in the practices of BioArt, Artlink, Vol.34, No.3, 2014, p.32
[947] *Time Capsule* is the 1967 installation-based performance work that took place in Casa da Rosas, in Sao Paulo, Brazil.
[948] E. Kac, 2007, p.10
Time capsule is described by the Encyclopaedia Britannica as a combination of performance and conceptual art that centred on the injection into Kac's leg of a microchip normally used to track pets; he registered himself in the tracking company's database. 'Time Capsule' http://www.britannica.com/topic/Time-Capsule-by-Kac web page
Edward Steichen is perhaps the first artist to propose and produce biologically framed art when he exhibited his hybrid Delphiniums at New York's Museum of Modern Art in 1936.
[949] E. Kac, 2007, p.23

'paintings' were not intended as works of art but were produced for scientific purposes in that they were an illustration of the use of cultures for growing bacteria. For Fleming the bacterial paintings were a method that 'has enabled me to prepare excellent permanent specimens. . .'[950] Similar to Fleming's scientific inquiries artists are using 'cultures' in their research thereby enabling a wider frame of reference in which to create works of art.

Figure 37

The emergence of bio-art as an art practice has created both definitional confusion and ethical concerns. It is beyond the scope of this thesis to provide a discussion relating to the various ethical challenges relating to art. However, because bioart represents what Francis Stracey refers to as a crossover of art and the biological sciences there is a recognition that conflicting intellectual, ethical and aesthetic aims and interests do exist. [951] For example, the relationship between art and the life sciences is frequently depicted as science's influence over art, but for Ingeborg Reichle this crossover has not only provided an opportunity for non-normative

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[950] A. Fleming, 'Penicillin', *Nobel Lecture*, December 1945, pp.83-93, available from http://www.nobelprize.org/nobel_prizes/medicine/laureates/1945/fleming-lecture.pdf (accessed 18/1/2014) p.88
[951] F. Stracey, 'Bio-art: the ethics behind the aesthetics', *Nature,* Vol.10, No.7, 2009, pp.496-500, available from http://kathyhigh.com/pdfs/writing-about-kh/ctt.pdf (accessed 20/10/2014) p. 500

debates about life and its limits, but has also framed these debates within wider cultural issues involving the influence of both science and art on our societies. [952] Furthermore artists are engaging with science so as to challenge its frameworks and speculate on its limits. [953] Thus, rather than reflect on scientific ideas, works of art are tangible evidence that science functions as a point of departure for artists rather than simply a site of influence.

6.3.2 Science a Point of Departure

6.3.2 [i] Reframing art

For this study the works that constitute 'bioart' function primarily to reframe art, and this restructuring occurs within art's own disciplinary boundaries, within a cultural and societal context and within the wider knowledge debate. The most notable example of such restructuring involves Eduardo Kac's 2000 transgenic 'GFP Bunny', Alba.[954] This productive encounter between art and living anatomy is described by Suzanne Anker and Dorothy Nelkin as 'an art-world evocation of the bioluminescence experiments'. [955] The controversial work continues to attract wide ranging debate from various intellectual perspectives that focus on issues such as ethics, the definition of art, and the employment of specialised scientific knowledge for the purposes of experimental research in the arts. For Eduardo Kac the work concerns an ongoing dialogue between art, science, philosophy, law, communications, literature, social sciences, as well as a wider public, on several issues including scientific research, ethics, and the expanded 'practical and conceptual boundaries of artmaking to incorporate life invention'. [956] Alba was the focus of the 2000 symposium *Art, Ethics, and Genetic Engineering: The Transgenic Art of Eduardo Kac* in which members of a multidisciplinary panel, including Edward A. Shanken, attempted to address concerns relating to Kac's use of genetic engineering as an artistic medium. In responding to questions regarding the

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[952] I. Reichle, 2014, p.32

[953] I. Reichle, 2014, p.32

[954] Alba is a genetically modified "glowing" rabbit created under Eduardo Kac's contract with the National Institute of Agronomic Research in France. The acronym GFP [Green Florescent Protein]. Kac argued that Alba was a transgenic art work and not a breeding project.

[955] S. Anker & D. Nelkin, 2004, p.95

[956] E. Kac in G. Nadarajan, 'Ornamental Biotechnology and Parergonal Aesthetics', in E. Kac (ed.), *Signs of Life: Bio Art and Beyond*, The MIT Press, Cambridge, 2007, p.52

appropriateness of genetic engineering performed in the name of art, Shanken acknowledged the advances of science but he 'also noted that the advances made by the arts towards interrogating the limits of knowledge and consciousness, and towards plumbing the depths and reconfiguring the conditions of human existence, are arguably of no less social significance'. [957] As a site for dialogical exchange Kac's artistic research served to argue for a broader idea of art that included incorporating methods and processes from science. Although opinions varied Suzanne Anker, Susan Lindee, Edward A. Shanken, and Dorothy Nelkin note a general agreement from the panel stating that the creation of a transgenic rabbit was acceptable in the pursuit of scientific and medical knowledge but not in the pursuit of art. [958] According to this account Alba functions as the catalyst for academic debate, however in the context of this study Alba also functions as a site of interdisciplinary inquiry which serves to challenge both the traditional concepts of knowledge and art's role in stimulating debate on socially significant issues such as genetic engineering.

6.3.2 [ii] Art as a meta-discipline

For Anna Dumitriu a productive engagement with living organisms occurred within the 'meta-discipline' of Art rather than within specific disciplinary boundaries. [959] In this way the assemblage of 'things' such as art, science, history and philosophy has provided an avenue to create meaning and advance understanding through works that resonate at a visceral level. [960] The concept of art as a meta-discipline has attracted the interest of scholars such as Luis Camnitzer as well as institutions of art who view this idea as an extended form of interdisciplinary research. Camnitzer proposed that art should be considered 'as a way of thinking, acquiring and ordering knowledge

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[957] E. A. Shanken, cited in S. Anker, S. Lindee, E. A. Shanken & D. Nelkin, 'Technogenesis: Aesthetic Dimensions of Art and Biotechnology', in B. A. Lustig, B. A. Brody & G. P. McKenny (eds.), *Technogenesis: Aesthetic Dimensions of Art and Biotechnology Altering Nature. Volume One: Concepts of 'Nature' and 'The Natural' in Biotechnology Debates,* Springer, Netherlands, 2008, p.312

[958] S. Anker, S. Lindee E. A. Shanken & D. Nelkin, 'Technogenesis: Aesthetic Dimensions of Art and Biotechnology', in B. A. Lustig, B. A. Brody & G. P. McKenny (eds.), *Technogenesis: Aesthetic Dimensions of Art and Biotechnology Altering Nature.* Volume One: Concepts of 'Nature' and 'The Natural' in Biotechnology Debates, Springer, Netherlands, 2008, p.312

[959] A. Dumitriu in E. Kekou, 'Interview with Anna Dumitriu' *4Humanities*, posted 18 January 2013, available from http://4humanities.org/2013/01/dumitriu-interview/ (accessed 25/11/2015) web page
According to Marcia Bates, 'An Operational Definition of the Information', Meta-disciplines cut across the entire conventional academic spectrum, and concern all kinds of information. The meta-disciplines shape the subject matter of all the traditional disciplines according to the social purpose of the meta-discipline, p.2

[960] A. Dumitriu, 2013, web page

with a boundless use of our imagination, to make connections, and as a tool for subverting conventions in order to refresh and shape culture and improve society'. [961] Because art incorporates science Camnitzer argues that art 'is the umbrella that hovers over and includes everything', this 'inclusiveness makes art a meta-discipline' whereby 'science must be viewed as one of the many sub-categories of art'. [962] Dumitriu's bioart is illustrative of an interdisciplinary mode of art practice that flourishes within a framework of experimental laboratory practice by bringing 'things' together in order to understand the world. [963] Works such as *Where There's Dust There's Danger* (Fig. 38), for example, suggests a form of research in which 'things' were employed in order to focus on society's complex relationship with the microbial world and the different ideas about disease.
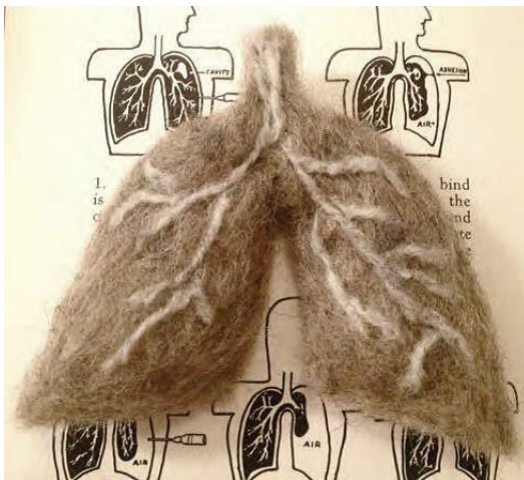

Figure 38

Such concepts were embodied in this work, which consisted of a series of miniature needle-felted lungs which were constructed from wool and household dust and embedded in the culture medium for tuberculosis, which was later sterilised. The

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[961] L. Camnitzer, 'Editorial: Who and What is Arts Education For?', Debates, *Colección Cisneros*, posted 2 September 2014, available from http://www.coleccioncisneros.org/editorial/debate/who-and-what-arts-education (accessed 15/12/2015) web page

[962] L. Camnitzer, 2014, web page

[963] A. Dumitriu 2013, web page
According to Marcia Bates, 'An Operational Definition of the Information', Meta-disciplines cut across the entire conventional academic spectrum, and concern all kinds of information. The meta-disciplines shape the subject matter of all the traditional disciplines according to the social purpose of the meta-discipline, p.2

work featured, alongside other bacteriologically-based artforms, in the 2014 exhibition *The Romantic Disease: An Artistic Investigation of Tuberculosis*, in which the history of tuberculosis was explored from artistic, social and scientific perspectives. [964]

This exploration included the various ways in which disease was understood, the complex treatment programmes that have existed through time, and the disease's literary and romantic associations. [965] The Exhibition 'assembled' the conceptual and practical processes of both art and science, in addition to 'things' which included philosophy and history. For Dumitriu history is an important way of understanding the world, consequently 'the history of something is as important as knowing the scientific basis for it, or feeling its emotional impact viscerally'. [966] Framed within a collaborative rather than an interdisciplinary approach to research, the exhibition *The Romantic Disease: An Artistic Investigation of Tuberculosis* was a project that developed from an artist-in-residence programme and culminated in a symposium at Watermans Art Centre on World TB Day, a historically significant day for science. [967] The previously mentioned work *Where There's Dust There's Danger* represented a site of artistic and scientific research, however the exhibition *The Romantic Disease*: *An Artistic Investigation of Tuberculosis* became the context through which the work became known as art instead of science. Specifically, as a vehicle for the production and dissemination of knowledge, the exhibition acted to convey the meaning embedded in the displays from an art perspective. [968] Within this context the exhibition provides the avenue by which to identify art as a meta-discipline. For this study the concept of art as a meta-discipline includes the notion that knowledges, materials and methodologies of other disciplines, such as science and history, function as a medium for art.

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[964] Wellcome Trust, 'The Romantic Disease: An Artistic Investigation of Tuberculosis' by Anna Dumitriu', *Wellcome Trust: News*, posted 10 January 2014, available from http://www.wellcome.ac.uk/News/2014/WTP055336.htm (accessed 15/6/2014) web page

[965] Due to its impact on society the ancient disease tuberculosis has achieved a high level of cultural visibility. It was a topic that attracted the interest of Charles Dickens and Alexandre Dumas and John Keats and featured in the images of the Pre-Raphaelite artists. As well as claiming the lives of authors such as of John Keats and the Anne and Emily Bronte.

[966] A. Dumitriu, 2013, web page

[967] 24 March commemorates the announcement of the discovery of Mycobacterium tuberculosis by Robert Koch in 1882. The pathogen is the causative agent of most cases of tuberculosis.

[968] R. Greenberg, et al, 2005, p.1

6.3.2 [iii] Ways of thinking and knowing

Intervention

Art practice for Anna Dumitriu involves intervening, 'as an artist, in the world of microbiology and to try to enable others to gain an understanding of the bacterial world.' [969] The term 'intervention' applies to art designed specifically to interact with an existing structure or situation 'be it another artwork, the audience, an institution or in the public domain'. [970] For philosopher of science Paolo Garbolino intervention is a productive activity involving change, in that 'both artists and scientists intervene in the world and intervention is a process in which an underlying causal reality is used to do, make, or change things'. [971] Displays such as the *VRSA Dress* and the *MRSA Quilt,* function as the means for Dumitriu to intervene as an artist into the scientific world. [972] These works consist of fabric infused with antibiotic-resistant pathogenic bacteria and antibiotics, thus they not only emphasize science's response to disease, such as the production of medication, but as 'interventions' these works also function through the communicative process of rhetoric, so as to advance the public's understanding bacteria. Dumitriu's use of infused fabric to advance understanding of the microbial world forms part of an enduring tradition whereby different types of fibre have been employed to convey cultural information. Accordingly, textiles have 'a long history of communicating difficult and complex stories and ideas, which extends from the *Bayeux Tapestry* to the *AIDS Memorial Quilt*.' [973]

The aforementioned works the *VRSA Dress* and the *MRSA Quilt* portray the complex problem of antibiotic resistance to disease. The *VRSA Dress* (Fig. 39) serves to communicate the story of infection by metaphorically mapping the evolution of *Staphylococcus aureus* from a harmless human microbe into a killer bug'. This rhetorical dialogue concerns a dress styled from nineteen-sixty, 'the year that MRSA

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[969] A. Dumitriu, 'The challenges and rewards of working with Bacteria as an Artistic Medium', *Artlink,* Vol.34, No.3, 2014, p.55

[970] TATE, 'Intervention', TATE Glossary of Art Terms: Online Resources, available from http://www.tate.org.uk/learn/online-resources/glossary/i/art-intervention (accessed 15/12/2015)web page

[971] P. Garbolino, 'What the Scientist's Eye Tells the Artist's Brain', in M. Ambrožič, & A. Vettese (eds.), *Art as a Thinking Process: Visual Forms of Knowledge Production,* Sternberg Press Co-published Iuav University of Venice, Venice, 2011, pp.74-87

[972] The term 'display' refers to those works exhibited within an art context, such as a museum of art.

[973] M. Venkataramanan, 'Cosy quilts made of killer superbugs', *New Scientist,* posted 18 October 2013, available from https://www.newscientist.com/article/dn24432-cosy-quilts-made-of-killer-superbugs/ (accessed 12/10/2014) web page

was first observed', stitched with bacteria and antibiotics 'to make patterns and reveal the stories behind microbes'. [974] The use of visual metaphor enables the artist to communicate to an audience the role of science in detecting and treating bacterial infections as well as the impact of antibiotic resistant bacteria on society.

Figure 39

Context and meaning-making

As sites of meaning-making Dumitriu's works, which involve an assemblage of science, bacteriologically-based materials and metaphor, were dependent on context. The works that constitute the exhibition *The Romantic Disease: An Artistic Investigation of Tuberculosis* are grounded within the specific context of production, laboratory-based art research, and the context of presentation, an Art Centre commemorating World TB Day. Therefore, exhibitions such as *Romantic Disease* were meaningful on several levels, including an avenue to explore the links between art and science, between tuberculosis and creativity as well as those between creativity and knowledge construction. The work references tuberculosis' long

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[974] A. Dumitriu, in M. Venkataramanan, 'Cosy quilts made of killer superbugs', New Scientist, posted 18 October 2013, available from https://www.newscientist.com/article/dn24432-cosy-quilts-made-of-killer-superbugs/ (accessed 12/10/2014) web page

history with garment making as well as women's ways of constructing knowledge through making. [975] As Dumitriu explains:

> *During the Enlightenment, women were seen as part of nature and something to be studied (like the tide) rather than individuals who were able to contribute to science in their own right, . . . One of the most highly respected achievements for a woman was a proficiency in embroidery, encouraged to learn just enough about the natural world to create designs of plants and flowers, but no more. So for me, to perform 'science' through that lens, and on my own artistic terms, seems appropriate.* [976]

Context also involves the engaged viewer, and for Dumitriu the audience is an important aspect of artistic research because members of the public 'bring their own forms of knowledge and diverse expertise to the work, telling stories about their own experiences that can lead to the development of new artworks or techniques'. [977] Dumitriu's audience consists of engaged viewers who contribute to artistic research. An engaged viewer differs from both the 'naïve viewer' who is concerned with representational content, and the 'knowledgeable viewer' who is enslaved by interpretative explanations, the engaged viewer contributes to artistic research. [978] Viewers engage with bioart because bio-art displays function through an 'invitation to look', and therefore invite interest.

Ways of understanding

Significant to understanding the cultural impact of tuberculosis are the various ideas about disease itself. Prior to the discovery of the causative agent the cause of the disease had long been the subject of speculation and this speculation was a focus of the exhibition *The Romantic Disease: An Artistic Investigation of Tuberculosis*. Displays such as the previously mentioned *Where There's Dust There's Danger* have embodied the various myths that surround ideas of disease and transmission thereby

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[975] Due to the crowded working environments T. B. has a long association with female occupations such as lace making and garment making

[976] A. Dumitriu, in M. Nettell, 'Anna Dumitriu: "The practice of microbiology feels very like making art"', *A-N: The Artists Information Company*, posted 5 February 2015, available from https://www.a-n.co.uk/news/the-romantic-disease (accessed 2/1/2016) web page

[977] A. Dumitriu, 2014, p.52

[978] M. Helmers, 2008, p.66

highlighting the enlightenment gained through scientific research. [979] Along these lines metaphor constitutes a way of knowing, [980] in that metaphor was used as a way of expressing a form of knowledge such as the beliefs about the role of dust in the transmission of disease. [981] Thus Camnitzer's proposal that art involves a way of thinking is reflected in Anna Dumitriu's use of metaphor to create art. The links between metaphor and thinking were noted by George Lakoff and Mark Johnsen who suggest that all thought is metaphorical. [982] For Aristotle the utilisation of metaphor inferred genius whereas Elizabeth Camp argues that comprehending metaphor involves the 'theory of the mind'. [983] Furthermore, Thomas Benson claims that devices such as metaphor are 'the fundamental material of our thinking, and govern our ideas without our awareness – hence they appear in human discourses not merely as devices of persuasion but the underlying forms that make thought possible, sometimes at the risk of distortions and confusions'. [984] This means that in addition to providing a means of expression visual metaphors also present a way of thinking for the viewer because understanding is brought into existence through critical engagement with the works. In this way metaphor provides an avenue for Dumitriu to intervene as an artist and therefore elicit understanding through various interpretations and new insights.

For Dumitriu the meta-discipline of art is about sharing including methods and other disciplines, and rather than discuss art in terms of impact and the contribution of art as research in the present academic paradigm, the artist argues that the contribution of art is art. [985] As a site of both artistic and scientific research works such as *Where There's Dust There's Danger* represent a common ground of inquiry between art and science, these works also provided the framework in which to reconsider art's position as a knowledge discipline.

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[979] Even though other forms of transmission exist, scientific research has revealed that mycobacterium tuberculosis is the main causative agent of Tuberculosis which is *primarily* an airborne disease transmitted via droplet infection
[980] B. L. Ott & G. Dickinson, p.398
[981] R. N. St Clair, p.85
[982] G. Lakoff & M. Johnson, *Metaphors We Live By*, The University of Chicago Press, London, 2003, p.6
[983] E. Camp, 'Metaphor in the Mind: The Cognition of Metaphor', Philosophy Compass, Vol.1, No.2, 2006, pp.154–170, available from http://www.sas.upenn.edu/~campe/Papers/Camp.MetinMind.pdf (accessed 12/05/2014), p.157
[984] T. Benson, 'Beacons and boundary-markers: Landmarks in rhetorical criticism', in T. Benson (ed.), *Landmark essay on rhetorical criticism,* Hermagoras Press, Davis, 1993 p.xviii
[985] A. Dumitriu, 2013, web page

6.3.3 Essences of Knowledge

6.3.3 [i] The invisible reality

Mapping the invisible

Works of art have long served to argue the existence of a 'human essence', which as an abstract concept has attracted scholarly debate since ancient times. Plato and Aristotle, for example, contemplated theories of reality through issues such as being, matter, and substance. More recently, technological developments, particularly in optical instrumentation, have enabled researchers to access and make concrete the body's previously theoretical sites. Just as Galen had opened the body to map the world of knowledge hidden within the bodily interior, scientists are seeking to identify and map more recent discoveries. Cartography is a much used rhetorical device in scientific discourse. Its usefulness lies in the parallels drawn between the ancient explorers navigating the 'unknown' and present day scientists building maps and charts with which to explore new scientific frontiers. [986] Maps are not only associated with accessing the previously unknown, they are also associated with fallibility. However, rather than misadventure a failing map is also an opportunity for the imagination to take over, in that maps 'may be inadequate in themselves to express human life, they may resist poetry, but nevertheless they can inspire imagination, emotion, and words'. [987]

This study has found that advanced methods of viewing and mapping the interior of the body function to provide scientists and artists with access to a previously imagined world. As Suzanne Anker and Dorothy Nelkin explain, science has not only extended ways of seeing but has also expanded the possibilities for imagination and play. [988] Imagination and play also involves notions such as a 'quest for the invisible reality'. Linda Dalrymple Henderson draws attention to links between this quest by artists such as František Kupka and Marcel Duchamp and the discovery of x-rays by Wilhelm Conrad Röntgen. [989] According to Henderson the 'shadow'

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[986] D. Haraway, 'Deanimations: Maps and Portraits of Life Itself', in C. A. Jones & P. Galison (eds.), *Picturing Science, Producing Art*, Routledge, New York, 1998, p.199
[987] K. C. Ryden, *Mapping the Invisible Landscape: Folklore, Writing, and the Sense of Place*, University of Iowa Press, Iowa City, 1993, p.22
[988] S. Anker & D. Nelkin, 2004, p.2
[989] L. D. Henderson, 1988, p.323

produced through x-ray technology revealed the invisible, and 'allowed a painter to go beyond the preoccupation of Realism and Impressionism with surface appearances . . . to concentrate on the essence of form'. [990] Drawing on the work of Henderson, Anker and Nelkin suggest that evidence of this 'quest for the invisible reality became an underlying idiom in the work of these artists. [991] Duchamp's quest is revealed in works such as his 1911 painting *Portrait (Dulcinea)* (Fig. 40) which depicts a woman moving across the canvas in progressive stages of undress. Through the successive stages of movement Dulcinea's body is partially transparent and dematerialised just as the X-ray opened up the closed boundaries of forms. [992] In his inquiry into the invisible reality Kupka adopted a similar approach creating images such as the 1910-1911 painting *Planes by Colours, Large Nude* (Fig. 41).[993] For Henderson works such as *Planes by Colours, Large Nude* allude to an association between Kupka's interest in shadows as a means to access the invisible reality and Plato's allegory of the cave, whereby the two-dimensional shadow cast on the cave wall, provided a ready analogy to the notion of the three-dimensional world as the shadow of a higher, four-dimensional reality. [994] For these artists the 'essence' concerned the higher reality that could be discovered through art.

Figure 40

Figure 41

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[990] L. D. Henderson, 1988, p.329
[991] S. Anker & D. Nelkin, 2004, p.2
[992] L. D. Henderson, 1988, p.333
[993] Drawing on the work of Henderson, John Hatch, 2013, in 'A sense and essence of nature: Wave Patterns in the Paintings of František Kupka' p.148, argues that Kupka's 'Planes by Colours, Large Nude' 'incorporates X-ray imagery in the depiction of the nose of the female figure, where Kupka shows it as a shadowed image closely parroting the rather unique image of a hallow cavity of the nose found in X-rays.
[994] L. D. Henderson, 1988, p.329

More recent quests concerning the essence of form involve the ideas of genetic mapping and notions of personhood. Deoxyribonucleic acid, generally referred to as DNA, is the molecule that stores the genetic instructions that govern the growth and function all known living organisms. Described as 'the secret of life' by Francis Crick and 'the most golden of molecules' by James Watson, DNA has been called the 'ultimate explanation of the human being', the 'blueprint of destiny, and 'a portrait of who we are'.[995] DNA is structurally composed of double stranded molecules referred to as the double helix, which according to Martin Kemp has so insinuated itself into our visual consciousness that it has transcended its original context.[996] As a visual metaphor the double helix has become an established convention within the scientific discourses, however artists have also incorporated the concepts of DNA into their works. These concepts are evident in the displays of 'bioart' and DNArt exhibitions thereby indicating an increased interest in the issues and associations of the relatively new science of genetics. Nelkin and Anker explain that this interest preserves the long tradition of artists' engagement with and the re-interpretation of scientific discoveries, principles and ideas. [997] This re-interpretation ranges from Salvador Dali's *Butterfly Landscape, The Great Masturbator in Surrealist Landscape with DNA* (Fig. 42) and Olivia Parker's 1999 image *Forms in Blue* (Fig. 43) to the bronze spiral *Code Noah* created in 1988 by Tony Craig. (Fig. 44) These works demonstrate that the gene has become a site of intellectual inquiry for both art and science. Consequently artists, like scientists are 'mapping' an increasingly accessible and previously invisible world in the pursuit of knowledge.

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[995] S. Anker & D. Nelkin, 2004, p.1
DNA first isolated by the Swiss physician Friedrich Miescher in 1869. In 1927 Nikolai Koltsov described a giant hereditary molecule. In 1953 James Watson and Francis Crick published their model of the molecular structure of DNA in the form of a double helix, proving that genes are units of inheritance. Rosalind Franklin was posthumously recognised for her pioneering work on the molecular structure of the molecule

[996] M. Kemp, 'The Mona Lisa of modern science', *Nature,* Vo.421, No.6921, pp.416-420, 2003, available from http://www.nature.com.ezproxy.usq.edu.au/nature/journal/v421/n6921/pdf/nature01403.pdf (accessed 10/03/2013) p.416

[997] D. Nelkin & S. Anker, 'The influence of genetics on contemporary art', *Nature Reviews: Genetics*, Vol.3, No.12, 2002, pp.967-971, available from http://www.nature.com/nrg/journal/v3/n12/full/nrg950.html (accessed 10/10/2014) p.967
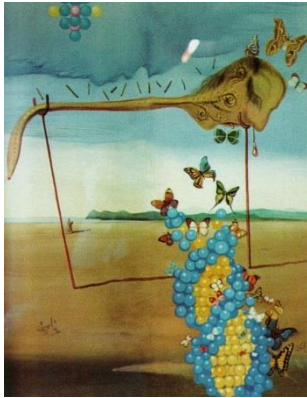
Figure 42

Figure 43

Figure 44

Exploring personhood

As the 'essence of life' the gene, which includes DNA, is widely associated with the concept of personhood. However as a social construct personhood is not recognised in some fields of science. Therefore in light of recent advances in genetic technology concerns relating to the commodification of the body have been the topic of scholarly debate. [998] Artists have demonstrated interest in the 'movement of this science from code to commerce, as genetic material has become a valued commodity' and genes have become products to be mined, banked and patented. [999] Larry Miller addressed these concerns in 1993 by creating the *Genetic Code Copyright Certificate*, (Fig. 45) an 'official-looking document' that invites the viewer to consider their personal genetic code by appealing to the authority of ownership over one's body. From Dorothy Nelkin's view Miller's work mocks the notion that a human is a patentable object by playing on the construction of DNA as the essence of being human, the source of one's identity and the very definition of self. [1000]

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[998] B. Williams-Jones, 'Concepts of Personhood and the Commodification of the Body', *Health Law Review*, Vol.7, No.3, 1999, pp.11-13, available from http://genethics.ca/personal/papers/CommodificationHLR.pdf (accessed 25/10/2015) p.3
A genome is described as an organism's complete set of DNA, including all of its genes. Human genome: All the genetic information in a person. The human genome is made up of the DNA in chromosomes as well as the DNA in mitochondria
[999] D. Nelkin & S. Anker, 2002, p.967
[1000] D. Nelkin, 'The Gene as a Cultural Icon', *Art Journal*, Vol.55, No.1, 1996, pp.56-61, available from http://web.b.ebscohost.com.ezproxy.usq.edu.au/ehost/pdfviewer/pdfviewer?sid=1a3600cb-cb89-498b-b0be-16d7c679012a%40sessionmgr102&vid=0&hid=124 (accessed 10/10/2014) p.56

Figure 45

The custom of portraying the gene as the 'essence of personhood' has gained currency in some areas of scientific research. Nelkin notes that this perspective has been cultivated by the rhetorical techniques of scientists who use religious metaphors such as the Bible, the Holy Grail, or the Book of Man in order to promote the significance of areas of research such as the *Human Genome Project*, which aimed to identify and map the entire genetic makeup if the body. [1001] This exploration of personhood has extended beyond comodification to creation and design. Edwardo Kac's artistic research into the world of genetic engineering provides both an opportunity for dialogue across disciplines and a means to argue that science is a medium for art. Generic engineering is also the focus of Suzanne Anker's 1999 work *Material Power*. This work, as an examination of reproductive technology and genetically engineered potential humans, serves to emphasise science's intervention into the origins of life. [1002] Anker's artistic intervention into the world of genetics provides a map by which to navigate current societal issues, in particular, how have we became what we are and in the light of science's capacity to 'construct nature', what might we become?

[1001] D. Nelkin, 1996, p.57
[1002] S. Anker & D. Nelkin, 2004, p.114

6.3.3 [ii] Image'ing the essence

Molecular scripting

Artistic interventions in the modern life sciences and genetic engineering have made new means of artistic expression and art forms possible.[1003] Anna Dumitriu for instance, creates biologically-based works in order to intervene in the microbiological world, whereas for Suzanne Anker, genetics became the paradigm in which to frame her artistic practice. [1004] Within this framework the world of genomics is considered from a perspective of written language and communication. This is not a new concept, physicist Erwin Schrödinger identified a rhetorical model of the gene by labelling it a 'code script', and drawing on the language of information theory geneticists proposed that that organisms, which were assembled according to a set of instructions encoded on chromosomes, could best be understood by decoding these instructions. [1005] The body has therefore been re-contextualised from a living organism into a decipherable text through which instructions in the form of a code are transmitted through the generations. Genomics has been referred to as the lingua franca of life, consequently the use of linguistic metaphors had become essential to the discourse of genetics. [1006] The convention of the genetic code and its chromosomal containers, as symbols of the capacity of DNA for replication and genetic transmission of information, has also been widely adopted by artists. This metaphorical language is used in works such as the previously mentioned *Material Powers* (Fig. 46) and the 2000 work *Micro Glyph (Soma Font)* (Fig. 47). In these works Anker employs the iconography of chromosomes in order to imply the existence of a link between hereditary markers and language forms. [1007] Similar to maps images such as *Micro Glyph (Soma Font)* transform the molecular body into grids and codes. Nancy Princenthal implies such a similarity exists by suggesting that these 'glyphs' of human and chromosomal figures are aggregated and sequenced in

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[1003] I. Reichle, 2009, p.35

[1004] S. Anker, in L. Criado, 'Suzanne Anker', *Clot Magazine,* posted 29/10/2015, available from http://www.clotmag.com/suzanne-anker (accessed 12/12/2015) web page

[1005] S. Anker & D. Nelkin, 2004, pp.17-18

[1006] Lingua Franca - also known as a bridge language, common language, trade language or vehicular language, is a language or dialect systematically (as opposed to occasionally, or casually) used to make communication possible between people who do not share a common language

[1007] S. Anker, 2015, web page

ways that allude to the conventions of text (sentences, paragraphs) and also to scientific charts and diagrams. [1008]
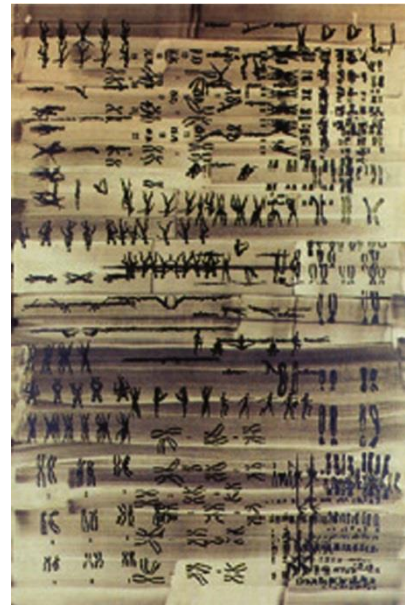

Figure 46

Figure 47

Assembling metaphors

In her work Anker employs the magnifying and refracting properties of water as a metaphorical device to emphasise the historical relationship of optical science to microbiology. The 1993 installation *Zoosemiotics: Primates, Frog, Giselle, Fish* (Fig. 48) consists of six rows of sculptured chromosomes mounded on a wall which are viewed through the clear glass water-filled vessel positioned in front of the sculptures. Ingeborg Reichle suggests the artist's intention is not to visualise the diversity and forms of the chromosomes but rather to instruct the eye in the simple, analogue, optical technique of magnification through a glass filled with water. [1009] This property of water to magnify objects, and therefore to reveal hidden knowledge, was known since ancient times, and was widely utilised by early scholars for observing minute objects. In the Preface of the *Micrographia* Robert Hooke described the technique of using a 'round Globe of Water or a very deep clear *plano*

[1008] N. Princenthal, in S. Anker, et al 'Technogenesis: Aesthetic Dimensions of Art and Biotechnology', in B. A. Lustig, B. A. Brody & G. P. McKenny (eds.), *Technogenesis: Aesthetic Dimensions of Art and Biotechnology Altering Nature. Volume One: Concepts of 'Nature' and 'The Natural' in Biotechnology Debates,* Springer, Netherlands, 2008, p.288

[1009] I. Reichle, 'Where Art and Science Meet: Genetic Engineering in Contemporary Art', *kunst-texte.de*, No.2, 2003, pp.1-11, available from http://edoc.hu-berlin.de/kunsttexte/download/bwt/reichelenglisch.PDF (accessed 13/06/2014) p.3

convex Glafs' to focus light. [1010] Frances Terpak suggests that Suzanne Anker's *Zoosemiotics* employs both these functions, in that it 'not only magnifies but also focuses the viewer's gaze on the four designs scattered across the walls of the installation'.[1011] For Terpak the playful patterns produced by the refracted light emulate the depictions of the subtle genetic differences between species found in scientific charts, whereby chromosomes 'act as abstract notational schemes or visual shorthand for living organism'. [1012] To this extent the work not only demonstrates the existence of a productive relationship between art and science but that Anker's assemblage of 'things' provides an avenue for the viewer to generate new insights into the genomic world from a perspective of art.

Figure 48

These insights also involve the acknowledgement that the language of genetics has moved out of its confines in the scientific laboratory and into the social space of the world of art. [1013] This means that this assemblage of things communicates

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[1010] R. Hooke, Preface [no page number]
[1011] F. Terpak, 'Zoosemiotics', in B. M. Stafford & F. Terpak, *Devices of Wonder: From the World in a Box to Images on a Screen*, Getty Research Institute, Los Angeles, 2001, p.220
[1012] F. Terpak, p.220
[1013] S. Anker, et al, 2008, p.285

metaphorically. It also means that once the 'essences' of life are recontextualised as art they are subject to multiple interpretations through various perspectives. Accordingly, metaphors shape the way art is created and the way is which art is considered, as well as the way in which art shapes and presents knowledge. This notion of artworks as a rhetorical artefact is expanded by Andre Brodyk who describes genetic art as a 'creative, metaphoric, fictional equivalent of genetic engineering processes, a transformative and shaping medium' whereby genetic artists 'utilize the creative capacity of their art as a transformative process in making creative connections and eliciting such connections in the mind of the viewer'. [1014] In this way metaphoric works such as *Zoosemiotics: Primates, Frog, Giselle, Fish* and *Where There's Dust There's Danger* function as a transformative process of knowledge

6.4: Images: Sites of the Visual Communication of Ideas

Within the framework of this study the image represents a site of intellectual engagement for both art and science and as the site where knowledge is constructed and transmitted, the image is also considered to be a rhetorical device. As a rhetorical artefact the image has been associated with persuasion, argumentation and more recently, understanding. As such, images including Andreas Vesalius' *Seventh Plate of the Muscles* and Suzanne Anker's *Zoosemiotics: Primates, Frog, Giselle, Fish* are not only tangible evidence of scholarly research and dialogue across disciplines but such works also function to communicate concepts within specific contexts. In contrast to Vesalius's scientific inquiries, which served to illustrate anatomical concepts during the so called 'golden age of anatomy', Anker's current artistic research aims to shape ideas about life during the golden age of biology.

With the publication of Andreas Vesalius' *De Humani corporis Fabrica* came the realisation that images had a significant role in the advancement of knowledge.

[1014] A. Brodyk, 'Genomic Art and Culture', Presentation Paper, 6th Annual AIHLE Conference, *Science Technology and Culture*, 28 June-1 July 2001, Melbourne, available from http://www.mi.sanu.ac.rs/vismath/proceedings/brodyk.htm (accessed 15/12/2015) web page

Vesalius sought to communicate his research of the bodily interior through the anatomical images that constitute the *De Humani corporis Fabrica*. The images of the *Fabrica* remain highly valued for their contribution to art. However these images were significant to the epistemology of science, in that they were intended as aids in strengthening the memory of what the students had seen during their dissections. [1015] Thus, the images were meaningful within the context of the illustrated anatomy because anatomy is a descriptive science, and as such anatomical images functioned to record and preserve knowledge obtained through observation. Sachiko Kusukawa described the *Fabrica* as a complex interdependence of *res*, the human body, *and verba*, the anatomist's description of the body, as well as *pictura*, the anatomical illustrations. [1016] Consequently, images such as the 'muscle men' could not be divorced from their textual context, which according to Kusukawa served to reveal a story of the triumph of naturalism, empiricism or observation. [1017] The images as a pictorial interpretation of body were integral to Vesalius' argument for a new science bought into existence through firsthand experience of the subject. In keeping with William Ivins who argues that in the absence of an actual specimen, anatomy, like botany, is best served by well-made pictures, Martin Kemp suggests that a good picture encourages us to become surrogate eye-witnesses. [1018] Observing realistic 'truthful' images therefore serves as a legitimate substitute for the direct observation of phenomena being studied. In order to ensure the viewer that the anatomical image was an accurate account of the phenomena depicted, philosophers such as Vesalius drew on ancient rhetoric and invoked the authority of the eye-witness.[1019] This appeal to autoptic authority by natural philosophers frequently involved a portrait of the

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[1015] B. A. Rifkin, p.14

[1016] S. Kusukawa, 'Andreas Vesalius and the canonisation of the human body – res, verba, pictura', presentation, *Seeing science. Image, text, and nature 1500-1800*, Princeton University, 25-26 March 2005, pp.1-28, available from http://www.princeton.edu/~hos/Seeing%20Sciences%20Wkshp/SeeingSciencePapers/paper-kusukawa.pdf (accessed 11/02/2013) p.19

[1017] S. Kusukawa, 2005, p.19

[1018] W. M. Ivins, *Prints and Visual Communication,* Harvard University Press, Cambridge, 1953, E-book and text archive available from Internet Archive, http://ia700300.us.archive.org/13/items/printsandvisualc009941mbp/printsandvisualc009941mbp.pdf p.16
M. Kemp, 2012, p.47

[1019] A. Pagden, *European Encounters with the New World: From Renaissance to Romanticism,* Yale University Press, New Haven, 1993, p.51
The appeal to the authority of the eye witness, concerns autopsy which is a category in ancient rhetoric, which refers to the privileged understanding which those present at an event have over all those who have only read or been told about it. The use of phrases like 'I saw', 'I found', 'this happened to me',' was not an opportunity to boast, it was evidence that 'things are within my understanding, that is from the experience and sight I had of them, and because I will speak of things that it is very probable that no-one before has ever seen, much less written about. p.51

author displayed within the Preface of the publication. In this way the images also served the same function as the spectacle, which was to emphasise the authority of the anatomist.

For Anker the 'golden age of biology' offered opportunities to create works of art because this new scientific age involved advanced imaging technologies and unprecedented investigations, such as those technologies that involve the alteration of life forms. [1020] The boundary-work *Zoosemiotics: Primates, Frog, Giselle, and Fish*, for example, integrated the world of genomics into the world of art. Therefore the assemblage of things included a metaphorical configuration of cultural icons and symbols, involving chromosomes and artificial 'karyotypes' encoded within a museum context, whereby organisms are catalogued according to identifying characteristics. In keeping with the notion of the 'generic code', whereby identity is constructed materially and conceptually through configuration and style, the work 'offered 'an abbreviated blueprint of cultural code summarizing the materialization of idea into visual form'. [1021] This account informs us that the study of genetics has provided science with the means by which to intervene in the natural world and therefore shape living matter. This account also reveals that as an artist Anker has intervened in the science of genomics by providing the opportunity for viewers to engage with works of art and 'shape' the idea of life.

[1020] S. Anker in B. H. Kevles & M. Nissenson, 'An Interview with Suzanne Anker', in Picturing DNA, posted 2000, available from http://www.geneart.org/genome_Anker.htm (accessed 12/10/2015) web page
The period between 1543 and 1627 has been widely described by scholars such as Andrea Carlino and Charles O'Malley as the golden age of Italian anatomy
[1021] S. Anker, 'Cellular Archology', in J. Wayne, T. Siler, S. Anker, K. Clarke, A. Denes, M. J. Grey, R. Kavenoff, T. Kovachevich, D. Kremers, J. Newman, & M. R. Rich, 'Models, Metaphors, and Matter: Artists and Scientists Visualize Scientific Concepts', *Art Journal,* Vol.55, No.1, 1996, pp.33-43, available from http://www.jstor.org.ezproxy.usq.edu.au/stable/pdf/777805.pdf?acceptTC=true (accessed 12/1/2015) p.33

Chapter 7:

Discussion & Concluding Statement

7.1: Introduction

7.1.1 Focus of the Chapter

This study concerns the construction of a substantive grounded theory of *the visual image in academic discourse* and in doing so advances the understanding that art, like science, is an authoritative way of knowing and is therefore significant to the knowledge debate. Such an understanding is premised on the notion that images are an area of commonality between art and science. That is, both forms of inquiry employ images to shape knowledge and transmit meaning, which means that the separate disciplines of art and science are linked through the art of rhetoric.

The focus of this final chapter is to present the key insights derived from the study's research findings. Whilst the research findings functioned as this study's contribution to scholarly debate, whereby such findings are both 'sharable and challengeable', the key insights enabled a deeper level of understanding the complexities that involved this study. [1022] Rather than 'discover' new information relating to the notion that art is a knowledge discipline, the purpose of this interdisciplinary literature-based study is to consider a new way of interpreting existing information which takes in to account the interlinking concepts that concern this complex topic. Consequently, this study contributed to academic discourse through the utilisation of existing knowledge in order to engender new ways to understanding the role of the image in art's claim as an authoritative way of knowing. A further focus involves this study's contribution to the research process itself, which in this case concerns the utilisation of grounded theory methods within a visual arts literature-based inquiry.

[1022] L. Candy, 'Practice Based Research: A Guide', CCS Report, University of Technology, Sydney, 2006, pp.1-19, available from http://www.creativityandcognition.com/resources/PBR%20Guide-1.1-2006.pdf (accessed 3/11/2014) p.5

This chapter begins by restating the position of the researcher as well as a restatement of the aims and research questions that guide this study, in addition to a short summary of the preceding chapters. This is followed by a summary of the research findings and the ensuing insights as well as an observation of the significance of the research. An evaluation of the study follows this section, the chapter then ends with a concluding statement.

7.1.2 Restating the Position of the Researcher

A constructivist grounded theory method has been adopted in order to address the research questions that guide this study. The interpretative nature of this approach and the role of the researcher as the co-constructor of theory is in keeping with the constructivist-interpretative framework that underpins this study, in which new possibilities concerning art and science, the image, and the ways of knowing are constructed from the data. [1023] Consistent with this paradigm is the notion of multiple realities influenced by context and the construction of meaning through an interrelationship between the researcher and the researched. Consequently the insights attributed to this research are derived from a relativist ontological position and a subjectivist epistemology. This means that 'knowledge is relative to particular circumstances – historical, temporal, cultural, subjective – and exists in multiple forms as representations of reality (interpretations by individuals)'. [1024] The position of this researcher is reinforced through Jennifer Mason's notion that research is an intellectual puzzle that is connected to the ontological and epistemological positions encapsulated in the research, and grounded within the specific context of the research problem. [1025] This position involves the following observations:

- That an interpretative researcher is an active part of the research process rather than an objective observer. The interpretative researcher's worldview is therefore subjective and contextual because 'people cannot be understood outside of the context of their ongoing relationships with other people or

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[1023] P. C. Taylor, 1996, web page
[1024] J. Q., Benoliel, 'Grounded theory and nursing knowledge', *Qualitative Health Research*, Vol.6, No.3, 1996, p.407
[1025] J. Mason, *Qualitative Researching* (2nd edn.), SAGE Publications, London, 2002, p.18

separate from their interconnectedness with the world'.[1026] In this way interpretative research acknowledges the notion of bias because according to Geoff Walsham 'we are biased by our own background, knowledge and prejudices to see things in certain ways and not others'. [1027]

- That the notion of value-laden subjective research is in keeping with the idea that a single objective reality does not exist. Therefore multiple realities need to be considered and these realities consist of an external reality which is defined as 'what actually happened in the physical world', and the internal realities which are subjective and reside within individual minds. [1028]

- That an interpretative researcher assumes that these multiple realities are only knowable through socially constructed meanings. [1029] Consequently, the researcher is concerned with understanding instead of merely describing the phenomena understudy. This means that research should not only produce explanation or argument through selective viewing and interpretation but that the researcher also must be explicit about the logic on which meaning or argument is based. [1030]

7.1.3 Restatement of Aims, Research Questions, and Overview of the Chapters

Aims

The purpose of this study is to contribute to the wider academic debate by proposing that art should be positioned, alongside science, as a legitimate way of knowing.

This petition is supported by the subsequent interrelated concepts:

[1026] P. Clarkson, in M. Carcary, 'The Research Audit Trial – Enhancing Trustworthiness in Qualitative Inquiry', *The Electronic Journal of Business Research Methods*, Vol.7, No.1, 2009, pp.11‑24, available from http://www.ejbrm.com/volume7/issue1/p11 (accessed 25/10/2014) p.12

[1027] G. Walsham, 'Doing interpretive research', European Journal of Information Systems, Vol.15, No.3, 2006, pp.320–330, available from http://www.palgrave-journals.com/ejis/journal/v15/n3/pdf/3000589a.pdf (accessed10/11/2015) p.321

[1028] F. Bannister, 'Through a Glass Darkly: Fact and Filtration in the Interpretation of Evidence', *The Electronic Journal of Business Research Methodology*, Vol.3, No.1, 2005, pp.11-24, available from http://www.ejbrm.com/volume3/issue1 (accessed 08/11/2015) pp.13-14

[1029] D. Snape & L. Spencer, 'The Foundations of Qualitative Research', in J. Ritchie & J. Lewis (eds.*), Qualitative Research Practice: A Guide for Social Science Students and Researchers*, Sage Publications, London, 2003, p.19

[1030] J. Mason, pp.7-8

- That images are a site of commonality between art and science.

- That images are a means to by which knowledge is shaped and meaning is transmitted.

- That images are a form of intellectual inquiry across disciplines.

- That if images are significant to both scientific and artistic research, then images are significant to art's claim as a knowledge discipline.

Research questions

These expectations were addressed through the following frames of reference:

- How are the complexities that the image poses to the traditional concept of knowledge described within the different ways of knowing? That is, does the notion of multiple ways of knowing, including the visual communication of concepts, have validity across disciplines?

- Has the intellectual scrutiny of images, as carriers of information and sites of knowledge production, privileged only one tradition of knowledge such as science, or have strategies been employed in order to integrate ideas about art and knowledge into academic discourse?

- Is there a specific framework in which the image might be perceived as a manifestation of the maturation of the complex and dynamic relationship between art and science, or does an engagement with the visual involve appropriated concepts and methods rather than a form of organised collaboration?

Overview of the chapters

In addition to providing the context and the background for the study chapter one highlighted the significance of engaging with images as a mode of inquiry. Chapter Two concerned the methodology, which was presented as a systematic process that functions to address the research questions through a constructivist grounded theory approach. This approach permits flexibility and creativity while maintaining a detailed, rigorous and systematic method of research. Grounded theory methods were concerned with building substantive theory which served to provide insights into the significance of art to the knowledge debate.

In the following chapter a critical review of the relevant literature was undertaken through a selective reference to the extant literature. The literature review provided a clearer understanding of the arguments that focus on the relationship of visual representation to knowledge within the wider art-science debate. In keeping with this study's grounded theory approach the literature review was an ongoing process undertaken concurrently with further data collection and analysis. This method served to not only capture emerging insights in addition to the existing information, but also functioned to construct the overlapping themes of art and science, the image, the image-makers, the ways of knowing, and the art of rhetoric. Thus, the literature review was the site in which a concise critical analysis of the existing body of work was presented in order to establish a theoretical framework for the study.

Chapter Four involved the conceptual framework for this study, whereby three distinct but interrelated concepts were constructed in order to establish the platform for a structured debate concerning the image as a multidisciplinary mode of research. In keeping with a constructivist grounded theory approach these key concepts were constructed following a conceptual analysis of the relevant data whereby the main categories and sub-categories were identified and the core category of rhetoric was established. [1031] These concepts provided the framework through which the following chapters addressed the research questions that guided this study.

Consistent with literature-based research, chapters five and six involved a critical analysis of the core findings derived from the research data. This analysis focused on the key themes and issues identified in the conceptual framework. Even though the image is the primary object of consideration for this study, the aim of these two chapters was to demonstrate that links exist between image and knowledge, between theory and practice, and between making and thinking, and that such linkages are best examined through a perspective of rhetoric. Chapter Five examined the significance of the image-maker to the production of knowledge, whereby the image-maker as rhetor has a long tradition of creating images in order to achieve a desired outcome. This practice was explored through the work of the artisan, considered

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[1031] M. Birks & J. Mills, p.12

central to the production and communication of early scientific knowledge as well as the artists who engage with the concepts of science in various ways for the purposes of creating works of art. Chapter Six extended on the notion of the images as a rhetorical device in academic inquiry by presenting the image as an intellectual strategy by which scholars bring forth new findings and thus new knowledge. [1032] This notion was explored through the scientific and artistic images that function to create meaning and advance understanding of the life sciences with a particular focus on the body. These images concern those illustrations that contribute to the advancement of anatomical knowledge as well as the works that are created within the framework of 'bioart'.

7.2: Research insights: Understanding Complexity

7.2:1 A Framework for Synthesising the Research

This study sought to generate substantive theory through the synthesis of a range of concepts, outlined in chapter four, and theories across disciplinary boundaries for the purpose of contributing to the wider academic debate relating to the role of the image in scholarly research. Research synthesis is also referred to as meta-analysis and for this study synthesis involved an analysis of extant knowledge through grounded theory methods. In keeping with Kenneth Strike and George Posner synthesis for this study is not only a process of combining or integrating parts into a whole, synthesis also 'involves some degree of conceptual innovation, or employment of concepts not found in the characterization of the parts as means of creating the whole' [1033] Synthesis therefore concerns building substantive theory through a process that enables understanding of both the context and the implications of the research findings.

The research synthesis for this constructivist grounded theory study involved secondary data analysis whereby the analysis of pre-existing data progressed through various levels of conceptualisation to the construction of grounded theory findings

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[1032] C. Wickman, p.24

[1033] K. A. Strike & G. J. Posner, 'Types of synthesis and their criteria', in S. Ward & L. Reed, (eds.), *Knowledge structure and use: Implications for synthesis and interpretation*, Temple University Press, Philadelphia, 1983, p.346

that are described in terms of explanatory relationships. It is in explicating the relationships between and among the concepts that the researcher raises the level of abstraction from a conceptual framework, or a loose association of ideas, to [substantive] theory in which the workings of, and relationships between, those ideas is revealed. [1034] Because these findings concerned complex multifaceted phenomena, the initial concepts and the links between them were derived from an inductive analysis of the actual data. However, this study is concerned with new ideas and relationships, therefore the interplay between researcher and data involved both inductive and deductive analysis, which is referred to as abductive logic, through the constant comparative process. [1035] For example, deductive logic was utilised when formulating this study's research questions from which inductive logic was employed to both narrow the scope of the study and construct the conceptual framework. Consequently, the findings of this research were synthesised through a long process of analysis. However for Mike Weed, the value of synthesis is determined by the extent to which it is synergistic, that is, to the extent to which it produces insights that are more than the sum of the parts. [1036] A synthesis of the research findings and key insights are provided in the following section of this chapter.

7.2:2 General Research Findings and Key Insights

Consistent with a grounded theory approach, 'findings', or ongoing comparative analyses, were discussed throughout this project. However the 'research findings', which account for the questions that guide this study, represent the final stage of data analysis that aids in developing substantive theory. In this way the analytical story moves in a theoretical direction during this advanced stage of coding. [1037] This is because the findings extend beyond descriptive analysis to not only explain the relationship between concepts but provide a coherent link between the findings, the conceptual framework, the research questions and the research methodology. This

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[1034] R. S. Schreiber, 'The "How To" of Grounded Theory: Avoiding the Pitfalls', in R. S. Schreiber & P. N. Stern (eds.), *Using Grounded Theory in Nursing,* Springer Publishing Company, New York, 2001, p.78
[1035] K. Charmaz, 2008, p.104
[1036] M. Weed, "Meta Interpretation": A Method for the Interpretive Synthesis of Qualitative Research', *Forum: Qualitative Social Research*, Vol.6, No.1, Art.37, 2005, pp.1-21, available from http://www.qualitative-research.net/index.php/fqs/article/view/508/1097 (accessed 12/10/2015) p.18
[1037] K. Charmaz, 2006, p.63

analytical transition is illustrated in the following three accounts. Although the questions that guide this study and the research findings that addressed these questions concern overlapping concepts and interrelationships, each question and the resulting findings are presented separately as follows.

7.2.2 [i] Research Finding One: Images are significant modes of representation in understanding and presenting concepts

This finding addresses the first question which asked:

> *How are the complexities that the image poses to the traditional concept of knowledge described within the different ways of knowing? That is, does the notion of multiple ways of knowing, including the visual communication of concepts, have validity across disciplines?*

Question one concerns the image as a site of inquiry and meaning-making for art and for science, and this study has found that images are significant modes of representation for both understanding and presenting concepts within these forms of inquiry.

This question sought to identify, examine and evaluate the links between the visual image and the concept of knowledge, in particular, the utilisation of the image as a mode in which meaning is constructed and communicated within the different ways of knowing. In this way the findings that relate to this question concern the original purpose of the study, which was to argue that images provide a framework for art's claim as a knowledge discipline. An analysis of the research revealed that despite the notion that the relationship between the image and knowledge is problematic; the image has long been accepted as an appropriate mode for understanding and presenting concepts within various fields of inquiry. This is primarily because the concept of knowledge is shifting from a science oriented theoretical form of knowing that is articulated as a linguistic proposition, to the idea that knowledge exists through a plurality of practices and involves both verbal and non-verbal forms of representation. The research finding that addresses this question is described through the following insights.

Insight one: Images are artefacts of knowing

The notion that images have epistemic value has long been contested and despite their ubiquitous presence in contemporary life, the role and function of images in relation to knowledge continues to be problematic in current theoretical discourse. However, according to this study the status of the image as a questionable knowledge artefact has been challenged by a wide range of scholars representing various forms of inquiry including critical engagements through both artistic and scientific discourse. Therefore, focusing on issues such as the word/image dichotomy in relation to the hierarchical representation of knowledge was unproductive for this inquiry. This is because scholars, including W.J.T. Mitchell, make the point that all representations are heterogeneous and that transgressing the text-image boundary is the rule rather than the exception. [1038] Drawing on Mitchell's interpretation of representation this study has found that images function as epistemic artefacts across a variety of knowledge forms ranging from engineering and medicine to art history and aesthetics. This finding also considers the epistemological functions of the image which range from the presentation of information and the representation of concepts to a rhetorical function which refers to the way in which images persuade, construct argument, and convey meaning.

This study observed that the image has long been a significant epistemic artefact for science, primarily because images serve to concretize abstract concepts, that is to say, images serve to make scientific knowledge visible and thus accessible to a wider society. Anatomy in particular is highly dependent on visual representation, and anatomical illustrations have not only contributed to the critical mass of knowledge, they have also served to promote collaborative research between scientists and the image-makers since the early modern period. [1039] The anatomical illustrations that comprise the *De Humani Corporis Fabrica*, for example, functioned primarily to present and disseminate anatomical knowledge, they were also the product of collaborative research between the anatomist and an artist. These écorché images, attributed to the artist Jan Stephan van Calcar, were commissioned by Andreas

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[1038] W. J. T. Mitchell, 1994, p.5 & 1986, p.155
[1039] K. Acheson, 2010, p.128

Vesalius to document his research of the previously unknown interior of the body. From this account it was found that anatomical knowledge was made visible through the practice of dissection and preserved through the practice of image-making. Consequently, the body became known through both scientific and artistic discourse whereby links were established between seeing and knowing and between theory and practice. The image therefore was significant to the development of science, in that images were fundamental for understanding complex and previously unknown phenomena. As this study has conceptualised the visual artefact through the art of rhetoric it was found that images remain an effective tool for science. This is because in addition to providing an avenue for understanding and interpreting phenomena, images also communicate scientific concepts through argument. Sachiko Kusukawa for instance, noted that Vesalius utilised the argument of comparative authority to persuade audiences of the differences between animal and human anatomy. [1040] Accordingly, images have been utilised to form and direct an argument so as to persuade and influence the viewer of the validity of the scholar's claims.

According to the findings of this study these rhetorical devices exist within the broader knowledge debate, in that images continue to pose questions for scholars in a range of disciplines other than science. Such ongoing intellectual scrutiny not only includes art research but, as noted, such analysis is compatible with the notion of the knowledge artefact. For Karin Knorr Cetina these 'objects' display a lack of completeness that is consistent with the dynamism of research. [1041] In other words, by considering images as knowledge artefacts scholars continue to pose questions about the images under study, and thus contribute to the existing knowledge concerning the specific topic of research and well as to the knowledge debate in general. According to this study the 'lack of completeness' also applies to works of art because such works are subject to constant scrutiny and thus reinterpretation by viewers. Works such as Albrecht Dürer's *Large Piece of Turf* would be described as

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[1040] S. Kusukawa, 2005, p.13
[1041] K. Knorr Cetina, 'Objectual practice', in T. R. Schatzki, K. Knorr Cetina & E. Von Savigny (eds.), *The Practice Turn in Contemporary Theory*, Routledge, London, 2001, p.185

lacking completeness because the image continues to invite speculation from a range of scholars including art theorists and historians of science.

Insight two: Images are effective modes of inquiry

This study found that despite issues of trust and the notion that the image is an inferior form of knowledge, images have long been employed as a method of representing the way we conceptualise world. Marita Sturken and Lisa Cartwright have argued that in addition to representing imaginary worlds and abstract concepts images are used to represent, make meaning of, and convey various sentiments about nature, society and culture. [1042] Additionally, Michael Leja noted that the image concerned a convergence of seeing, thinking and depicting. [1043] This study expanded on these accounts in proposing that the image as communicative artefact, not only provided a link between making and thinking but remains a significant element in a scholar's toolkit. This is because scientific research has a strong visual component even though the conventional concept of scientific knowledge is one that privileged thinking rather than visualising. [1044] Galileo Galilei for example, presented his astronomical arguments through pictorial sequencing. Phylis Morrison suggested that Galileo's drawings of the moon functioned firstly to provide evidence that the 'heavenly bodies' were tangible and earthly, and secondly that the utilisation of visual models provided a new way of doing science by 'opening all that one saw to possible question'. [1045] The early philosophers had recognised the significance of images as a tool for both the conceptualisation of the various dimensions of their practice and the communication of those concepts.

This study found that artists also make their concepts visible through images which function to produce, preserve, and convey meaning. Linda Dalrymple Henderson made this point in relation to the Cubist painters' research into non-Euclidean geometry and their subsequent rejection of the traditional three dimensional pictorial

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[1042] M. Sturken, & L. Cartwright, p.13
[1043] M. Leja, p.999
[1044] B. S. Baigrie, 'Introduction', in B. S. Baigrie (ed.), *Picturing Knowledge: Historical and Philosophical Problems Concerning the Use of Art in Science*, University of Toronto Press, Toronto, 1996, p.xii
[1045] P. Morrison, 'Images in Science: A Gallery of the Past', in F. Frankel, *Envisioning Science: The Design and Craft of the Science Image*, The MIT Press, Cambridge, 2002, pp.15-16

representation. [1046] For Henderson the 'pictorial space of Cubism' is the result of artistic research into the 'spaces of Poincaré'. [1047] Thus, Cubism's concept of reality remains preserved in the multiple perspectival images that are associated with artists that include Georges Braque and Jean Metzinger. As such, images, including Metzinger's 1910 *Nude*, are the material findings of the artist's research into the world of physics and mathematics. Similarly, Chris Henschke's experimental work with physics is communicated through images such as the 2007 *Smaller Frequencies*. Henschke's images portrayed art's engagement with energy and matter, in addition to representing a mode of collaborative inquiry in which art sought to critically and meaningfully engage with science. Such findings are in line with the insights provided by Pamela Smith who advanced the notion of 'artisanal epistemology' whereby knowledge is gained through the act of observing and making.[1048] According to Smith the knowledge-claims of image-makers such as Dürer are based on the artist's engagement with the natural world, and such claims are expressed by the realistic representation of what the artist directly observed. [1049] This study therefore found that images, whereby meaning is produced, expressed, preserved, and conveyed, are mostly the result of interdisciplinary research and that work of researchers such as Dürer and more the recent image-makers including Henschke concerned 'boundary-work' rather than discipline specific research.

Insight three: Image-making concerns thinking as well as making

In contrast to the notion that images are primarily associated with making, this study found that thinking is a significant part of the image-making process. According to the traditional concept of knowledge, images, as the product of human activity, concern practice rather than theory, which means that image-making is not considered to be an intellectual pursuit. However, this study argued that image-making is an intellectual pursuit insofar as it is a practice that involves visually shaping knowledge for the purpose of constructing and transmitting meaning. Thus, for this study image-making was associated with rhetoric. For Aristotle rhetoric, as

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[1046] L. D. Henderson, 2013, p.188
[1047] L. D. Henderson, 2013, p.188
[1048] P. H. Smith, 2004, pp.6-8
[1049] P. H. Smith, 2007, p.95

an art, is a form of techne involving practical and productive knowledge. [1050] However within the Aristotelian scheme of knowledge rhetoric also concerns episteme, or a theoretical way of knowing, because it involves understanding. [1051] For these reasons this study found that image-making is not only a productive form of knowledge, but it also involves thinking because it is a process based in theory. This finding is consistent with the concept of images as epistemic artefacts whereby knowledge is brought into existence by the action of an image-maker. The finding also takes into account M. Norton Wise's concept of 'materialised epistemology' in which images 'attain their greatest power for knowledge production. . . when they become incorporated into the material culture of research, as part of a tradition of thinking and acting within an entire field'. [1052] Wise was referring to the concretisation of scientific concepts, whereby an integrated visual argument is a significant component of scientific research. The drawings that constitute Galileo's *Sidereus Nuncius*, for example, function as an intellectual argument, but this study has found that the drawings also function to 'show' thinking and thus assist in the interpretation and understanding of research findings.

This study has found that artists have long been familiar with the concept of materialised epistemology. Julia Marshall for instance, argued that artistic research is a mode of knowledge construction because research findings are shaped in the form of visual images in order to construct meaning. [1053] This means that the concept of materialised epistemology in relation to artistic research involved the idea that meaning is constructed through differing levels of interplay between the image-maker and viewer.[1054] Thus, the concretization of artistic concepts not only concerned the rational as the basis for such research but also involved multiple layers of interpretation. Image-makers, including the Cubists, recognised this notion when they employed the image as a means to make sense of interpreted realities. Artistic research also has an investigative function whereby works made visible the issues outside of the scope of social recognition. Such explorations were found in the work

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[1050] J. M. Atwill, p.x
[1051] R. Parry, web page
[1052] M. N. Wise, p.82
[1053] J. Marshall, 2007, p.24
[1054] For this study, in the context of visual communication 'viewing' and 'reading' are used interchangeably

of Patricia Piccinini, in that these works portrayed the potential impacts of experimental science. Consequently this study found that, similar to the images that constitute scientific research, the visual products of artistic research functioned within the tradition of rhetoric. In this way such images attained their greatest power for knowledge production through the construction and transmission of meaning. Therefore, the notion of the image-maker as rhetor conforms to the idea of the image-maker as theorist because the process of visually shaping knowledge for the purpose of attaining a desired outcome involved both practical and theoretical knowledge. For this study image-making was found to be an intellectual pursuit because image-makers, such as the aforementioned artists, employed the image as a means to shape knowledge and transmit meaning.

7.2.2 [ii] Research Finding Two: Artworks function as epistemic artefacts within a pluralistic framework of knowledge

Research finding two addresses this study's second question that asked:

> *Has the intellectual scrutiny of images, as carriers of information and sites of knowledge production, privileged only one tradition of knowledge such as science, or have strategies been employed in order to integrate ideas about art and knowledge into academic discourse?*

Despite the reality that contemporary research involves perspectives from several disciplines, this question relates to a perceived lack of acknowledgement by disciplines such as science, that art is a way of knowing. This is even though images, as works of art, function as epistemic artefacts within a pluralistic framework of knowledge.

The study has noted that art's contribution to knowledge, specifically scientific knowledge, is well documented and that images are a recognised form of inquiry. However, according to Danielle Boutet the notion that works of art function as epistemic artefacts is little understood beyond art's disciplinary boundaries. [1055] This is in contrast to scientific illustrations which are considered valid forms of research

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[1055] D. Boutet, p.106

across disciplines. Yet, the idea that only scientific images concern the production and transmission of knowledge has long been challenged by scholars, including artists, who argue that because images belong to art as well as science images are a form of intellectual inquiry across as well as within disciplines. The findings that addressed this research question in part addressed the central claim of this study, which argued that if images, as an area of commonality between art and science, are significant epistemic artefacts for science, they are also significant epistemic artefacts for art, thereby demonstrating that art alongside science is a legitimate knowledge discipline.

Insight one: We can know through art as well as through science

This study has found that art contributes to the wider knowledge debate even though the epistemological aims of art differ from those of science. These differences have been explained by James Magrini who informed us that science aims to provide certainty by demonstrating truth claims about nature, whereas art does not hand us any ready-made certitudes, but 'illuminates, reveals, and intimates truth perceptually, and within moments of insight, shows us what life is, and concomitantly, invites us to imagine what life might become'. [1056] The notion that art's way of knowing functions differently than science's has been a topic of intellectual debate since antiquity when Greek scholars, such as Aristotle, argued that art or productive knowledge was distinct from theoretical knowledge or science. However, during the early modern period science transitioned from a theoretical form of accumulated knowledge to a practice whereby new knowledge was produced through experiment and observation. Pamela Smith proposed that these artisanal empirical skills played a significant role in the development of the 'new science' and its 'new epistemologies'. [1057] Rather than replace the previously formalised form of knowledge, science had appropriated and integrated a form of techne into its processes of episteme. The arts were also intellectualised through the production of various treatises which served to transmit a wide range of artisanal knowledge which was further influenced through

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[1056] J. Magrini, 'On Art Education: Can Art Give us Knowledge?', *Philosophy Scholarship,* Paper 26, 2011, pp.1-3, available from http://dc.cod.edu/cgi/viewcontent.cgi?article=1026&context=philosophypub (accessed 04/05/2014) p.2
[1057] P. H. Smith, 2004, p.19

Humanist teaching. [1058]

This appropriation and integration of artisanal practices as well as their intellectualisation through publication pointed to a tangible link between the artisanal knowledge and scientific knowledge. For Smith the art of observing and representing went beyond vision and description to a form of embodied skill and knowledge which gave the artisan the ability to render visible the invisible powers of nature. [1059] Accordingly, this type of knowledge involved both making and thinking because the role of the artisan was to communicate research findings by making knowledge both visible and legible. Consequently, this study found that the artisan was not merely a transcriber of information from one form to another but an active interpreter and creator of visual forms of knowledge.

This study noted that the concept of active participation in the construction of knowledge is central to artistic practice. On this point Smith argued that for image-makers such as Albrecht Dürer the visual communication of concepts involved knowledge that was based on first-hand experience with nature. [1060] This argument also provided the structure in which more recent image-makers framed their practice. For Anna Dumitriu, to intervene as an artist involved a productive engagement with living organisms. [1061] Thus, because Dürer's images helped change the view of what constitutes knowledge and Dumitriu's interventions functioned to advance understanding, this study found that artistic research provides an opportunity to know through art. This finding was demonstrated through the insights gained in addressing the previous research question. Dumitriu's works, including the *Romantic Disease Dress* and *Where There's Dust There's Danger*, were not only effective modes of inquiry because as communicative artefacts they provided the means by which viewers gain insight into society's complex relationship with microbial disease, but that these works also functioned as epistemic artefacts. This means that the works that constitute Dumitriu's artistic investigation of tuberculous perform a rhetorical function because they served to construct and convey meaning, and in keeping with

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[1058] P. O. Long, 2001, p.245; S. Dupré, 2011, pp.1-2
[1059] P. H. Smith, 2006. p.95
[1060] P. H. Smith, 2006, p.95
[1061] A. Dumitriu, 2014, p.55

Knorr Cetina, the works display a lack of completeness in that they continue to provoke questions from a wide range of scholars. Although science claims that knowing occurs systematically through a 'scientific' method, Dürer's images and Dumitriu's interventions provided an avenue to argue that we can also know through art.

Insight two: Because context is intrinsic to meaning and knowing it is crucial to understanding

This study found that the concept of understanding is best comprehended through its connection with context. Consistent with Michael Biggs' ideas on the role of context in art research this means that the different ways of knowing are meaningful in relation to the environment in which research is produced and consumed. [1062] In order to advance understanding of society's response to infectious disease, works of art, such as the aforementioned *Romantic Disease Dress* and *Where There's Dust There's Danger*, were meaningful through various contexts including the contexts of production and presentation. This study found that meaning is not only context-dependent, but also that context was determined by the artist. David Pledger made this point when he wrote that the 'context in which an artwork is created and the complicity of the artist within that context is intrinsic to its meaning'. [1063] From this view Dumitriu's bioart is understood within specific contexts that make them meaningful, and that these contexts are constructed by the artist for the purpose of achieving the intended outcome of the research. Subsequently this study found that the notion of intentionality conforms to the rhetorical concept of context, whereby works are grounded in a specific context so as to bring about change, such as understanding, through the purposeful discourse.

This study found that specific context also involves the mode by which research is produced and presented, in that research is made meaningful through a particular mode of representation. Dumitriu's research, for example, was framed within a

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[1062] M. Biggs, 'Editorial: the role of context in art and design research', Working Papers in Art and Design, Vol.4, 2006, pp.1-4, available from http://www.herts.ac.uk/__data/assets/pdf_file/0018/12375/WPIAAD_vol4_biggs.pdf (accessed 05/03/2014) p.1
[1063] D. Pledger, 'Circles of context: giving a work of art its meaning, The Conversation, 22 July, 2014, available from https://theconversation.com/circles-of-context-giving-a-work-of-art-its-meaning-29401 \ (accessed 04/05/2015) web page

visual context, whereby the works shape not only what we see but how we see. [1064]
Specific context might refer to particular area of inquiry. For instance, Dumitriu's
engagement with the microbial world is framed within a context of artistic research,
whereas Andreas Vesalius's engagement with the anatomical world primarily
involved the advancement of scientific knowledge despite the images also being
utilised to advance artist's understanding of anatomy. According to this study issues
such as original intention and meaning are difficult to determine when contexts
change. [1065] For example, Gunther von Hagens' anatomical palatinates have been
framed variously as 'anatomical art' or 'event anatomy'. The écorché figures were
originally interpreted as anatomical artworks, however, because the exhibition *Body
Worlds* became accessible only in science museums von Hagens' palatinates were
recontextualised as science. Consequently the exhibition was understood as a
celebration of enlightenment and scientific progress, rather than a form of
entertainment. [1066] As such, a change of context served to make the works
meaningful within a specific way of knowing.

7.2.2 [iii] Research Finding Three: Images involve an engagement of processes within and among disciplines

Research finding three concerns the final research question that guided this study.
This third question asked:

> *Is there a specific framework in which the image might be perceived as a
> manifestation of the maturation of the complex and dynamic relationship
> between art and science, or does an engagement with the visual involve
> appropriated concepts and methods rather than a form of organised
> collaboration?*

Question three related to the concept of 'borderless knowledge' in which the image is
viewed as an opportunity for scholars from diverse fields of inquiry to engage in
productive dialogue while acknowledging that multiple perspectives rather than

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[1064] B. L. Ott, & G. Dickinson, 2009, p.398
[1065] E. S. Jenkins, p.445
[1066] L. Schulte-Sasse, p. 314

consensus are required to encourage academic debate and prevent intellectual stagnation.

This study's argument is premised on the concept that images are a site of commonality between art and science because the image is utilised by both disciplines as a means to shape knowledge and transmit meaning. This study also noted that despite the notion that knowledge disregards disciplinary boundaries, issues such as knowledge transfer and the co-construction of concepts is problematic for art and for science. However, a consideration of the image as a process of engagement rather than just a product, has in part resulted in a wider appreciation of different disciplinary approaches to and about knowledge, as well as greater understanding of specific disciplinary contribution to the knowledge debate.

Insight one: Art functions through blurred boundaries and shared concepts

This study has found that even though artistic research consists of a plurality of practices, such research is grounded within a theoretical framework of knowledge on art theory. [1067] This finding draws attention to art's long tradition of 'boundary work' in relation to the different claims about knowledge. Stephen Eastaugh's interdisciplinary research reflected the artist's critical engagement with a remote environment and served to advance an understanding of society's impact on a seemingly inhospitable location. For the Antarctic Division however, art was deemed to be in the service of science, whereby Eastaugh's work functioned to communicate the significance of science's achievement in the Antarctic. [1068] These differing perspectives reflect long held beliefs about knowledge that originated in antiquity when scholars such as Plato and Aristotle contemplated the merits to society of both episteme and techne. The ancient philosophers also provided the foundation for a hierarchical view of knowledge whereby episteme was more highly ranked than techne, thus distinguishing between scholar and craftsperson and therefore between theory and practice. [1069] Although this study has demonstrated that the distinction

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[1067] M. Šuvaković, p.6
[1068] T. Fleming, p.03
[1069] P. O. Long, 2011, p.127

between theory and practice has less relevance in a post-modernist context, a structured concept of knowledge that differentiates between artistic research and scientific inquiry has persisted in academic culture.

In consideration of current debates concerning the relationship between the arts and the sciences scholars such as Sabine Flach and Bergit Arends make the point that not only does art function differently from science but that comparison of artistic and scientific knowledge itself presupposes a specific knowledge inherent in art. [1070] Thus, rather than compare knowledge forms, this point reveals that scholars of art consider artistic research to be a significant contributor to the knowledge debate. A notion that is exemplified in the practice of artists such as Anna Dumitriu and Suzanne Anker whose epistemic works involve an interrogation of scientific concepts and materials. This study found that artists intervene in the world of science in various ways for the purpose of creating new means of artistic expression. For example, artists' references to science are made through the employment of the tools of science in order to create new artforms, through an analysis and interpretation of the work of science, and through the concept of 'artist as participator', whereby artists develop their own research agendas and undertake their own investigations. [1071] These references function through a conceptual engagement between artist and viewer through the utilisation of the visual metaphor. [1072] Consistent with the notion that art communicates metaphorically this study found that artistic research involved knowing through rhetoric. This form of knowing concerns the way images create meaning, in particular, how culture and meaning is reflected, communicated, and transformed through visual art. However, as this study has shown, science also employs the strategies of rhetoric to visually communicate concepts. The early anatomical atlases are replete with visual strategies, such as the metaphor, which served to convince the viewer of the veracity of anatomical research. [1073] Even though art and science interpret knowledge differently, both forms of knowledge utilise the visual metaphor to communicate complex concepts.

[1070] S. Flach & B. Arends, p.1
[1071] S. Wilson, 2007, p.1
[1072] L. Stone, p.14
[1073] M. Kemp, 2010, p.199

Insight two: Artists employ science as a medium for art

Although artists utilise scientific methodologies and knowledge to construct works, art is not a scientific process, rather science is put into the service of art. Noting parallels to scientific research Miško Šuvaković claims that 'the artist apparently becomes an external user *or cultural worker* who employs, simulates, consumes, applies or performs cultural and social-ideological effects of science in art by way of deemed autonomy of art in culture and society', in this way scientific research 'appears as an ideological theoretical practice enabling the artist to grasp a 'new result' with particular effects on science, technique/technology, art, but also on culture and society. [1074] However, rather than consider the similarities or differences to scientific research, this study has found that artists primarily utilise science to create art, in this way science is a resource for art. For artists science is a useful form of knowledge because as a medium for art, science functions to advance artistic research. Thus, for artists the notion of disregarding disciplinary boundaries might refer to a form of methodological pluralism and epistemological inclusion within a framework of art.

According to this study artists have long utilised the resources of science in their practice. The Cubists for instance, integrated the principles of mathematics into their pictorial research. For Suzanne Anker the potential of science as medium was realised through the utilisation of the language of genetics in works such as *Zoosemiotics: Primates, Frog, Giselle, Fish and Micro Glyph (Soma Font)*. Chromosomes have been identified as the containers for DNA, which according to Anker is way in which the body materially and conceptually writes itself. [1075] Consequently, employing the iconography of chromosomes in the aforementioned works served to imply the existence of a link between these hereditary markers and language forms. For this study the notion of science as a medium for art has presented new ways in which understand art research as well as providing new ways in which to consider science. Anna Dumitriu found that 'things', including science,

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[1074] M. Šuvaković, Epistemology of Art: Critical Design for Procedures and Platforms of Contemporary Art Education, TkH: Centre for Performing Arts Theory and Practice, Belgrade, 2009, available from http://www.old.tkh-generator.net/files/casopis/!!!%20epistemologija%20mala.pdf p.60
[1075] S. Anker, 2015, web page

history and philosophy are assembled within a meta-discipline of Art. [1076] Within this inclusive view Luis Camnitzer described art as a way of thinking, acquitting and ordering knowledge, while also suggesting that science is a sub-category of art. [1077] For Camnitzer a meta-discipline of art would function as a way of approaching knowledge. For Dumitriu the notion of art as a meta-discipline concerned the challenges of compartmentalised knowledge, whereby an unstructured form of research provided an opportunity to create work through an exploration of concepts from diverse forms of knowledge and methodologies. For this study the notion of art as a meta-discipline assists in understanding art's utilisation of science as a medium in which to create works of art. Additionally, this notion of art as a meta-discipline provides an avenue to investigate how different knowledge forms function as mediums by which to create art.

7.2:3 Significance of the Research Findings

The significance of the research findings is the construction of the substantive theory of *the visual image in academic discourse* whereby the research findings that addressed the questions guiding this study prompted new insights into the role of the image in the knowledge debate. Such insightful synthesis served to provide an avenue to argue that art, like science, is a knowledge discipline. For this study the significance of the research findings also concerned the methodological approaches taken to address the research questions and therefore generate substantive theory. Consistent with a grounded theory approach the substantive theory of *the visual image in academic discourse* is constructed from the data whereby theory is constructed through the interplay between the researcher and the data. Moreover, a constructivist approach to grounded theory ensured that 'analysis is contextually situated in time, place, culture, and situation'. [1078] This means that that not only are the findings supported by the data but also that insights are context-dependent, in that the findings are only meaningful within a specific context.

[1076] A. Dumitriu, 2013, web page
[1077] L. Camnitzer, 2014, web page
[1078] K. Charmaz, 2006, p.131

For this study the significance of findings are the insights themselves. Because insights are based in the researcher's epistemological and ontological orientation these insights represent the researcher's interpretation of the findings as well as an understanding of the application of such findings. For example the research findings functioned to explain three issues identified as problematic to the notion that art is knowledge discipline. These problematic issues formed the research questions which framed this inquiry.

7.3: Evaluation of the Study

The significance of this study to the knowledge debate is not limited to the construction of substantive theory that accounts for the role of the image in intellectual inquiry. Also important are the methods by which this substantive theory was constructed because artists as researchers rely on the rigour of their method to substantiate their claims. For this study a grounded theory approach was deemed the most suitable even though there is a dearth of literature that supports its use in visual art research. For this reason an evaluation of the processes of the research methodology and how such processes relate to the aims of the study are considered to be significant to the wider knowledge debate. This is because an evaluation provides valuable insight into the research process itself. This evaluation includes a review of how the criteria for a grounded theory method applies to this study as well as an assessment of the study's limitations, which are framed in terms of challenges to be addressed.

7.3.1 Criteria for a Grounded Theory Study

Although a number of criteria for evaluating grounded theory research exist, this study has adopted the criteria advanced by Kathy Charmaz so as to enhance rigour and transparency of the research process. [1079] The four criteria used to evaluate this research include credibility, originality, resonance, and usefulness. [1080] Of these Charmaz argues that 'originality and credibility increases resonance, usefulness, and

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[1079] K. Charmaz, 2006, pp.182-183
[1080] K. Charmaz, 2006, pp.182-183

the subsequent value of the contribution'.[1081] Even though these criteria are utilised by the researcher to assess this study in relation to a grounded theory approach, it is the reader who will ultimately critique the value of the work. [1082] This study is described as grounded theory research according to the following criteria.

7.3.1 [i] Credibility

Notions of credibility in qualitative research range from a vivid and faithful description of the phenomenon to the trustworthiness of the findings. For Melanie Birks and Jane Mills the credibility of a study also reflects logic and conceptual grounding. [1083] For this study credibility entails that the data is of sufficient depth and richness to support ongoing analysis and eventual synthesis. Rich data are 'detailed, focused, and full' in that they reveal 'views, feelings, intentions, and actions as well as the contexts and structures'. [1084] This 'rich data' concerned 'thick' descriptive memo writing as well as the collection of relevant data from various fields of inquiry. Credibility also concerns a logical research process whereby the links between data and analysis and eventual synthesis provide a logical line of reasoning. This process involved establishing an audit trail, such as memos, and conceptual maps which served to track the analytic steps taken in the development of the substantive theory. These audit trails were a useful strategy for determining the trustworthiness of a study. [1085] The memos produced during the course of this research not only documented theoretical, methodological and analytical decisions, but also enabled this researcher to verify the research findings. In this way the researcher might independently judge whether research inferences are logical, whether findings are grounded in the data, and whether a study's research process is suitable as a basis of further study. [1086] This study's credibility is demonstrated through the aforementioned processes as well as disclosures, such as ontological and

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[1081] K. Charmaz, 2006, p.183
[1082] K. Charmaz, 2006, p.182
[1083] M. Birks & J. Mills, p.152
[1084] K. Charmaz, 2006, p.14
[1085] M. Carcary, 'The Research Audit Trial – Enhancing Trustworthiness in Qualitative Inquiry', *The Electronic Journal of Business Research Methods*, Vol.7, No.1, 2009, pp.11‑24, available from http://www.ejbrm.com/volume7/issue1/p11 (accessed 25/10/2014) p.15
As private jottings that function to tie concepts memos are neither showable nor submissible. That is, memos do not form part of the final research paper. Once memos mature from free ideas they become part of the paper itself.
[1086] M. Carcary, p.21

epistemological perspectives, which alert the reader to the researchers' orientation as well as the researchers' awareness of the potential for bias to exist.

7.3.1 [ii] Originality

This study's contribution to scholarly research concerned art as an interdisciplinary form of research whereby claims to originality primarily involved the provision of new insights and new interpretations of the complex interrelationships of art and science, and epistemology and the image. By privileging a rhetorical lens this work has offered new ways of considering these concepts through the aforementioned findings and insights that were derived from the perspective of visual art research.

7.3.1 [iii] Resonance

The resonance of a study relates to the need for the theory to have meaning and scope for all those to whom it may be relevant. [1087] Resonance is demonstrated through the construction of three broadly defined concepts that formed the framework for this study. Thus, meaning is framed within a systematic structure of interlinking concepts that concern the complex issues involved in understanding the notion that art is a knowledge discipline. This means that the insights of this study resonate with the reader in that they are meaningful in the context of the aims of the study. In this way the substantive theory *the visual image in academic discourse* provides the reader with a deeper understanding of the significance of the image to the knowledge debate.

7.3.1 [iv] Usefulness

As Birks and Mills tell us, grounded theory is rarely 'generated to produce knowledge for the sake of knowledge alone', rather, theories 'constructed through the use of grounded theory methods aim to provide understanding of a phenomenon that will ultimately inform practice in a given discipline'. [1088] The usefulness of a study therefore relates to both knowledge development and practical application. Applicability is dependent on the credibility of the theory; the relevance of the theory

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[1087] M. Birks & J. Mills, p.152
[1088] M. Birks & J. Mills, p.154

to a given situation; the capacity to tailor the theory to a specific purpose and the utilisation of the theory to implement change. [1089] The substantive theory *the visual image in academic discourse* was developed in order to address the notion that art is an authoritative way of knowing. Consequently, as credibility has been determined, this substantive theory has relevance because it concerns a delimited problem in a specific area. This means that this study is useful because, firstly it contributes to the wider academic debate, and secondly this study demonstrates that art should be positioned, alongside science, as a legitimate way of knowing.

7.3.2 Limitations of the Study

This study contains limitations which have the potential to reflect on the findings of this research. Rather than weaken the study, acknowledging these limitations serves to engender trust in both the researcher and the research itself. [1090] These limitations presented a number of challenges that were addressed throughout the study. This included the challenges related to qualitative research, such as the arguments related to subjectivity and possibility of researcher bias. The notion of researcher bias is an expectation of grounded theory in that the process itself involves an acknowledgment of the researchers' bias through disclosure of the researcher's world view, as such, this study has disclosed a relativist ontological position and a subjectivist epistemology. [1091] The second challenge relates to a lack of data relating to literature-based studies and perceptions of credibility relating to secondary analysis. The issue of literature-based studies is identified as a significant gap in the research data, consequently this study relied extensively on the work of Malcolm Carey and Andrew Abbott to inform and validate this choice of method. Additionally, secondary analysis in research remains a contentious issue among scholars. However the potential of secondary analysis to research is recognised by a number of scholars, including Barney Glaser, who makes the point that secondary analysis can lend new strength to a body of knowledge. [1092] The third challenge concerns the adoption of a grounded theory approach to address the research questions. Grounded theory is a

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[1089] M. Birks & J. Mills, p.154
[1090] M. Birks & J. Mills, p.36
[1091] M. Jones & I. Alony, 2011, p.7
[1092] B. G. Glaser, 1963, p.11

relatively unexplored form of research for visual artists whose research is primarily articulated through practice-led or practiced-based models. As a qualitative research method grounded theory is widely used across a range of disciplines and subject areas, however, there is little evidence that this is an approach favoured by art researchers. This accounts for the additional attention given to grounded theory in this chapter. Consequently, the utilisation of a grounded theory approach and the generation of substantive theory has provided an avenue to argue the suitability of this method for research in visual art.

7.4: Concluding Statement

In conclusion, this study has served to advance understanding of the complex issues concerning the image in academic discourse. Such issues emphasise unresolved concerns on the nature of knowledge and art's position in the knowledge economy. Although the findings of this study cannot provide certainty on these issues they do offer possibilities. These possibilities are demonstrated through the substantive theory of *the visual image in academic discourse* which was constructed through grounded theory methodology. The capacity to offer recommendations and suggestions concerning the findings of this study exceeds the sphere of this study. In keeping with Kathy Charmaz' notion that it is the reader who will consider the value of this work to the wider academic debate, it is also the reader who will determine the implications of the findings. Such implications involve the usefulness of the work to inform practice as well as its capacity to provide a starting point for further research.

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