Beyond Linearity: Contemporary Drawing and the Naturalistic Representation of Experience

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Statement of originality:

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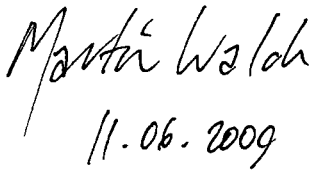
Martin Walch



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Abstract:

This research project sets out to demonstrate that a contemporary application of systematic drawing principles to the representation of natural environments could extend beyond the linear conventions upon which these principles are founded, and thereby produce dynamic and expressive interpretations of human and non-human systems. The project was pursued through an exploration of themes central to representation of natural environments. These include; the technologies of mapping systems; the construction of temporal and spatial frameworks; the aesthetics of natural environments; and concepts related to locality and placement. Research methods included the reconstruction of optical devices, the undertaking of extensive field trips, and the learning of new computer languages.

The background to the project is located in: the history of geometry and the concept of the visual ray as first posited by Aristotle; the writings and research of Patrick Maynard, who analysed the role of drawing in the construction of the modern technological world; Manuel DeLanda's writings on Gilles Deleuze, and his concepts of the manifold, intensive science, and virtual philosophy; the alternative mapping strategies proposed by John Pickle; and the writings of Arnold Berleant who discussed the aesthetics of natural environments. These concepts are drawn out contextually in the exegesis through reference to visual artists involved in (re-)mapping their environments; including Hamish Fulton and John Wolslely in relation to representation of direct experience of being in the land; Bea Maddock's inverted geometric projection of Tasmania; Mark Lombardi's visualisation of networks; and Daniel Crooks's temporal re-mapping experiments.

The outcome of the research is a body of five artworks; *Origin 2004-2008 (constant change), Range 2006 (strange attractor), Sticks and Stones, Drowning by Numbers* and *Source*. These works were created in response to an analysis of conventional mapping systems, and the limitations of their geometric and optical drawing methodologies in visualising natural environments. The works in the thesis exhibition use various strategies, based on the application of alternative mapping methodologies, which engage the viewer in new temporal and spatial networks, and thus challenge perceptions of what it is that constitutes experience of environment.

Acknowledgments:

This research project relied on the help, support, advice and technical expertise of a number of individuals. I would like to thank Emeritus Professor Geoff Parr for his advice during my early candidature, Dr David Stephenson for his supervision and guidance throughout the project, and Professor Noel Frankham for input during the final phase. Dr Bill Hart deserves special thanks for his generous technical advice and detailed feedback on my project and my writing, as well as his loan of LCD screens for my exhibition.

Thanks also to Tony Brown (Curator of Indigenous Cultures - Tasmanian Museum and Art Gallery), Greg Lehman (Director of Aboriginal Education - Department of Education Tasmania), and Dr Julie Gough (Curator of Indigenous Art - visiting Tasmanian Museum and Art Gallery), for their support and advice in relation to Tasmanian Aboriginal cultural heritage and its representation. Dr Kim Ackerman (Dr of Anthropology and Archaeology) generously advised me on questions related to field archaeology, and the manufacture of stone tools. Thanks also to Tony Naughton (Secretary of the Nomenclature Board of Tasmania), for access to the Nomenclature Database of Tasmania.

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Contents:

Overview:

This is a research project aimed at representing the experience of engaging with real spaces and locations over extended periods of time. As such it should come as no surprise that the wanderings I have undertaken in my research mirror the twists and turns of my exploratory tracks in the bush. Just as when conducting a search in physical space, my methodological advances began at a known locations, and then fanned out as promising lines, that were pursued until they disappeared or until they led to a "conceptual clearing". This exegesis is therefore a narrative that seeks to locate my artwork in the context of the experience and knowledge I have gained in my search for new ways of drawing.

Chapter one begins with an analysis of lines of sight and their relation to the development of drawing, mapping, surveying, geometry and mathematics. A discussion of the benefits and limitations of the technologies and aesthetics of drawing machines when representing natural environments follows. Chapter two contextualizes the artwork through an examination of contemporary Aboriginal attitudes to natural environment and the European aesthetics of colonisation, as well as questions related to locality, space and time, and the computational beauty of nature. Chapter three outlines the development of the artworks that comprise the exhibition, and the way they relate to the content of chapter two.

Background to the Project:

Mapping and drawing are intimately linked. Indeed it is hard to imagine a map without some kind of drawing involved in its production. All maps are not paper however, and research shows that humans and other animals develop and refine mental maps of their external environments. Mental maps are key tools for survival as they enable more effective use of the physical environment, and the shelter, food and other resources it contains. Whilst it remains arguable whether all animals use mental maps to internally represent their environment, it is beyond doubt that a wide range of animals make and use tools, and that some also share songs and other forms of cultural information. Human animals do however appear to be unique in their production of physically rendered maps.

Mapping is at essence a process of finding; recording and representing selected correspondences and associations that exist between information sources, it is a process of seeing patterns in information. In mathematical terminology 'mapping' refers to the association of the elements of one set with the elements of another set. Some maps achieve a one to one relationship between the source elements and their representation, for example a finger-print,

or the plaster-cast of a footprint, where the modeling material makes direct contact with the original, and takes on its scale and form, its resolution limited by the fineness of its 'grain' or sample rate. Maps of landscapes are pointless at one to one of course, and this is where drawing and geometry come into their own, as tools for simplifying and scaling elements selected from the infinite detail available.

My Masters by Research concerned drawing in four dimensions, and an analysis of the aesthetic character of the naturalistic space presented by the stereoscope. In my investigations I used the natural movement of the wind, clouds, moon and stars, and my body, to draw with light in the landscape at night. These traces were recorded in long time-lapse exposures, on stereoscopically aligned pairs of 35mm slide film; resulting in stereo-views that depict a naturalistic perspective, in terms of height, width and depth; but with time recorded as the overlaid movement of elements within this space; in a super-real simultaneity. They are scaled drawings in light, that compress a four dimensional continuum into a coded pair of two-dimensional abstractions.

Figure 1. *Prince Lyell Workshop Tunnel*, 1998.

My approach to my candidature was to launch myself from the edge of my prior knowledge into new areas that looked interesting, and to follow that impulse without fear to see where my insights might lead. My starting point was a desire to extend my stereoscopic explorations further into the realm of drawing, and my initial experiments were attempts to manually draw stereo-pairs in pencil. These were valuable failures that led me to reconsider my approach. I turned my focus to drawing machines that might be an aid to faster and more accurate drawing, and researched and constructed a room sized camera obscura, and a series of mirror based camera lucidas. I learnt a vast amount from their construction and use, including the surprising ability of the camera lucida to refine my ability to draw accurately when not using the device.

My readings to this point had exposed me to a large array of material relating to optical drawing aids, but it was not until I began to construct 3D computer models of the optical pathways of my own devices, that I realised the significance of the computer itself as the contemporary expression of the drawing machine. My investigation convinced me that this developmental trajectory was founded on the concept of the "line of sight" and its exploitation and utilisation in a wide range of practical activities and theoretical disciplines through ray tracing.

This was the critical turning point in my project. It led me to re-consider what drawing is, and thus freed me from the limitations of my preconceptions. My subsequent researches uncovered written references to the visual ray from as early as circa 350 BC. In Section One, Part Two, of Aristotle's "On Sense and the Sensible", he states:

> *It is, to state the matter generally, an irrational notion that the eye should see in virtue of something issuing from it; that the visual ray should extend itself all the way to the stars, or else go out merely to a certain point, and there coalesce, as some say, with rays which proceed from the object.*[1]

In that final phrase "with rays which proceed from the object",[2] I recognised the stereotypical description of the lines I had so often encountered in the optical diagrams and maps of my research. This discovery enabled me to recognise and comprehend the network of connections linking lines of sight with the pragmatics of vision and visual representation. This network connects seeing with drawing and geometry, as well as surveying, map-making and historical developments in land-use, and ultimately the contemporary conventions of naturalistic representation of both human, and non-human, aspects of the environment.

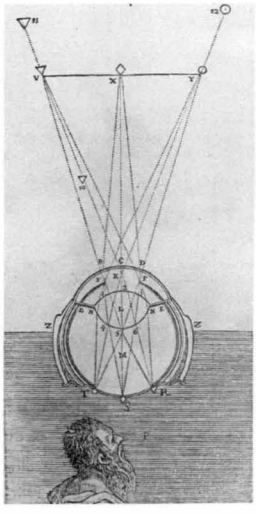

Figure 2. The Optical system of the eye, from Descartes's *Discours de la methode plus la dioptrique, les meteors et la geometrie,* Leiden, 1637.

This insight allowed me to shift from an obsession with the line as an analog object, and a desire to produce hand-made stereoscopic drawings, to an expanding notion of the functionality of the line as an idea, as a one dimensional concept that appears from the earliest examples of western geometry, and by extension, is the basis of the capabilities of contemporary computer mapping and visualisation. It also enabled me to recognise that the 3D track logging capabilities of a handheld GPS device represented the perfect tool to draw in four-dimensional space-time, and

1 Massachusetts Institute of Technology. "On Sense and the Sensible". Internet Classics Archive. http://classics.mit.edu/Aristotle/sense.html, January 6th, 2009.

2 Ibid.

at spatial and temporal scales and resolutions that would easily surpass the limitations of manual or photographically based drawings.

Chapter 1: Lines of Sight from Signs of Light:

> *He that works with less accuracy is an imperfect mechanic; and if any could work with perfect accuracy, he would be the most perfect mechanic of all, for the description of right [straight] lines and circles, upon which geometry is founded, belongs to mechanics. Geometry does not teach us to draw these lines, but requires them to be drawn, for it requires that the learner should first be taught to describe these accurately before he enters upon geometry, then it shows how by these operations problems may be solved. ...Therefore geometry is founded upon mechanical practice, and is nothing but that part of universal mechanics which accurately proposes and demonstrates the art of measuring.*[3]

This chapter provides a contextual framework for my investigations into a variety of practical and conceptual approaches associated with the study and exploitation of lines of sight. By illustrating a biological history of sight that precedes human evolution, I wish to establish that these issues remain active beyond our anthropomorphic perspective. Through a discussion of drawing, and its role in geometry, I will argue that the practices of conventional mapping are founded on linear abstractions that fail to accurately represent natural processes as dynamic systems. I will also show that this failure has largely been one of public imagination, in light of the contemporary application of computer based drawing machines to these limitations.

The concept of the line of sight forms the foundation of my research and thus the development of my thesis. Simply put, a line of sight is the visual pathway that connects an eye with its object of attention. Lines of sight obey the laws of optics, that branch of physics that seeks to understand the way light moves through, interacts with, and reflects from, the substances of physical reality. At the scale of unaided human perception, light appears to travel in perfectly straight lines; a line of sight only deviates at the point where it encounters or leaves a transparent medium, or is absorbed or reflected by a surface.

At the human scale of experience, this perfectly straight line connecting the eye to the world exists without clearly definable width or breadth; the smaller the aperture the line of sight passes through, the lower the image intensity and the sharper the image that is formed, however there is no clear point at which we might declare the minimum width or breadth of the line had been crossed, that is, where the line of sight is suddenly cut off. Clearly the wave length of light that determines the limits of its interactions with apertures, surfaces and transparent media is many orders of magnitude too small for direct experience, and thus the lines of sight we visually perceive are founded on an essentially abstract reality; that is to say that they

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3 Newton, Isaac preface to the first edition of The Mathematical Principles of Natural Philosophy (1687), trans I B Cohen

appear as one dimensional virtual lines, delimited by two points in space that locate the perceiver and the perceived.

It is my belief that the recognition, exploitation and systematic refinement of the concept of the line of sight forms the basis of image making and information mapping tools in current western technological societies. The line of sight is a concept of great antiquity, appearing in the writings of Aristotle and his references to the 'visual ray'[4] and in the survey methods of the ancient Chinese, Egyptians and Babylonians. However preceding the historical record is the experiential reality and significance of lines of sight for all sighted creatures; I will briefly look backwards toward the biological origins of the line of sight, before returning to its recent recorded history.

Ancient Eyes:

The biology of the eye is ancient and varied; its evolution from a simple light sensitive pit to a complex lens based optic having occurred across eight different phyla of animal, since the beginning of the Cambrian explosion over 500 million years ago.[5] Eyes first appear in the fossil record in this period, and are initially associated with various species of hard-shelled marine creatures called trilobites. This period in the geological record is characterised by a massive explosion in species diversity, and it has been argued that this was in fact due to the appearance of the eye, and the advantages it gave to species when competing for resources, and hiding from threats. Such theories suggest that the line of sight that existed between predator and prey dramatically increased the evolutionary pressure at both its ends; resulting in diverse biological solutions to the challenge of exploiting the opportunities, and camouflaging the threats, presented by the reciprocity and reversibility of the visual ray. From the outset, making eye contact has been a risky business mitigated only by its high potential rewards.[6]

Sighted creatures evolved rapidly and diversified as a result of increases in efficiency at finding food and shelter, and in recognising potential predators and mates. Understood in this way, the line of sight can be thought of as the "base-line" of an information exchange occurring between the visual environment and the optical perceiver. In order to negotiate this exchange of information with the environment, sighted creatures have developed complex processes that help determine when and what they display to their environment, and also how they react to the varied implications of seeing, and being seen. The development of camouflage in the natural world reveals a highly successful range of strategies for confusing, deceiving, disrupting and

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4 Aristotle, op cit.,

5 Philosophical Transactions of The Royal Society. "Darwin's dilemma the realities of the Cambrian 'explosion' " The Royal Society http.//journals royalsociety org/content/qu151t4722902768/ Accessed January 2009

6 Parker, Andrew In the Blink of an Eye Cambridge, Massachusetts, USA Perseus Books, 2003

concealing the clear exchange of visual information with the environment. Camouflage strategies have in turn applied their own evolutionary pressures, resulting in the reciprocal development of more acute forms of vision. Vision is a form of remote sensing, and thus adaptations that enable improved control of physical position, and thereby the control of distance between predator and prey, can be seen in the evolution of forms of locomotion that enhance speed and agility and endurance.

As sighted creatures, humans share varying degrees of our perceptual reality with all sighted animals; our eyes and visual systems ultimately stemming from branches on the same evolutionary tree, albeit at different points of remove. I think it important to stress that the functional reality and significance of sight lines to our present biological structure, is in large part attributable to the depth of our sighted history that precedes our human species. Personal experience of direct eye contact with animals; and of seeing while being seen by them; leaves me in no doubt that there are common elements in our visual perceptions, founded in large-part on an awareness of the multiple sight lines that are extending from, and leading to, the perceiving eye, and the threats they may pose.

Measuring the Earth:

Having grounded the concept of the line of sight in its biological heritage, I will return to its technological and conceptual construction as an abstract one-dimensional ray or line. In western science this concept has emerged as a result of the synthesis of geometric and mathematical techniques through systems of "ray-tracing" and geometric drawing. The study of astronomy is considered the oldest of all the sciences, and its' ancient history is evidenced in constructions like Newgrange in Ireland. Newgrange dates from circa 3,200 BC, and is approximately 500 years older than the Great Pyramid of Giza in Egypt and 1,000 years older than the major structures at Stonehenge. Newgrange reveals a well planned man-made structure that has been carefully positioned according to its' line of sight relationship with the sun at mid-winter. In order to be correctly set, these visual alignments necessitate the accurate counting and recording of the passage of time over very long periods. It can be seen that, even from the earliest records of western history, mathematics and sight lines become intimately associated with each other through their use in the construction of technological systems that measure and represent time and space.

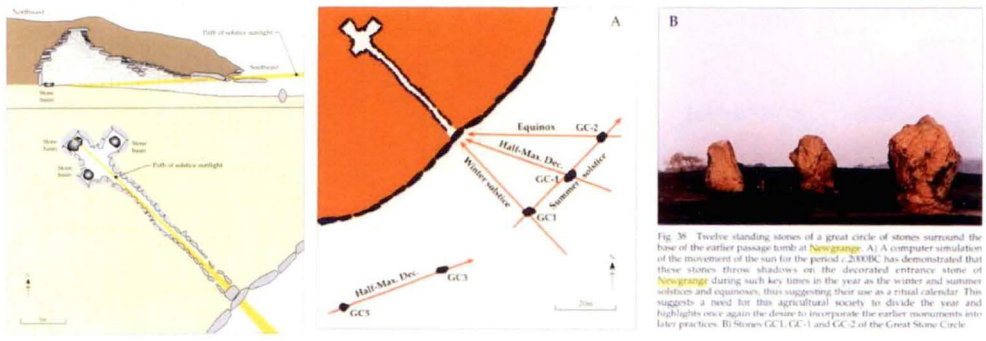


Figure 3. Plan views of Newgrange showing solar alignment.

Prior to the formal definition of geometry by the ancient Greeks, physical evidence of mathematical knowledge begins appearing from approximately 30,000 BC, when Paleolithic peoples in central Europe and France began recording numbers as marks on bones, and over the course of the next 5,000 years geometric designs gradually began to appear in common usage.[7] By 5,000 BC the first decimal number system had been developed for use in Egypt, and 1,000 years later Babylonian and Egyptian calendars made their first appearances. Egyptian artifacts from the period beginning 3,400 BC, (about the same time Newgrange was being constructed), mark the first known time that symbols representing numbers and simple straight lines were being utilised.[8]

Geometry is the term used to describe both the shape and relative arrangement of the parts of something, as well as the particular mathematical systems that describe such properties. Its literal translation from its ancient Greek origin is "earth measuring", and this etymological foundation illuminates its practical grounding in methods for the synthesis of direct observation with mathematical theory. By 2,700 BC, Egyptian geometrical techniques included precision surveying, (marking north by the sun's location at noon), and records begin to appear from circa 2,000 BC that cite approximations for π and for square roots. Exact statements of number, written arithmetic tables, algebra problems, and practical applications with weights and measures also begin to appear from around 2,000 BC, with several problems solved by abstract arithmetical methods. It has been shown that clay tablets from Babylon circa 2,000 BC (1,500

7 It is also worth noting here that the successful use of stones and arrows by prehistoric hunters necessitated an intuitive understanding of the geometry of trajectories that was essential to enable the hunter to compensate for the fundamental curvature of the line of flight, as distinct from the straight line of sight that connected hunter and prey. Some theories of the development of the human brain have argued that there are direct links between the invention of early ballistic weapons and the increased size of the human visual cortex. The theory suggests that humans have developed specific mental processes that facilitate the visualisation of these complex and abstract paths.

8 School of Mathematical and Computational Sciences University of St Andrews. "A Mathematical Chronology". University of St Andrews-Scotland. http://www-groups.dcs.st-and.ac.uk/~history/Chronology/30000BC_500BC.html. Accessed January 2009.

years before the time of Pythagoras), already reveal the early use of Pythagorean Triplets in the mapping and measuring of land boundaries, and for the calculation of their area when assigning land taxes.[9]

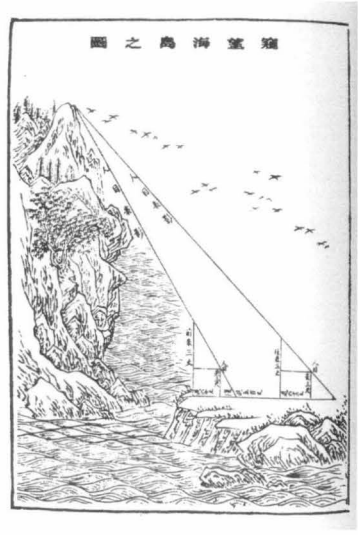
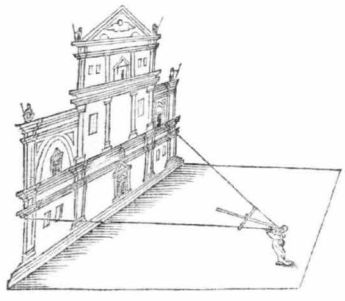


Figure 4. Survey of a sea island, from *The Sea Island Mathematical Encyclopaedia.*

There is also evidence that the Pythagorean Theorem was understood and utilised by the ancient Chinese; argument continues as to whether this knowledge existed slightly earlier than 1,600 BC, or whether its first appearance coincides with the publication of the Mo Jing, circa 330 BC; however it is clear from the example of the third century AD publication of The Sea Island Mathematical Manual, by Liu Hui, that Chinese geometry, like its Egyptian and Babylonian counterparts, had also evolved in close association with surveying and mapping.



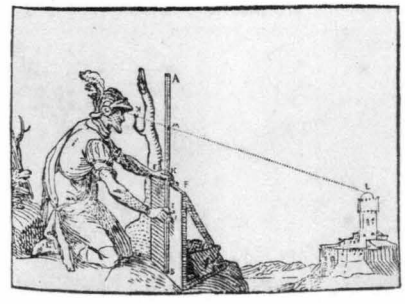


Figure 5. The *radio astronomico* used to measure the width of a façade from Germa's Frisius's *De Radio astronomico...,* Antwerp, 1545.

Figure 6. Cross-staff device for perspectival projection, from Cigoli's 'Prospettiva practica', (c.,1600).

9 Department of Mathematics Texas A&M University. "Babylonian Mathematics". Texas A&M University. http://www.math.tamu.edu/~dallen/masters/egypt_babylon/babylon.pdf. Accessed January 2009.

Physical and written evidence from a variety of cultures in these early periods, reveals that line of sight observations were repeatedly being utilised as the basis for systematic surveying and mapping techniques, and that, as these two-dimensional forms of representation evolved, elements of linear geometry began to be used to symbolise the sight lines and visual rays of their construction. In geometry, a straight line on a piece of paper does not inherit the thickness of the pen used to describe it; rather it is a one-dimensional abstraction, analogous to the line of sight which it represents. It was the mathematical utility of this technical innovation that ensured the success of geometric drawing as a consistent, reliable and predictable method for representing aspects of the physical world. In circa 270 BC Euclid published his *Elements*, which described the geometry of lines and flat planes. It is a geometric system that provides a reasonably accurate two-dimensional representation of small areas of the earth's surface; however at large scales there is a fundamental misalignment between the curved form of the earth's surface and the mathematical flatness of Euclidean space. It was this flatness that meant Euclidean geometry was fundamentally inadequate for use in global navigation.

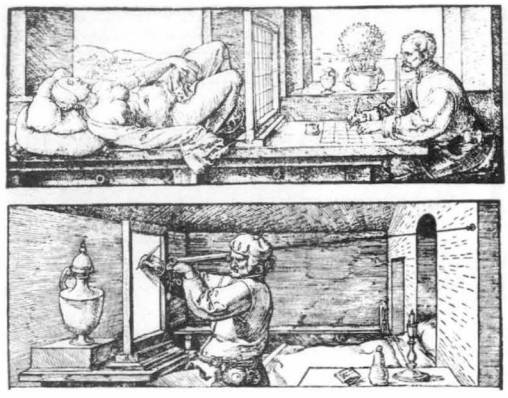


Figure 7. A draughtsman using a net to draw a nude in foreshortening, and Draughtsman using Jacob de Keyser's perspective device. (1538) Woodcuts from Durer's *Underweysung der Messung*, 2nd edn.,

The fifth proposition of Euclid's Elements states that parallel lines never meet, and this seems correct at an intuitive level, however it is only true in the flat space of Euclidean geometry; mathematicians have discovered that there are many geometries where this is not the case. The problems of navigating at sea using a map made with a Mercator Projection demonstrates the problem, since this projection shows all lines of longitude as parallel to each other from pole to pole, despite the fact that they converge and meet at each pole. The result is that the shortest distance between two points, (normally a straight line), is actually a curved line when traced on a Mercator projection. Dava Sobell's book *Longitude* gives a detailed account of the development of marine navigation and the central role of accurate time keeping in determining location, whilst in contrast Will Kyselka's *An Ocean In Mind* provides a fascinating insight into traditional Polynesian navigation using stars, winds, currents and waves.

New Perspectives:

Central to what later becomes the Cartesian view of space, is the idea of a flat Euclidean space that extends in three dimensions. Cartesian space is delineated by three perpendicular axes, which extend to infinite distance, and thus define a homogenous and undifferentiated volume of space within which all activity can be located and all distances can be measured using straight lines. By the fifteenth century, and the perspective experiments of Filippo Brunelleschi, the connection between an eye-line and a geometric-line had become explicit. Brunelleschi himself was trained in surveying, as Martin Kemp observes:

> *On his first visit to Rome, as described in his biography, he made measured drawings of Roman buildings, using his understanding of standard surveying techniques 'to plot the elevations', using measurements 'from base to base' and simple calculations based on triangulation. The results were recorded 'on offcuts of parchment ... by means of squared divisions of the sheets, with arabic numerals and characters which Filippo alone understood'. The basis for such procedures would have been the 'abacus mathematics' he learnt as a boy.*[10]

Brunelleschi played a key role in developing linear perspective and in "the demonstration of an internally consistent system for all the spatial elements in a picture and, above all, a proof that the systems rested upon non-abitrary foundations."[11] In contrast to previous methods, Brunelleschi's invention offered scientists and artists the first truly systematic approach to illusionist naturalism. As Patrick Maynard explains, the implications of this success for contemporary culture are profound:

> *By far the most important modern kinds of images would be drawings, and not artistic ones but technical and design drawings. Without such drawings it is hard to see how there could be a modern world. For there would be neither the kinds of technological thinking nor the kinds of manufacture that make industrial and postindustrial societies possible, nor their use and maintenance.*[12]

In addition he states that:

> *Linear and other forms of perspective might also be effective because they transfer powerful natural cues of space perception—cues that work for almost all sighted creatures—into the perception of drawings, paintings, photographs, and also three-dimensional media. Again, what we do when watching moving pictures is significantly like what we do when watching*

10 p.11 Kemp, Martin. The Science of Art. New Haven and London Yale University Press, 1990

11 Ibid

12 p.7. Maynard, Patrick. Drawing Distinctions: the varieties of graphic expression. Ithaca and London Cornell University Press, 2005

moving objects; what we do when looking at two images through a stereoscope is significantly like what we do when looking at things with binocular vision.[13]

Even when a commodity does not have to be drawn before it can be made, given that all artifacts are produced from materials shaped by other artifacts, those tools of manufacture will themselves have been drawn in order to be produced by other machines, and so on. This is true even for such crucial modern commodities as petroleum products, wood, grain, ores: though they need not be drawn in order to be produced, the mechanisms by which they are extracted, processed, and transported to market must be. Thus, whether or not they are themselves complex and precise, all modern artifacts and processed materials arise from substrata of drawings that are. Again, such was not the case before the modern age of industrial production—and such is not the case even in much of the so-called modern world of our time, when billions of people still use pre-industrial methods for their most important activities. Thus the chronological line that separates millennia of traditional craft and manual labor practices and modern productive technologies, like the cultural line that today separates post-industrial from traditional societies, is drawn as much by designers and engineers as by capital, organization of labor, etc. As a result, today in "the developed world", just as we might divide countable individual things as artificial and natural, we might almost as well divide them between the drawn and not drawn. With apologies to the poet Lawrence Ferlinghetti's "Pictures from the Gone World," we can even say, of one world's "pictures", that the modern world is a drawn world. For this world, the gone world is one that does not have to be drawn in order to exist.[14]

I have endeavoured to illustrate three important points. Firstly, that drawing as a methodology for measuring the world has existed at least since the time of the first forms of written language; it is a tool that has been developed and utilised by a range of cultures and which has its roots in our biological heritage. Secondly, this cross-cultural appeal is based on a long period of observed and tested correspondences between natural phenomena and abstract mathematical rules; geometrical drawing has proved itself to be consistent and practical in all its various incarnations. And thirdly that, despite their abstract nature, lines and numbers and mathematical ideas do have a very real existence and a remarkable utility. The way these entities fit together remains consistent across time and space, and in fact it is their "abstract objectivity" that constrains the formation of matter and energy, and thereby the appearance and behaviour of our physical world. It is this consistency and transportability at the core of these abstractions, which in turn guarantee their effectiveness and utility as systematic representations of natural processes. Here I quote the mathematician Roger Penrose:

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13 Ibid p 16

14 Ibid p 20

Mathematics itself indeed seems to have a robustness that goes far beyond what any individual mathematician is capable of perceiving. Those who work in this subject, whether they are actively engaged in mathematical research or just using results that have been attained by others, usually feel that they are merely explorers in a world that lies far beyond themselves - a world which possesses an objectivity that transcends mere opinion, be that opinion their own or the surmise of others, no matter how expert those others might be.[15]

Of course such a successful tool comes with a price, since its application in the real world is always limited by the current state of human knowledge. In mathematics we may have a tool kit that can theoretically model any natural process, but until the workings of a system are fully understood, any predictions or actions based on an understanding of only its parts are liable to be in error.[16] This is not a serious issue when modeling the elements within a simple closed system, however human history has repeatedly shown that complex and open systems like those found in natural ecologies may react in entirely unpredictable ways when impacted by human technologies. Euclidean geometry, (that is to say geometry that works for straight lines, flat surfaces and Cartesian space), is only one *possible* formulation of space, (and one which treats time as a separate variable), and since Euclid's era, many other possible geometries, with entirely consistent mathematics, have been developed to describe natural processes that do not comply with linear models of behaviour, and which inhabit spaces of 4 dimensions and beyond.[17] In contrast to Euclid's era, it is now clear that non-linear and dynamic systems actually dominate physical processes; and are in fact the norm, rather than the exception. Thus to adequately describe and represent natural systems, artists must learn to accept and incorporate the core aesthetic characters of multi-dimensional natural environments into their worldview and their art.

The Post-Cartesian Universe:

The 'cartographic gaze' ... assumes what Adorno called a 'peephole' metaphysics, an observer epistemology, and a Cartesian commitment to vision as the privileged source of 'direct' information about the world. It presupposes what Martin Heidegger called 'world space', a parametric manifold within which nature and society can be thematized in terms of their spatial relations. It has prioritized mathematical forms of abstraction over other forms of abstraction in this process of thematization. It has come to see itself as a technical-scientific practice of representing (mirroring) nature. It has accepted a universalist logic, underpinned by commitments to particular forms of parametric space,

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15 p 13. Penrose, Roger The Road to Reality - A Complete Guide To The Laws Of The Universe London· Vintage Books, 2005

16 For more information on the limits of computability see Godel's incompleteness theorems, proved by Kurt Godel (1906-1978) in 1931, and subsequent work by Alan Turing (1912-1954)

17 For a more detailed description of the relationship between linear and non-linear geometry see Appendix D

geometry and scale. It is, above all, a controlling gaze rendering the broad swathes of worldly complexity and enormity in miniature form for a discrete purpose. And, as the history of mapping demonstrates, the ordering principles of the cartographic gaze have always had political intent and/or consequences. The cartographic gaze is dominated by a commitment to modeling a God's eye view, what Donna Hathaway (1991) called the 'God trick'. This transcendental positioning is both the view from above, an elevated two-point perspective bird's-eye-view, and an all seeing eye that views everywhere at the same time.[18]

As I have demonstrated, at the core of this cartographic gaze is the notion of a straight line with a single dimension that has underpinned the development of mathematics and geometry in western cultures. Its practical implications also underpin the reciprocal "line of sight" relationships that arise between predator and prey, and thus in human societies those that exist between enemies on the battlefield. For this reason the development and exploitation of geometric systems has always been a key subject of military interest. Galileo and Newton both worked on the physics of ballistics, and conducted research and experiments for military patrons. Both used their skills and knowledge to develop mathematical models of the parabolic trajectories of projectiles.

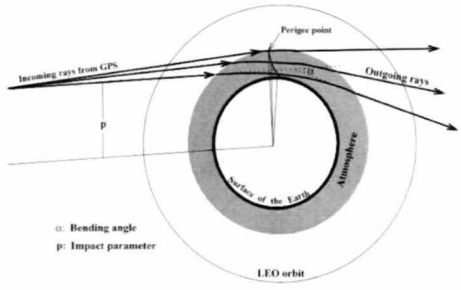

Figure 8. Raytracing of GPS signals in atmospheric analysis.

The current benchmark for accuracy in the world of modern navigation is that provided by the cartographic gaze of satellite based Global Positioning Systems. The oldest of these is the network of 24 satellites called the NAVSTAR GPS network that has been in operation since 1978. Constructed by the US military, the satellites are managed by the United States Air Force 50th Space Wing, and are deployed at an altitude of 20,200 kilometres above the earth's surface, circumnavigating the globe twice a day at a speed of approximately 14,000 kilometres per hour. Positions on the earths' surface are calculated by triangulation relative to these bodies in space; that is, in relation to these 'sky-marks', rather than traditional landmarks. Although these positional calculations are based on the same Pythagorean equations used by land based navigators for centuries, the high speed of the satellites, in conjunction with the reduced gravity at their operational altitude, means that positional calculations must accommodate relativistic

18 p.80. Pickles, John. A History of Spaces – Cartographic reason, mapping and the geo coded world. London and New York: Routledge, 2004.

effects. At the core of this system is a paradox; due to its accuracy and operational ease, the network of satellites has led to the impression that it is the apotheosis of the Cartesian dream, whereas, in fact it is only able to function due to our recently developed understanding of relativistic and quantum physical models. The spatial accuracy of the network depends on a precise temporal calibration, using cesium and rubidium clocks that are themselves used to define the international standard second as 9,192,631,770 cycles of radiation corresponding to the transition between two energy levels of the ground state of the caesium-133 atom. These clocks were originally designed in order to test Einstein's theories about the relativistic effects of gravity on time; hence the model of nature they were designed to confirm to is one that incorporates time as the fourth dimension in a spacetime continuum. In such a model, not only does the speed of an observer relative to their frame of reference affect the passage of time and the frequency shifts in the light rays they observe; but in addition these lines of sight can be bent by the curvature of the gravitational field through which they propagate.

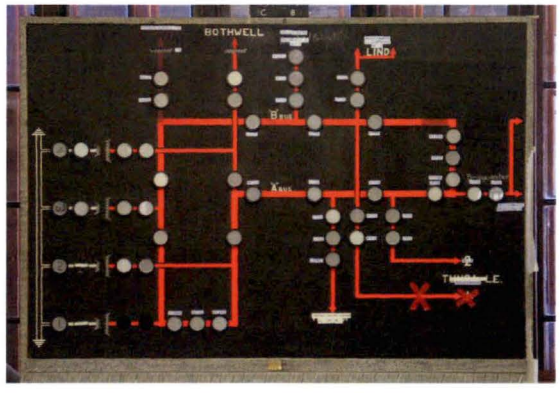

Figure 9. Topological map of electrical transmission for the Derwent hydro-electric development, circa 1920, from Waddamana 'A' Power Station, central Tasmania. 2005.

In conventional topographic surveying and mapping, (the graphic representation of 'topos' or place), the distance values of sight-lines measured between places are used as the raw information that reveals the spatial relationships between places when represented on the map. As demonstrated, this approach works extremely well in defining the extensive qualities of discrete objects that might be the subject of observation or intended manufacture, however this approach tells us very little about the other relationships that exist between objects and the components of the systems in which they are embedded. In contrast to topography, topology is unconcerned with extent, and instead replaces the measure of distance between places with the logics of their connectivity.

Topological analysis thus concerns itself with the way that the constituent parts of a system are connected, and thereby inter-related as a network; rather than possessing length, lines of linkage within a network are either present or are absent and their single dimension is their 'diameter' through which more or less information flows. The topological study of ecological networks allows the representation and comparison of the biotic interactions within real ecosystems. Rather than just showing where things are located, topological analysis of the

complexity, connectance, clustering, compartmentalisation and nestedness of these linkages reveals the behaviour of natural systems and the processes that underlie them. As Jordan Scheuring points out;

> *"It is not species themselves but the topology of their interspecific interactions [that] is the most important for understanding the functioning of an ecosystem."*[19]

It is my contention that lines of sight are key visual phenomena that have influenced the behaviour and development of sighted creatures. As such, they serve to reinforce our connection with the natural world, and to guide our behaviour within it, according to a range of influences, many of which are common to sighted creatures that share significant aspects of our optical evolution. In addition I have sought to demonstrate that the abstract one-dimensional character of the sight line has been readily transposed onto, and into, the geometric world of mathematics and measurement, through its symbolic representation as the straight-line. Further to this, the mapping and representation of natural environments is still dominated by the old Cartesian paradigm that produces historical 'snapshots' that deny the reality of nature as a network of complex and self-organising systems and processes. It is my contention that the motif of the line, with its range of connections to concrete methods such as direct observation and the establishment of ground truth, as well as to abstract methods such as measurement, vectorisation and connectivity, is itself a critical node in a larger network comprised of scientific and artistic representations of natural systems. Over at least the last five thousand years the deceptively simple concept of the line has evolved to form a 'hub', (in topological terms a key node with many connections), within the discourse of western technological societies.

> *More recently the computer and computer assisted drawing (CAD) have been changing even the heuristic practice, since their programs are algebraic developments of systematic projective geometry. The use of computers may already be entering the visualizing imaginations of drafters—which may be all to the good, should that carry them clear of the physical projection models of shadow and camera.*[20]

In conclusion, I will use an example from my recent experience as a way of bringing this discussion to a current focus. I had been to Canberra for the opening of the new National Portrait Gallery, and was now flying back to Tasmania via Sydney. Seated at a window on the port side, in the row where the emergency exits are located, I was listening as the attendant took three of us through the emergency safety procedures. I began considering the drawings we held, beautifully coloured cartoonish symbols with smooth black outlines that detailed the

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19 Ferenc Jordán and István Scheuring "Network ecology: topological constraints on ecosystem dynamics" Physics of Life Reviews 1 (2004) 139–172

20 Maynard, op cit., p 43

threats of fire, smoke and structural damage that would indicate we could not open the exit. There were no photographs of burning planes, or people sliding down escape ramps in paddy fields amongst their burning luggage. Every element was abstracted, distanced and cool; understandably so. As I reflected on this I began to see that the whole idea of aviation is unthinkable without the use of drawings; the profiles of the wings and the jet turbine blades were self-similar projections, refined and replicated in every aircraft; similarly, the electrical and hydraulic systems existed as drawings before manufacture and installation, and then later as maintenance guides. By now we were taxiing to the runway, and I could see that the pilot was following an immense drawing on the expansive tarmac; reading colour coded lines and marks that announced safe routes and dangerous boundaries, until we arrived at the runway with its black and white bands like a checkered flag, and that final dashed line that the pilot followed into the sky. Leaving the end of that line, abstraction and distance grew to dominate, as elevation made everything a drawing; a living map, and I was suddenly reminded that the origins of modern aerial-cartography were located in this effect; that almost as soon they were invented, aircraft were used to observe, photograph, map and then bomb the trench-lines of World War One, and this is where contemporary photogrammetry was born. Of course somewhere in a control tower our flight was also a drawing on a screen—linked by lines of sight to a drawing in the cockpit of our aircraft; both drawings calibrated against the even wider field of view provided by GPS signals and weather radar, from satellites at elevations beyond the eco-sphere.

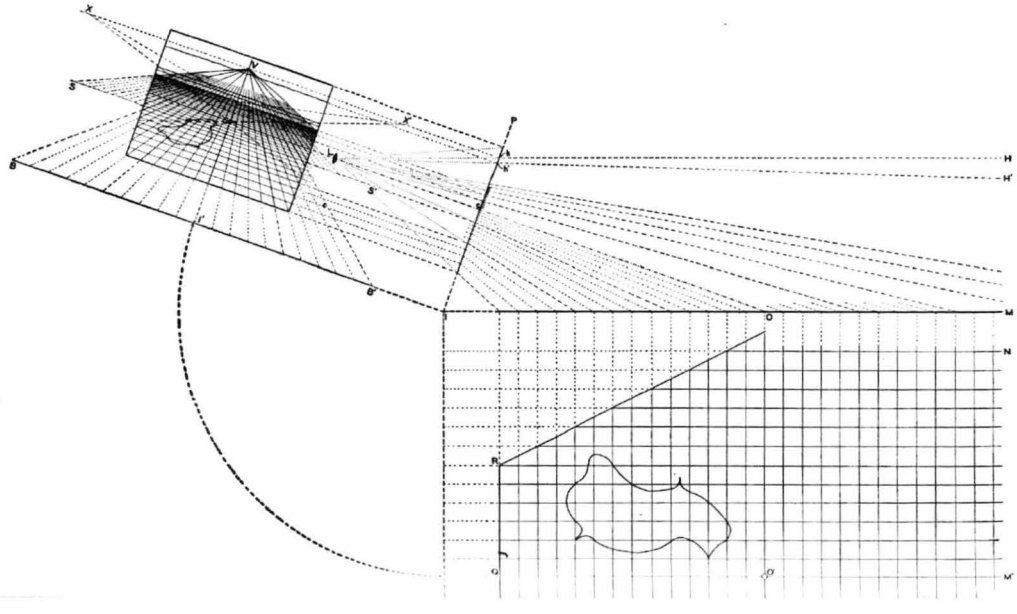

Figure 10. Raytracing a map from an oblique aerial photograph.

Chapter 2: The Aesthetic Terrain:

> *If it trivialises to see nature in terms of ready-made, standard "views", so does it also to see one self merely as the detached viewer - or indeed as a noumenally free and rational ego. There is a deepening of seriousness when I realize that I am myself at one with, part of, the nature over-against me. So, I want to say, an aesthetic appreciation of nature, if serious, is necessarily a self-exploration also; for the energies, regularities, contingencies of nature are the energies, principles and contingencies that sustain my own embodied life and my own awareness. Nature may be "other" to us, but we are no less connatural with it.*[21]

The aim of this chapter is to examine and discuss various benefits and limitations of 'linear' representations of natural environments, through reference to real localities within the context of Tasmania. This will provide a theoretical framework for the development of the alternative mapping strategies I have applied in the development of my artwork. This chapter explores the theoretical and artistic context of my project. Its function is to introduce and examine the thematic concerns, and the visual artists that have influenced my choice of mapping strategies.

Beginning with a discussion of contemporary theories relating to the aesthetic appreciation of natural environments, the chapter then investigates issues related to the colonisation of aboriginal space by the cartographic gaze. This discussion is followed by an investigation of locality and the meaning and significance of location, leading to an analysis of alternative modes for representing space and time. Finally the chapter looks at the computational beauty of nature, and the advantages and limitations of modeling natural systems in this way. Each section discusses a range of artists and writers whose work is directly related to the topic in question.

Background: The Colonial Context:

When the British established a settlement on the shore of the Derwent River in 1803, they brought with them a range of preconceived methods for representing the environments they were to encounter. Key to the imposition of British sovereignty over the land was the application of the 'cartographic gaze' and the then dominant picturesque aesthetic to the mapping and representation of Hobart and its environs.

> *The Picturesque view of nature is one that appreciates landscape in so far as it resembles known works of art. At the same time, Picturesque taste favors natural scenery for its untouched status, its remoteness from the word of art and artifice - it delights in the results of accident, the traces of agency of time and organic growth, it celebrates what is alien and*

21 p 69 Hepburn, Ronald W "Trivial and serious in aesthetic appreciation of nature," in Landscape, Natural Beauty and the Arts.

wild and spontaneous. As Picturesque taste, drawing on models of beauty from Italian and Dutch seventeenth-century painting, absorbs and reproduces its favorite material, in painting and garden design, what was strange and wild becomes increasingly familiarized and commodified. Uncultivated natural scenery is, as it were domesticated - it is accommodated within our daily experience both as an artistic experience and as a tourist amenity: it is esthetically colonized.

The formula derived from Picturesque conventions reduce novelty and variety to secure uniformity. The Picturesque makes different places seem like each other. In encourages us to edit out diversity, eccentricity and startling departures from the standard. It chooses to reassure, not to shock.[22]

As Simon Ryan elaborates:

The 'picturesque' works to delimit the continuity of the universe, to produce a frame which makes a text of the landscape so that it may be read and compared to the ideal. Framing landscape, and labeling it picturesque, combats its threatening vastness and unfamiliarity and demonstrates the triumphant portability of visual taste; it also defers the opening of the aesthetic process to native adaptations.[23]

Figure 11. *Pipra M&F. Spotted Manikins (Pardalotes),* Hunter Island and the Derwent from Hospital Hill. G.P.Harris,1806 water colour. Original in Mitchell Library, Sydney, NSW.

The history of Tasmania's invasion demonstrates that native adaptation was not to be tolerated. The earliest representations of Hobart consist in the most part of rough sketches and amateur drawings in a picturesque format. The works of surveyor George Prideaux Harris who was involved in the original 1804 survey of the town are notable in this regard. Harris produced a number of works of local birds in their habit, and notable amongst these is an image of the

22 p.129. Malcolm Andrews, Landscape and Western Art.

23 p.60. Ryan, Simon. The Cartographic Eye: How Explorers Saw Australia.

"Spotted Manikin", which appears perched above a fresh tree stump, with Hunter Island and Sullivans Cove as the backdrop. The drawing functions to naturalise the destructive processes of colonization (as evidenced by the stump in the foreground), whilst at the same time familiarising the colonist with the foreign appearance of the indigenous fauna. Harris's picturesque works depicted Hobart as an arcadian idyll, ripening under the southern sun.

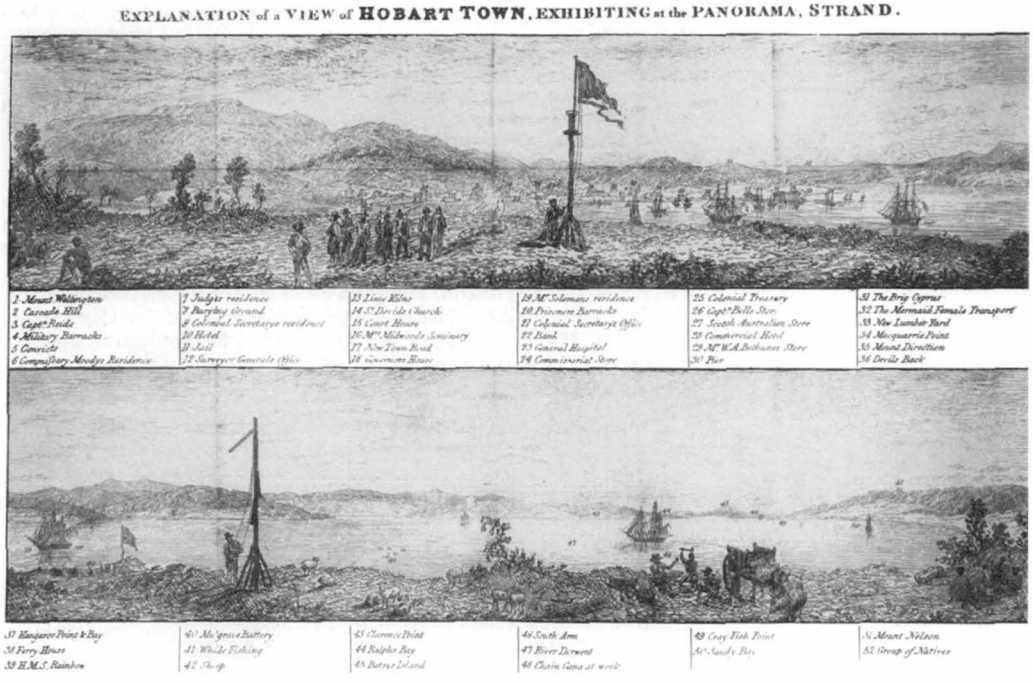

Figure 12. *Explanation of a View of Hobart Town, Exhibiting at the Panorama, Strand.*

During a visit to Hobart in 1825, the artist Augustus Earle produced a six-part panorama of the settlement nestled on the Derwent River. This is a beautifully rendered and very well scaled representation of the town; a *systematic* representation which displays a naturalistic depiction of the local topographic features. However, the Hobart panorama does not cover the full 360° range of the compass. The collection record details from the State Library of New South Wales, where these drawings are held, states that:

> *These drawings were the basis of a panorama, painted by Robert Burford, which was displayed in London in 1831. A guide, with an etched frontispiece of the panorama, was published to accompany it: "Description of a view of Hobart Town, Van Dieman's Land, and the surrounding country: now exhibiting at the Panorama, Strand / painted by the proprietor, Mr. R. Burford", London, 1831.*[24]

The record also makes this observation: "The frontispiece suggests that one sheet of the panorama, from the right hand side, is missing as its view is more extensive than the panorama."

24 *Panorama of Hobart c. 1825 - watercolour drawings by Augustus Earle.*

I believe the available evidence points to an alternative explanation. Comparison with the original site of Earle's drawings reveals that the six panels only cover slightly more than 180 degrees of the available view; however Burford was in the business of painting panoramic pictures that wrapped around the viewer through 360 degrees. Thus, in order to present the unified visual field expected by his patrons and demanded by the cartographics of colonialism, Burford invented an extra panel which functions to seamlessly cover the rupture in space; since only a local Hobartian might notice the fiction. As can be seen in the pamphlet that accompanied Burford's virtual Hobart, the extra panel in the bottom right bridges the gap whilst visually marginalising the Aboriginal owners of the land. As a form of advertising for colonial expansion, it was Burford's job to provide such seamless representations of new lands; bountiful and under the rule of law, with ample convict labour for improvement of the land.

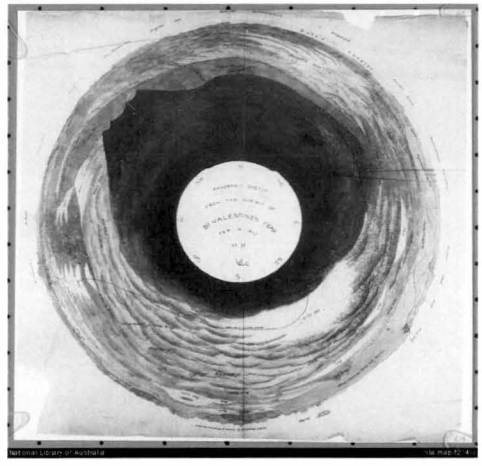

Figure 13. *Panoramic sketch from the summit of St. Valentine's Peak, Feb. 14 1827.* Henry Hellyer

In 1827 the surveyor Henry Hellyer produced a remarkable panoramic image of the view from St Valentines Peak in northwest Tasmania. The drawing is a complete circle, with the viewpoint located at its centre, and north at the top. The final drawing is a complex construction that again uses a systematic approach to create a unified and naturalistic impression of the landscape as a commodity. Hellyer's job was to identify grazing lands suitable for purchase by his employer The Van Dieman's Land Company. Having visited the location and experienced the view I discovered that Hellyer's drawing significantly exaggerates the vertical scale of the features on the horizon, and I imagine this was primarily to aid their identification.

These early picturesque and panoramic images are exemplary of the aesthetic system that the British invasion used to document and legitimise its claim on the land, and which also served to commodify land and advertise its availability for private ownership, exploitation and "improvement".

> *The culmination of the panorama and arcade experience was the emergence of the great world exhibitions, the first being in London in 1851–a mirror world of a different kind; a 'Crystal Palace'. It was in these great international exhibitions and fairs that the 'pleasure industry' had its origin and it is they that 'refined and multiplied the varieties of reactive*

behaviour of the masses. It thereby prepares the masses for adapting to advertisements'. The advertising industry and world exhibitions shaped a mass public that was at one and the same time individualized, nationalized and globalized.[25]

25 Pickles, op cit., p.139.

The Aesthetics of Natural Environments:

This section outlines the major philosophical themes relevant to the aesthetic appreciation of natural environments, and works through them towards an understanding of the ways in which the natural environment may be appreciated on its own terms; thereby offering potential alternatives that avoid the distanced contemplation of the cartographic gaze and the formulaic approach of the pictureseque. This section is aimed at locating and investigating the contextual boundaries for an informed appreciation of natural systems. The philosophers and artists I have chosen to discuss offer a range of alternative approaches that have in common their reaction against the detached and formalistic frameworks of the aesthetics of the picturesque and the cartographic.

Environmental aesthetics is a relatively new field of philosophy, having emerged in the mid 1960's. While its roots are in the eighteenth century works of "British and Scottish philosophers, such as Shaftesbury, Hutcheson, Burke, and Alison",[26] which were "solidified by Kant"[27] its contemporary revival and re-appraisal is attributed by Carlson and Berleant, to the publication of a 1966 essay by Ronald Hepburn, titled *Contemporary Aesthetics and the Neglect of Natural Beauty*. Against a background where some of his contemporaries narrowly defined aesthetics as "the philosophy of art",[28] Hepburn made a compelling case for philosophers to reconsider their neglect of the significance of the aesthetic appreciation of nature. Like Kant and Burke before him, Hepburn advocates a central role for the imagination, functioning as a:

> *focus imaginarius, that can play a regulative and practical role in the aesthetic contemplation of nature. It sees that contemplation as grounded, first and last, in particular perceptions, but as reaching out so as to relate the forms of the objects perceived to the pervasive and basic forms of nature; relating it also to the viewers own stance and setting, as himself one item in nature—a nature with whose forces he feels in harmony through the very success of this contemplative activity itself.*[29]

Before discussing the main arguments in more detail, it is timely to define some terms. In the following quote Holmes Rolston III succinctly sets the scene:

> *Here it might be useful to take stock of distinctions between some of these cognate terms - landscape, nature, environment. The following descriptions are useful:*

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26 p 11 Carlson, Allen and Berleant, Arnold. "Introduction: The Aesthetics of Nature." in The Aesthetics of Natural Environments.

27 ibid

28 p.43 Hepburn, Ronald "Contemporary Aesthetics and the Neglect of Natural Beauty." in The Aesthetics of Natural Environments.

29 Ibid. p 59

Nature is the entire system of things, with the aggregation of all their powers, properties, processes, and products - whatever follows natural law and whatever happens spontaneously.

Landscape is the scope of nature, modified by culture, from some locus, and in that sense landscape is local, located. ...Humans have both natural and cultural environments; landscapes are typically hybrid.

An environment does not exist without some organism environed by the world in which it copes. ... An environment is the current field of significance for a living being.[30]

Two major tendencies in the ensuing philosophical debate have sought to move the discourse beyond the constraints imposed by the disinterestedness and formalism of the picturesque aesthetic. One approach emphasises the importance of the cognitive in the aesthetic appreciation of nature, and this attitude is typified by the writing of Carlson; whilst the other approach in fact consists of a range of alternatives, that broadly speaking involve "an endorsement of the idea that the natural environment facilitates an open, engaging, and creative mode of appreciation".[31]

Brief summaries of the positions presented in Carlson and Berleant's book that develop the second approach, include;

- Noel Carroll, who advocates the incorporation of immediacy and emotional reaction into our appreciation;
- Cheryl Foster, who highlights nature's resistance to discursive formulation, and therefore the significance of the ineffable;
- Arnold Berleant, who offers a model for an aesthetics of engagement, based on the sublime;
- Yuriko Saito, who argues for an aesthetic appreciation of nature that embodies a moral capacity for recognising and respecting nature as having its own reality apart from our presence, with its own story to tell;
- Thomas Heyd, who argues that aesthetic appreciation of nature should be guided by a great variety of stories from a diversity of walks of life and cultures because these enrich our capacity to aesthetically appreciate nature.

Common to all these writers in the second grouping is a desire to move away from disinterested contemplation, towards forms of active engagement with natural systems that acknowledge, make allowance for, and even celebrate, the unavoidable anthropomorphic bias of all human

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30 Rolston, Holmes III, 'Does Aesthetic Appreciation of Landscapes need to be Science-based?', British Journal of Aesthetics 35, No.4 (October 1995),p 379.

31 Carlson and Berleant, op. cit., p 17

knowledge systems and all human experience, as well as their assimilation within the natural world.

As an exemplar of the cognitive approach, Allen Carlson argues that a person can best understand their environment by recourse to contextual knowledge provided by science and common sense.[32] His narrow prescription of the appropriate context for the aesthetic appreciation of nature offers no room for personal intuition or imagination, or encounters that hint at the ineffable and the transcendent. There is no doubt, however, that scientific and commonsense knowledge gained from direct experience of the natural environment are extremely valuable parts of the overall picture; but they do not provide the *only*, nor necessarily the most important, context for appreciation. For example, knowing that the ground I stand on may have last seen sunlight before plant life existed on the planet, certainly alters the context of my appreciation of a piece of dirt, and knowledge of geology deepens it; science has this capacity, but it seldom acknowledges its own limits, nor the importance of the things that continue to exist beyond its borders.

Arnold Berleant provides an alternative understanding of how to aesthetically engage with the natural environment. Berleant reminds us that:

> *The boundlessness of the natural world does not surround us; it assimilates us. Not only are we unable to sense absolute limits in nature; we cannot distance the natural world from ourselves in order to measure and judge it with complete objectivity. Nature exceeds the human mind, not just because of the limits of our present knowledge, not only because of the essentially anthropomorphic character of that knowledge so that we can never go beyond the character and boundaries of our cognitive process, but by the recognition that the cognitive relation with things is not the exclusive relation or even the highest one we can achieve.*[33]

Berleant says that under these conditions the proper aesthetic response is awe at the magnitude, power and mystery of the "ungraspable breadth of nature",[34] and that aesthetic pleasure is only possible in such a situation if we relinquish our efforts to objectify and control the natural world. Berleant suggests that:

> *[I]f the sublime becomes our model and we accept the unity of the natural world, then we must identify the qualitative character of our experience which becomes central on these occasions when aesthetic appreciation dominates. They are times of sensory acuteness, of a*

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32 p 72 Carlson, Allen "Appreciation and the Natural Environment," in The Aesthetics of Natural Environments.

33 p 82 Berleant, Arnold "The Aesthetics of Art and Nature," in The Aesthetics of Natural Environments.

34 Ibid

perceptual unity of nature and human, of a congruity of awareness, understanding and involvement mixed with awe and humility, in which the focus is on the immediacy and directness of the occasion of experience. Perceiving environment from within, as it were, looking not at it but in it, nature becomes something quite different; it is transformed into a realm in which we live as participants, not observers. The consequences are not de-aestheticizing, as the eighteenth century would have it, but intensely and inescapable aesthetic.[35]

Thus Berleant outlines for us an aesthetic experience of perceptual unity that springs from involvement and understanding founded on a direct engagement with the natural processes that assimilate us. Putting such theory into practice and making art about the experience of being engaged, is at the core of my project. Richard Long, Hamish Fulton and John Wolseley are three British artists who have successfully adopted methodologies of direct engagement with the environment in the creation of their artworks. The three studied together at St Martins School of Art, London, during the period 1966-68, and all three appear to have developed ways of working in reaction to the picturesque aesthetics that dominated British landscape art up until their emergence in the 1970s. Whilst Long has forged an international career by undertaking extensive walks in exotic locations and exhibiting the photographic documentation of his interventions in the environment, he is vulnerable to criticism for exploiting environments with which he has little prior connection, and simply using them as backgrounds for his "environmental drawings",[36] in addition his later artistic production has tended towards a retreat from direct engagement into an increasing preoccupation with formalism.[37]

In contrast, Hamish Fulton, who visited Tasmania in 1979, has recently used the elements of text and drawing to explore the ways in which formal elements can form overlays that add to the intensity and poignancy of the observations he makes in regard to the environment he photographs, and sometimes even replace them entirely.[38] Fulton describes himself as a walking artist. He states that for him there can be no work with out a walk. During his stay in Tasmania, Fulton spent 10 days walking from Lake St Clair in the central highlands, to the northern coast near Turner's Beach. *Tasmania: A Slow Journey 1979 Four works: Hand Outlines, Four Rocks; Rain, leeches, mud; Parrot, wallaby, wombat; Looking back from the seventh day, two crows,* is the resultant four panel photographic series he produced. In this early series the text

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35 Ibid

36 Long, Richard *A Line in Bolivia - Kicked Stones* (2 Versions), 1981, and *A Line in the Himalayas*, 1975, printed 2004 Richard Long "Sculptures". http //www.richardlong org/sculptures/8 html Accessed January 2009

37 Ibid *Waterfall Line*, 2000

38 Fulton, Hamish *Geese Flying South*, 1990 Tate Online "Hamish Fulton" Tate Collection http://www tate org.uk/servlet/ViewWork?cgroupid=999999961&workid=20810&searchid=9468

lies outside the photographic image, forming a caption for each of the four stations he recorded. The four images form a distillation of what he experienced in that time and space. Fulton presents the viewer with delicate compositions of wet rainforest and button grass, punctuated by lichen covered rocks that proudly wear their history and assert themselves as complete entities that share the land with the artist and the transitory subjects of his ambient title. It is a satisfying and engaging work in itself, and the viewer is involved in celebrating the personal and the incidental, as well as the particular and the strange; this is also what might be hoped for in an experience of the environment itself.

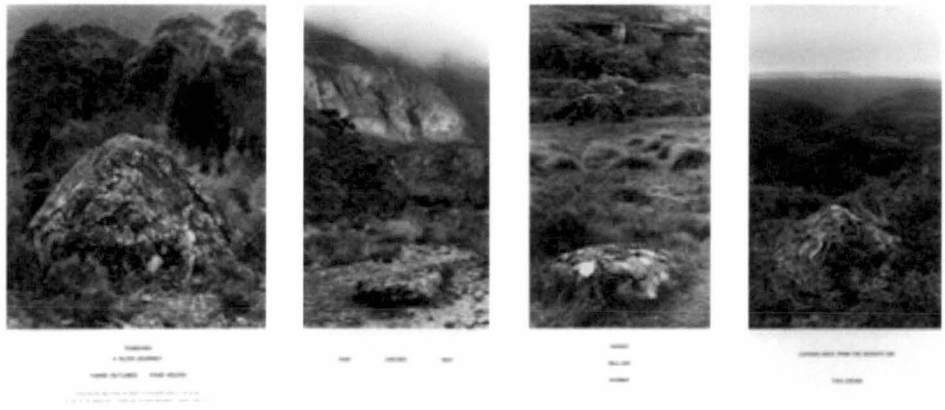

Figure 14. *Tasmania: A Slow Journey 1979 Four works: Hand Outlines, Four Rocks; Rain, leeches, mud; Parrot, wallaby, wombat; Looking back from the seventh day, two crows.* (1979). Hamish Fulton.

In 1976 Wolseley moved from England to Australia to live and work in an environment less dominated by the English landscape tradition. Rather than primarily using the camera, as do Fulton and Long, Wolseley is a skilled draftsmen, and works to break down perspectival space by creating works that consist of a multiplicity of elements. Rather than working with a unified photographic surface, Wolseley works with multiple sheets of paper, allowing them to be stained and torn by contact with their environment; even burying sheets of paper and working with the decomposing result. He delights in drawing and the capacity of the environment to draw itself. Wolseley offers a vision of drawing that measures the dynamic interaction of the artist with the environment, and which reacts against the kinds of linear boundaries that characterise human artifacts, and which do not appear in natural systems.

Wolseley literally and metaphorically seeks to transcend the opposition between the two sides of the Cartesian fence; here I quote at length from the dialogue in the DVD titled *The John Wolseley Australian Art Resources Pack*, made by Creative Cowboy Films in 2006.

So that's what's so poignant and poetic about it, is that the fence is the ultimate linear boundary, where people have said, right we want to do that in a very linear and directed way, and they want to do that ... the fence remains and is maintained, but in a case like this where it is frayed, and where it is falling into disrepair, it just becomes a memory of that attempt to create this way of thinking, and so for me its totally fascinating, because its so lovely to see what this mosaic of animals and plants does when its left to its own devices. The amazing biodiversity and the dynamic of how it survives, and then with just this little hint of a fence through it, reminds one of another side to how we appreciate nature; there's the wild nature and then there's the sense that we want to control it, it's that point of, are we controlling it, or are we not, that's so interesting in a painting.

Wolseley goes on to outline his methodology, his mode of engagement, and the difference between his approach and that of a scientist:

I sort of think well I want to do things in such and such an area, and then I allow days and days just to wander around, and its just such a lovely un goal-oriented thing, ... you see something in the distance and you think oh that pulls me in that way, and I go for sort of very long walks, and I'm just allowing the place to tell me what to do. And then in that process ... the land yields the places which have some kind of special excitement or tension. If you open yourself out to that, you don't drive in the car and say I'm going to do this important thing here ... the whole notion of doing a painting in the traditional western perspective is a very different one.

I'm not really documenting it, documenting implies a rational kind of cool approach, which perhaps a scientist might adopt, which is a very valuable way of doing something; I'm finding out about it, and making work about it. All of my processes are very much about trying to find a way in which the landscape speaks through me. It goes back a lot to the great Chinese traditions of painting, where the Chinese artist was someone who spent days and days just looking at a plant, looking at a tree, or a bowl of fruit, and they found a way in which ... those things moved into the brush and the ink, ... and it sort of happened, you were a vehicle for something. So this is very different from documenting.[39]

Through this discussion I have aimed to outline the major philosophical themes that have emerged from environmental aesthetics in response to the limitations of applying the aesthetics of art to the aesthetic appreciation of environment, as was the dominant case until the 1970s. Many of the philosophers I have mentioned would argue that aspects of the aesthetic appreciation of art should be reconsidered, in light of the insights gained by research into the aesthetics of natural environments; principally that distanced and formalistic representations

39 *The John Wolseley Australian Art Resources Pack* – Creative Cowboy Films – 2006

fail to convey much information about the varied, complex and extended interactions humans have with the natural environment within which they are assimilated.

Figure 15. John Wolsleley in conversation with Peter Hvlands.

My own approach is somewhat similar to Wolseley's, and this has been to use the highly accurate and objective systems of geo-spatial location provided by satellite navigation as a framework in which to embed the aesthetic products of my subjective experiences. This is essentially an attempt to set up a restrictive structure and then squeeze the poetry out of it. This has allowed me to spend time moving through the land and exploring as Wolseley does, following my perceptual curiosity and learning about the specifics of actual places; whilst taking photographs, making video recordings and drawings, and simultaneously leaving a digital bread-crumb trail of my movements on my GPS. Manipulating this information with the computer has allowed me to imagine and to visualise new connections between places, images and information that may have no "straight line" connections between them.

Indigenous Country:

> *This marsh is a remarkably picturesque one, and possesses a limited extent of very good pasturage. It is begirt with lovely swelling knolls, delightfully verdant banks, and is called "Painter's Plains", because of some sketches traced in charcoal on the bark of one or two aboriginal huts which Mr. Calder, Mr. Bagot, O'Boyle, and I, made a detour to visit. The huts were so utterly dilapidated, as scarcely to repay us for our trouble. They are the rudest conceivable abodes, being constructed of bark, the ridge pole sloping to the ground, with two forked sticks for an opening. The artist's labours comprised two "pictorial illustrations", one, the likeness of an emu, - the other, a representation of two savages spearing a kangaroo.*[40]

European settlement has attempted to impose itself upon Tasmania through a process of erasure and over-drawing. As Simon Ryan suggests, the contemporary construction of the Tasmanian landscape is founded on the denial and suppression of what might be termed its Aboriginal space:

> *The empirical endeavour encourages the construction of space as a universal, mensurable and divisible entity, for this is a self legitimising view of the world. If it were admitted that different cultures produced different spaces, then negotiating these would be difficult, if not impossible. Constructing a monolithic space, on the other hand, allows imperialism to hierarchise the use of space to its own advantage. In imperial ideology the Aborigines do not have a different space to the explorers; rather they under-utilise the space imperialism understands as absolute. The construction of a universal space also allows a homogenous mapping practice to be applied to all parts of the world: maps become an imperial technology used to facilitate and celebrate the further advances of explorers, and display worldwide imperial possessions.*[41]

This section acknowledges the existence of Aboriginal space prior to European colonisation, as the fundamental context in relation to which all subsequent representation of environment must be located. This is explored through a discussion of the responses of contemporary Aboriginal artists and writers to the imposition of imperial space on their country. In this section I will argue that respect for the indigenous modification and management of the Tasmanian environment is central to any intimate engagement with it, and any subsequent representation of it. No understanding of Tasmania is adequate without an acknowledgment of, and sensitivity to, the deep time of Aboriginal space that has existed here for over thirty-five

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40 p.19 Burn, David *Narrative of the Overland Journey of Sir John and Lady Franklin and Party from Hobart Town to Macquarie Harbour*

41 Ryan, op Cit., p 4

millennia. The opening quote at the top of this page, from David Burn in 1842, records a Tasmanian example of the direct collision between the colonizing power of the picturesque and the aboriginal space that it was appropriating. Burns sees the country in terms of its suitability for exploitation for grazing cattle, and praises the natural beauty of its "swelling knolls" and "verdant banks". His temporal distance from the "Aboriginal Frontier War" allows him to appreciate the "rude" construction of the Aboriginal shelters, and the skill of the Aboriginal "artists" and their "pictorial illustrations."[42]

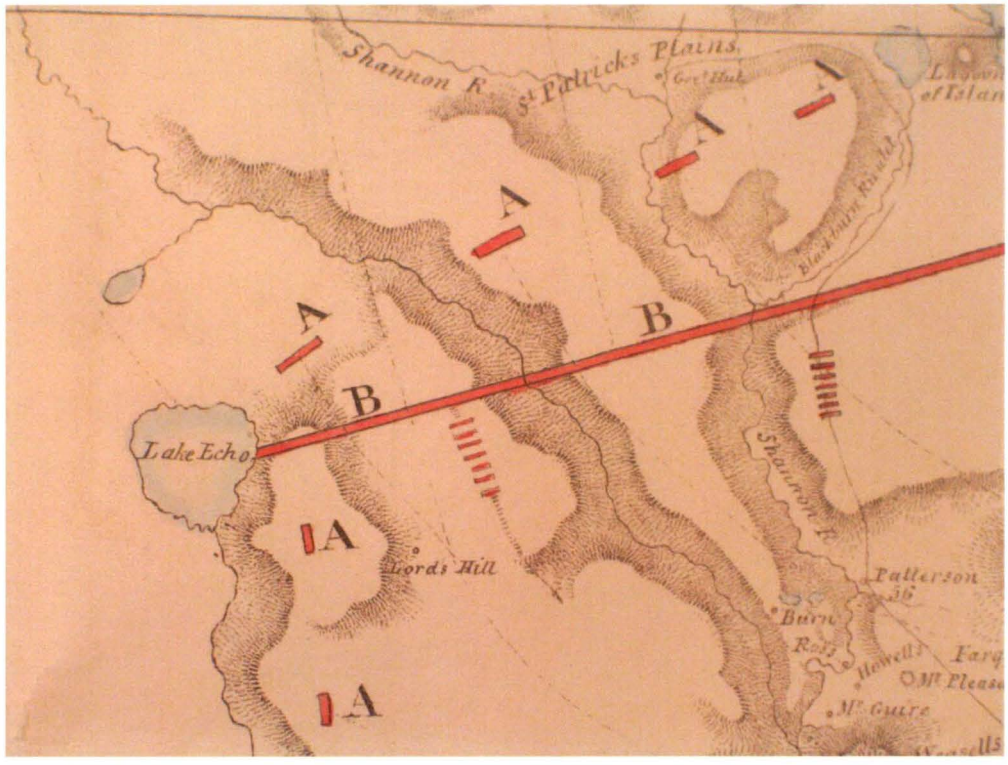

Figure 16. Detail from *Military Operations Against the Aboriginal Inhabitants of Van Diemen's Land: No 9, Field Plan of Movements of the Military.* (1831).

The premises for the spatial colonisation of indigenous Australia were established by the doctrine of *terra nullius*;[43] the continent was blank and unmeasured, empty, un-mapped and under-utilised; from the imperialist perspective, it had simply been waiting for the arrival and application of reason and measure.

> *Australia in this regard is unique. It is formed as a blank and is filled occasionally by fantasy, but one of these projections is blankness itself. Thus, Australia is semiotically 'filled in' by*

42 Connor, John. The Australian Frontier Wars 1788-1838..

43 Until *Mabo v. Queensland*, 175 CLR 1 (1992), *terra nullius* was the law that treated Australia as unowned land. For more information see Banner, Stuart. *Why Terra Nullius? Anthropology and Property Law in Early Australia*. "The History Cooperative". http://www.historycooperative.org/journals/lhr/23.1/banner.html. Accessed January 2009.

projections of blankness - both cartographically and in explorers' aesthetic descriptions. It is because maps act as a semiotic field that they need to be subject to a kind of investigation which denies them their commonsense foundational assumptions and instead views them primarily as cultural productions.[44]

In Tasmania the most dramatic example of this collision between indigenous and imperial spaces was the enactment of the 'Black Line' in 1830. The Tasmanian, (then Van Diemen's Land), Government declared martial law and began *'Military Operations Against the Aboriginal Inhabitants of Van Diemen's Land'*.[45] Studies of the map accompanying the report of this title reveal an early topographic representation, overlaid by the symbols of war. A series of red lines mark the abstract and idealised positions of the troops and settlers, as they swept in straight lines across the highlands to the southeast, apparently impervious to the disrupting influence of the topography. Official history records this event as a success; the remaining Aboriginal resistance was overwhelmed by an intimidating act of psychological warfare (that almost bankrupt the colony), all this despite only two individuals actually being apprehended by a force comprising roughly two thousand. It was in 1842, twelve years after the Black Line and the official removal of the Aboriginal population to the Bass Strait Islands, that Burn wrote his haunting description of the empty Aboriginal camp and the image of the now extinct endemic emu.

The Aboriginal Tasmanians did survive however, as have many of their traditional practices. Artist Lola Greeno (1947-) has maintained the shell-necklace and basket making traditions she was handed by her mother, while in contrast Julie Gough (1965-) has developed an internationally significant practice as an artist who uses installation and traditional techniques to explore the construction and intersection of her own Aboriginal and non-Aboriginal identities. Both these artists are concerned with understanding and respecting the connections between their past and present, and understanding the network of relations within which they are embedded.

Conversations with Aboriginal Tasmanians, including Julie Gough, writer and educator Greg Lehman and curator Tony Brown, have fundamentally changed the way I see and understand what is now called Tasmania. These three people generously agreed to form a group that offers me ongoing advice and guidance in making artworks that concern Aboriginal artifacts and cultural landscapes, as well as providing authorisation for the representation of Aboriginal cultural material in the public domain.

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44 Ryan, op. Cit., p.105

45 *Military Operations Against the Aboriginal Inhabitants of Van diemen's Land: No 9, Field Plan of Movements of the Military* (1831)

Underlying their worldview, (as Aboriginal people of Tasmania), is an awareness of the inherent reciprocity of our relationships with the natural world, and our being *of* the land, rather than simply *on* it, or *in* it. Tasmanian Aboriginal writer and activist Jim Everett, brings these relationships into sharp focus, Everett explains:

> *In a generalised sense traditional indigenous education is the practice of multi-interaction arrangements between human environments and natural environments. The lifestyles, roles and responsibilities of indigenous entities—both human and non-human—are embodiments of traditional indigenous education, just as the education occurs by living the lifestyles. The cores of indigenous education are the traditional knowledges which explain ecological food-chains and the protocols of respect that have existed between human and non-human entities of the Earth's eco-systems since the long periods of time indigenous peoples call the Beginning.*[46]

Whilst environmental philosopher Peter Hay warns us to avoid "insulting and sentimentalised interpretations of an idealised harmony" between Aboriginal cultures and their environment, clearly there is much that can be learned from the aboriginal emphasis on mutually supportive interactions between humans and their environments, and the manner of their representation in indigenous artworks.[47]

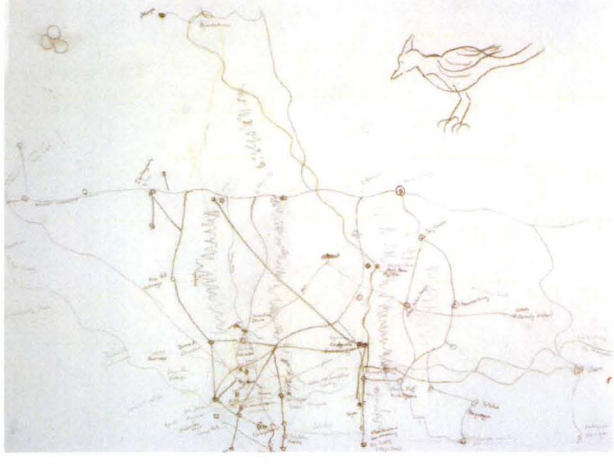

Figure 17. *Map of Anmatyerre Country,* (1988). Clifford Possum Tjapaltjarri.

In fact my experience of viewing the works of Aboriginal artists such as Clifford Possum Tjapaltjarri (1932-2002) and Dorothy Napangardi (1956-), has led me to recognise an inherently topological character in these indigenous representations of the land. In Clifford Possum's paintings the flows of life and dreaming move through the land from location to location, in a pictorial order determined by the artist's kinships to the animals and mythological creatures of his country, rather than by their strict spatial relationships. To anyone who knows

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46 p.11. Everett, Jim. *Aboriginal Education and Colonialism: Our Earthlinks Under Threat,* Australian Journal of Environmental Education, vol. 13, 1997.

47 p19. Hay, Peter. Main Currents in Western Environmental Thought..

the stories and the country they emerge from, the localities themselves are easy to find; their "placement" is self evident from a topological point of view, as the next water-hole is still the next water-hole, whether it is 500 metres or five kilometres distant. This topological approach also encrypts and conceals sacred and secret knowledge from the uninitiated. Tjapaltjarri is unusual from the point of view that he occasionally created topographic sketch maps that provided a spatial key to aspects of his dreaming country, (for example '*Map of Anmatyerre Country*, 1988).[48] In an earlier series of works from the late 1970's, of which '*Mt Denison Country*'[49], 1978, is part, Tjapaltjarri mapped sections of Anmatyerre land. In the expansive catalog for the touring exhibition, curator Vivien Johnson makes the following observations:

> *This painting is one of a series of large canvases from the late 1970s in which Tjapaltjarri mapped much of western Anmatyerre land. In this series the intersecting trails of a constellation of ancestral heroes are depicted as they traverse the mulga plains, rocky outcrops, creek-beds and occasional sand dunes of Anmatyerre country.*
>
> *The series is remarkable for several reasons. Firstly, by representing the trails of many ancestral heroes on one canvas, the totemic landscape as a whole is highlighted, rather than the ceremonial context of a particular event or series of events, as is usual in Papunya Tula Art. In revealing the spatial aspects of the totemic landscape, non-Aboriginals are given a clear insight into a central feature of Australian desert culture - the 'mental map' whereby sites of spiritual significance are conceptualised in their geographic relationship to one another. These configurations form the basis of route finding and orientation in everyday life. Finally, these paintings are maps in a more conventional sense as the vegetation, geology and topography of the area is represented by the arrangement of the background dots.*[50]

Tjapaltjarri generously offers a series of translational devices that allow non-Aboriginal Australians an insight into the "mutually satisfying interactions between humans and the natural world" that Jim Everett refers to in his description of the reciprocal network of relationships that sustain indigenous knowledge systems.[51]

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48 *Map of Anmatyerre Country*, (1988) Clifford Possum Tjapaltjarri Pencil on paper, 56 0 x 76.0 cm· Private Collection. Scanned from Johnson, Vivien Clifford Possum Tjapaltjarri Adelaide Art Gallery of South Australia, 2004

49 Mt Denison Country (1978). Clifford Possum Tjapaltjarri Synthetic polymer paint on linen, 200 0 x 170.0 cm, The Kelton Foundation Scanned from Johnson, Vivien. Clifford Possum Tjapaltjarri Adelaide: Art Gallery of South Australia, 2004.

50 p 233 Johnson, Vivien Clifford Possum Tjapaltjarri Adelaide: Art Gallery of South Australia, 2004

51 Everett, op cit., p 15

Figure 18. *Mt Denison Country* (1978). Clifford Possum Tjapaltjarri.

In contrast, in her work *'Driving Black Home'*, Julie Gough brings to our attention the colonisation of Tasmania by European language and naming, through her construction of a series of twelve postcards that highlight the European memorialisation of the Indigenous Tasmanians through roadside signage. Rather than providing a mode of translation, Gough states that this is;

> *[A] journey of mapping and jotting the intersections which make up this place's story and history. I see this big ongoing journey as an act of remembering. It is also my way of considering and disclosing the irony that although our original Indigenous place names were all but erased from their original sites; Europeans then consistently went about reinscribing our ancestors' presence on the land. I propose that these 'settlers' recognised the rights of occupancy of Aboriginal Tasmanians'- evidenced by their renaming of 'natural' features across the entire island in the image of Black, Native, Nigger and Abo...*[52]

Gough uses the title of her installation, and her choice of signage, to poignantly illustrate the guilt ridden overlay of European culture on the Tasmanian environment through the conventions of State nomenclature. It is the topological network of naming and significance embedded in the topography, that Gough brings to our attention and forces us to acknowledge.

52 James Cook University. Driving Black Home, 2000. Julie Gough Website. http://homes.jcu.edu.au/~jc156215/DrivingBlackHome.htm. Accessed January 2009.

Figure 19. Postcard image from *Driving Black Home.* (2000). Julie Gough.

Whilst Tjapaltjarri's career spanned a range of styles during a thirty year practice, the works of his *Mt Denison Country* series offer a unique bridge between Aboriginal and non-Aboriginal ways of seeing the land. Similarly Julie Gough's work offers the chance for non-Aboriginal Australians to empathise with the emotional trauma of Aboriginal dispossession of the land, and its memorialisation and legitimation by colonial power. Both these artists, and the writer Jim Everett, make it clear that Indigenous cultural knowledge systems precede European intervention in the Australian environment, and that Indigenous knowledge must be accorded respect in light of its successful integration of human and non-human elements of the environment over an unimaginable time period. Jim Everett offers this succinct summary of what is to be gained from respecting aboriginal knowledge:

> *... if white-Australia's environmental record were to be fairly compared with the thousands of years of Aboriginal interaction with the natural world, then it would be clear that principles of Aboriginality stand out as having an unquestioned success, and therefore can only benefit all peoples of Australia if taken seriously by all peoples of Australia. The Aboriginal record demonstrates an ideal education process which addresses the environmental needs of people, and the natural environments that sustain us all. It is an education lifestyle that we can all aspire to if we want to. However, getting there has a cost which dictates that Aboriginal people must embrace their spiritual-cultural identity, and that white-Australia must decolonise the Aboriginal cultural territories defined by Australian Aboriginal peoples.*[53]

53 Everett, op. cit., p.16.

Locality:

> *The projects of political unification, nation building and the consolidation of a notion of national space gave added importance to the mapping projects, particularly in regard to the defense of territorial borders. The national origins of early modern print culture are thus paralleled by (and related to) the emergence of mapping culture. A new cartographic impulse thus emerged historically along with a newly emerging sense of national identity, and – as Denis Wood insisted – from that point onwards, map-making is effectively a form of statecraft.*[54]

In this section I have chosen to talk about engagement and familiarisation with my environment in terms of locality rather than place, and this distinction is made to avoid ambiguity. Place is such a vague term with such varied common usage that I find it almost meaningless, and I suspect much of the term's main attraction is that it rhymes with space; "place from space" provides such a neat umbrella slogan to describe the transformation of emptiness into homeliness. But ambiguity lurks at its core; "my place" and "your place", our homes, are special places; if my place burnt down it would not simply be a matter of "re-placing" it by building another "place" in its place; the place just wouldn't be the same despite its identical "place-ment". In this type of usage the meaning of "place" is hard to define. Surprisingly, it is derived from the latin *"platea"*, meaning "open space", which doesn't sound very intimate or homely; therefore the original usage of *place* primarily refers to a position in open, Cartesian space, and only comparatively recently has the word come to be associated with the forging of the intimate connections that make one's position feel like a home.

In light of these ambiguities I much prefer the term locality, which is derived more directly from the root word *"locus";* which is Latin for place. A locality has greater breadth, it can be an open space, an area, a region; or it can be a position, a location, or an intimate locale. I particularly like the idea of "localness", which might be expressed in degrees, and its implicit acknowledgment of the importance of the locals that define it. And of course upsetting the locals is the last thing you want to do, whether they are people at the pub, (down at the local), or they are possums, whose home is in the tree under which you have camped.

Aside from the semantics, locality provides a useful terminology to enable a discussion about the ways in which humans and animals and plants form intimate attachments with their environments. Such attachments have both quantitative and qualitative dimensions that fuse memories of events with memories of the spaces within which they occurred. In my opinion, ever since the 'space race' delivered us images of our planet that presented it as a discrete object

54 Pickles, op cit., p.104

in space, we can no longer avoid recognition of the interdependence of its human and non-human systems, and their ultimate unity.

Paradoxically, this is a moment of distanced observation that has the power to reconnect us with an awareness of the earth as something more than the ubiquitous background in our photographs. We are all locals when viewed from space. Consequently my personal sense of localness is formed from a complex network of associations. My home in North Hobart is certainly the hub of my life, I return to it every day and all my "stuff" is stored there. Yet despite the fact I have rented there for a decade, I don't own the building, so it's not really "my place", but I do consider myself a local of the area, and my local pub is just down the road. In contrast, I lived in my parent's home for 20 years, and its was designed by my Dad and built for our family in 1962, so no one else has ever lived in it; it is unquestionably "our home" and the site of many formative experiences for me in a childhood spent in a dry schlerophyl woodland at the top of a 50 metre cliff. I became familiar with a dynamic fire adapted world. The fires of 1967 destroyed my tree house, blistered and bubbled the paint on our house, shattered its windows and set our car alight. The roof caught fire, but Dad put it out, whilst Mum and I were wrapped in wet blankets in the back of Mrs. King's green Vauxhall Viva at the open space at the top of Taronga Road, watching the macrocarpa exploding into flames around the Sherrin's farmhouse.

It was so dark with smoke before the fire front arrived Mum couldn't find her car keys. It was an event that completely changed my three-year-old worldview. The desolation of blackness, with the chalky x-ray profiles of animals burnt into the ground gave way to the purple and emerald splendor of glaucous abundance. The new spaces and the wide view filled in with a growth that made it seem like nothing had happened, until in 1992, with a huge fuel load on the ground, it happened again. This time I was able to be there as an active agent and fight back, and we saved house. The next fire, in 1997, was of a lower intensity and the wind was not strong. My parents still live in this house. This is my sacred ground, and it is only in the last few years that I have learned to see within it the marks of the people who loved it before me.

Over four decades my home range has expanded to include all of Tasmania, parts of mainland Australia, and even small parts of the rest of the world. There are many localities I have visited consistently over that entire time, both with my family and friends, and by myself; I consider myself privileged to have watched a range of environments change over a period of more than forty years.

Thus there are distant pockets in the land that I have a closer connection with than many of the spaces in the immediate local area of my home. In the age of global industrialism, where atmospheric pollution has spread man-made chemicals from pole to pole, there is little to be gained by persevering with the notion of "wilderness", of locations untouched by human culture. It is much more honest and informative to ask questions about the degree of wildness that an

environment exhibits. Similarly, when it comes to locating our personal points of origin, within the global spatial framework that is now our potential home range, I believe it makes much more sense to talk about degrees of localness when we examine our varied connections to localities and locations. Consideration of virtual spaces like books and cinema, as well 3D games and online communities, only serves to reinforce just what a huge proportion of our environment consists of topological information; information about the strength and directedness of reciprocal relationships that is intuitively understood by us, rather than our physical distance from those we relate to.

In light of these considerations regarding the nested character of the real and virtual spaces we inhabit, I believe that finding one's "place" is a process of defining one's environment, or current field of significance (as Holmes Rolston III put it), and then locating oneself in relation to that field; this process then has the character of a search, moving in from the margins, and out from an origin. The depth of that connection is both a matter of the intensity and the duration of experience. Artist Bea Maddock spent five years developing a panorama that offers a radical relocation of the viewer looking in from beyond a screen formed by the collision of two languages, at a topographically defined Tasmanian coast.

Figure 20. Section 10 of *TERRA SPIRITUS...with a darker shade of pale.* (1993–1998). Bea Maddock.

I had the pleasure of meeting Bea Maddock in 1995, as part of an art school field trip organised by Raymond Arnold. We met her at the Queen Victoria Museum and Art Gallery in Launceston, and she showed us her preliminary prints and drawings for *Terra Spiritus ... with a darker shade of pale,* 1993-1998.[55] This is a monumental work measuring over 38 metres in length, and consisting of 51 incised drawings. Each sheet is coloured with hand-ground ochre and white-chalk that Maddock sourced from the Launceston region where she lives and works. By locating the horizon high in the image, Maddock creates a pictorial space where the lower two-thirds are occupied by the ocean that separates the viewer from the land. It is within this

55 National Gallery of Australia."Bea Maddock". Image 20209. http://www.nationalgallery.com.au/landscapes/Pano2.htm. Accessed January 2009.

lower region of the image that she locates the Aboriginal and European names of the features of the coast and the hinterland, that are represented in the upper-third of the picture plane.

Terra Spiritus is a systematic re-configuration of the view inward upon Tasmania. Maddock developed her own highly sophisticated method to create this circum-littoral panorama. Using graph paper she painstakingly plotted the profiles of her coastline by tracing virtual sight lines, which originate from an imaginary line of circumnavigation out at sea, towards their intersection with the geographic centre of Tasmania. Her drawing technique entailed the geometric reconfiguration of the information contained in standard 1:25 000 topographic maps, which are in plan view; into the view-field of a mariner at sea level who is looking toward the centre of the island.[56] European names are incised into the surface with letter-press, the paper is embossed and re-shaped to accommodate their presence; they jostle like a ship's wake at the foot of each panel, foamy and illegible from more than an arms length. Above them the larger free hand script of the Aboriginal words pass like wave crests pushed on by the sea breeze; the land appears to lie very still beyond the shore.

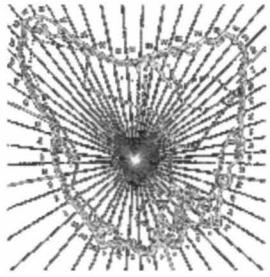

Figure 21. Map of sections drawn for *TERRA SPIRITUS...with a darker shade of pale..*

Maddock uses a tight palette constructed of ten tones mixed from ochre and chalk, and in the work this tonal range is used to imply the recession and advance of the coast and the ranges that would be visible beyond it. In conjunction, a series of horizontal lines are inscribed below the land like a reflected shadow on the darker sea; combined with the warmth of the ochre this generates the impression of a hot afternoon on shore beyond the reach of the sea breeze.

This is a complex construction that prompts more questions than it answers. Does the presence of English text imply a European view inward; perhaps the view of the colonist, or their descendants? Or perhaps the visual dominance of the Aboriginal words implies their pre-eminence, their volume and originality in the sea and the land beyond that shore; but this reading is weakened by my awareness that the Aboriginal words are English translations of a spoken language. I am left feeling that this is Bea's view, a personal poem of reconciliation for the Aboriginal people of Tasmania. This is not the explorer's view; coastal panoramas generally

56 National Gallery of Australia."Image TasMapSML". Image 20209. http://www.nationalgallery.com.au/landscapes/Pano2.htm. Accessed January 2009.

use a viewpoint that remains parallel to the coast, so as to "scan" along the features and record them. In contrast Maddock's view remains at all times fixated on the *exact* centre of the island, and I think this makes it clear that the heart of Tasmania is her real concern.

Maddock's work demonstrates the effectiveness of her mapping system. Through its material construction and its conceptual content *Terra Spiritus* successfully repositions the viewer outside Tasmania, and subsequently calls into question their relationship with the island and its original people. The work utilises a spatial framework that is systematic and consistent, and thus highly credible, despite its own minor distortions.[57] In parallel, a vague temporal framework is established by the use of the ochre, which is a traditional material associated with ceremonial and cosmetic use by Aboriginal peoples over thousands of years. The drawing also reminds us through its title of the doctrine of *terra nullius*; and offers an opportunity to imagine the land before it was invaded, to imagine a land full of spirit; before it was a land of emptiness for the arriving Europeans.

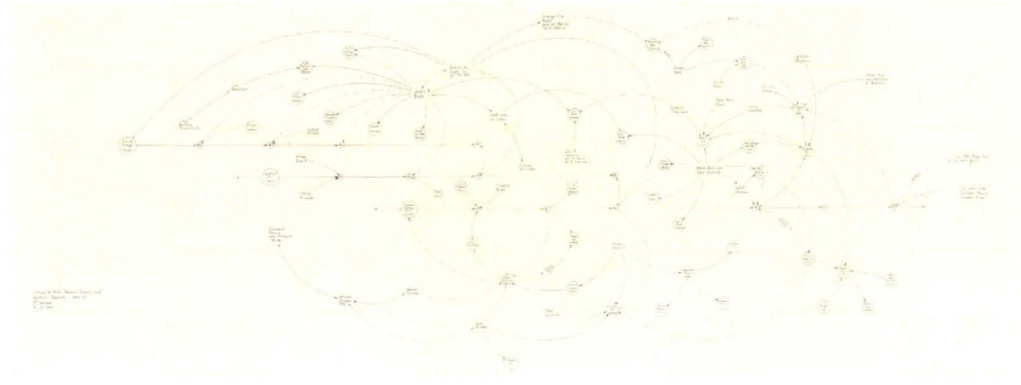

Figure 22. *George W. Bush, Harken Energy, and Jackson Stephens*, c. 1979-90 (5th Version), 1999, Mark Lombardi.

Unlike Maddock's topographic re-drawing of Tasmania as her field of current significance, American artist Mark Lombardi developed complex drawings that reveal the topological networks behind global financial intrigues and big-business scandals as his. Lombardi chose an information space as his environment and focused on the tracks of big business and organised crime. His work was meticulously researched and documented; his drawings having evolved from his note taking sketches while employed as a librarian and researcher after majoring in Art History. The press release for his retrospective exhibition at Pierogi 2000 in New York, says:

> *Working from syndicated news stories and other published reports, Lombardi compiles and transforms vast amounts of financial and historical data into what he calls "narrative*

57 Because Maddock's line of sight remains fixed on the centre of the island, all features of the coast that lie parallel with that line, will be horizontally compressed in scale.

structures" - drawings which at times consist of hundreds of notations juxtaposed and woven into a single, unified strand or image.[58]

In his drawing *George W. Bush, Harken Energy, and Jackson Stevens c.1979-90, 5th version, 1999*, Lombardi draws out the links between Osama Bin Laden, Sheik Salim Bin Laden, James R. Bath and George Bush Jnr, in a spidery web that belies the seriousness and the scale of these relationships when seen with post 9/11 hindsight. Devon Golden elaborates:

Lombardi, for anybody who doesn't know, made drawings of conspiracies. Not hypothetical or imaginary ones, but real ones like Iran-Contra and Charles Keating/Lincoln Savings. To do this, he pulled together hundred of facts from mainstream publications like the New York Times, Washington Post, and L.A. Times, cross referenced them on index cards - he had around 14,000 of them - and then laid out the schemes using carefully composed flow charts. His medium of choice: graphite on paper.

In a traditional artistic sense, Lombardi drawings eschew most of the draughtsman's vocabulary. There is no shading or cross-hatching, no pentimenti or rendering, no foreshortening or perspective. It would be hard to attribute any romantic or expressionistic quality to the artist's marks - quite the opposite, for their closest visual cousins would be scientific diagrams, power point presentations, or surveyor's maps. Simplicity and clarity are the ruling aesthetic.[59]

Both these artists configure their available drawing tools in ways that re*locate* us. Maddock applies the rigour of the coastal panorama to a new purpose that defines her "in-look", as opposed to "out-look" upon Tasmania. For people who do not live in, or are yet to visit Tasmania, this reconfiguration also serves as a visualisation of the often-difficult fit between the post-colonial European environment, and the Aboriginal space it claims as its territory. Lombardi relocates us in relation to the machinations of power, and maps its structure and potential for corruption via the links between individuals and their business dealings.

Lombardi's topologies are beautiful drawings, captivating for their composition and structure even before their content is encountered. *George W. Bush, Harken Energy, and Jackson Stevens* has the quality of a process control diagram or an electrical circuit, with flows of money and information implied by the double-headed arrows on the static matrix of graphite and paper. Writing this during the Global Financial Crisis makes Lombardi's concerns appear even more

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58 Pierogi Gallery Brooklyn "Global Networks" Mark Lombardi. http //www.pierogi2000.com/flatfile/lombardi html Accessed January 2009

59 Golden, Deven "Notes on Mark Lombardi." artcritical com. Editor DAVID COHEN November 2003

http //www.artcritical.com/golden/DGLombardi htm. Accessed January 2009

pertinent than perhaps they have in the past; clearly, whether I wish to acknowledge it or not, the ethics of global credit finance is part of my current field of significance.

Re-presenting Spacetime:

This section serves to contextualise the concept of locality in relation to post Cartesian conceptions of space and time. At the heart of any re-appraisal must be recognition that models that treat space as separate from time are fundamentally flawed. One of the key myths projected by the Cartesian model is the image of a three-dimensional space extending to infinite in all directions, a space within which all events and objects and "places" can be located. The Cartesian model claims to form a container for all spaces, and all events, allowing each variation to be appropriated as a subset of that over-view. The authority and familiarity of this myth also blinds us to a glaring omission; such mapping is only ever a low-resolution snapshot of a dynamic system that is unfolding over time. Since the beginning of this century scientific research has repeatedly demonstrated that space and time are elements of a single continuum; that is more correctly referred to as "spacetime".[60]

In the previous two chapters I have outlined and discussed the depth and character of the Indigenous space that existed prior to European colonisation, as well as the tools and methods of the new Cartesian paradigm with which the invading force sought to establish and measure its self legitimised sovereignty. The spacetime constructed in the early maps of colonial Tasmania is a monolithic and homogenous one that seeks to bring all elements in the land under imperial control through processes of empirical mensuration. There is no 'room' within the space constructed by empire for the temporality or spatiality of Aboriginal ways of understanding the environment. The spacetime of empire functions to over-write and erase all challenges to its authority; rather than assimilating and incorporating difference. Through its technologies of measurement and survey, and the reproduction of images that reinforce qualities such as objectivity and control, the empirical vision makes claim to all un-mapped land, (in the cartographic sense), by rendering it blank, and then filling it in.

The spacetime of the colonial picturesque still persists in the realm of popular culture in Tasmania, principally through the popularisation of images that uncritically perpetuate notions of Tasmanians existing in a harmonious balance between the arcadian pastoral ideal, and the pristine wilderness. The majority of postcards and coffee-table books, wilderness calendars and tourist guides produced in Tasmania, promote it as a 'clean and green' oasis nestled on the edge of the southern ocean and blessed with the cleanest air and purest water on the planet. There is generally no acknowledgment of the environmental issues that have fractured the social and psychological space of the island. There is no mention of the impact of industrial forestry

60 Albert Einstein used the term Space-Time in 1926 to imply the notion of a four dimensional continuum This form has since been modified to spacetime in general usage

practices or farming chemicals in the waterways, of the rapid decline and extinction of species, or the impact of feral invaders. The spacetime in which I find myself is far from the smooth and undifferentiated idealisations projected by the cartographic gaze of Tourism Tasmania or TASMAP.

Despite the dominance of these monolithic Cartesian constructions in contemporary topographic mapping, the subjective reality of my experience of spacetime is far more complex. Distance and proximity no longer relate to each other in the way they did when I was a child; for me Devonport in northern Tasmania is much further away than any of the global web communities I visit on a daily basis. My spacetime is now 'foamy' and full of local variation, rather than smooth and homogenous. It is full of punctures and tunnels—packed with short cuts and voids; it consists of a topological network of connections and relations, of flows of information and energy; wherein topographic spaces are the exception rather than the rule. I no longer trust the 'Carto-objective' world with its myths of distanced contemplation and temporal fixity. I no longer believe in the power of linearity and its attendant narrative impulses—its desire to form all events into a chronological stream, rather than the braided network of experience.

The French philosopher Gilles Deleuze has written extensively on the topic of spacetime and its characteristics. I have found Deleuze to be a difficult writer to read, but find Manuel DeLanda's interpretation of Deleuze a more direct point of access to his school of thought. In *Intensive Science and Virtual Philosophy* DeLanda manages to penetrate Deleuze's metaphorical style, and deliver a concise and informative analysis of his work and ideas.

Key to Deleuze's approach is an attempt to develop an ontological framework that removes the concept of the *essential* from formal analysis of the material world. Rather than having recourse to idealised standards that lie outside the physical realm, (platonic shapes for example); Deleuze takes an approach that considers form to emerge directly according to virtual tendencies that emerge in natural systems, rather than from any transcendent entity that lies beyond spacetime.

> *Essences are thought to act as models, eternally maintaining their identity, while particular entities are conceived as mere copies of these models, resembling them with a higher or lower degree of perfection. Deleuze replaces the false genesis implied by these pre-existing forms which remain the same for all time, with a theory of morphogenesis based on the notion of the different. He conceives difference not negatively, as lack of resemblance, but positively or productively, as that which drives a dynamical process. The best examples are intensive differences, the differences in temperature, pressure, speed, chemical*

concentration, which are key to the scientific explanation of the genesis of the form of inorganic crystals, or of the forms of organic plants and animals.[61]

Rather than imagining a vast and monolithic space in which objects aspire to essential forms, Deleuze conceives of a manifold abstract space with a variable number of dimensions; a "multiplicity" that contains within it the "space of possible states" which the physical system can have. Such manifolds are virtual because they contain *all* the possible states that define the tendencies of the system, and yet are "connected to material reality by their use as *models* of physical processes."[62]

In a Deleuzian ontology, on the one hand, species (or any other natural kind) is not defined by its essential traits but rather by the morphogenetic process that gave rise to it. Rather than representing timeless categories, species are historically constituted entities, the resemblance of their members explained by having undergone common processes of natural selection, and the enduring identity of the species itself guaranteed by the fact that it has become reproductively isolated from other species. In short, while an essentialist account of species is basically static, a morphogenetic account is inherently dynamic. And while an essentialist account may rely on factors that transcend the realm of matter and energy (eternal archetypes, for instance), a morphogenetic account gets rid of all transcendent factors using exclusively form-generating resources which are immanent to the material world. To anticipate the conclusion I will reach after a long and technical definitional journey: multiplicities specify the structure of spaces of possibilities, spaces which, in turn, explain the regularities exhibited by morphogenetic processes. The term "multiplicity" is closely related to that of "manifold", a term which designates a geometrical space with certain characteristic properties.[63]

Deleuze describes a model of the natural world wherein it is the shape of the manifold and its vector fields that describes the possible states that the system may occupy. Viewed in this way, the surface of the manifold is populated with peaks and depressions; the peaks describing temporary states that require a high energy flow to maintain, and the valleys and depressions functioning as basins of attraction that represent relatively stable and defined regions of behaviour requiring low energies to maintain and that hence tend to guide the system toward equilibrium. Whilst this is initially a rather foreign concept, it is an elegant approach that locates the morphogenetic processes from which structures are derived, *within* the system itself, rather than outside it in an *essence*; at the same time it provides a visual analogy for the folded state space that defines the virtual limits of natural systems, and their predominantly non-linear

61 p.6. DeLanda, Manuel. Intensive Science and Virtual Philosophy.

62 Ibid. p 13.

63 Ibid. p 10

behaviours. What the state space captures is not the static properties of a system, "but the ways these properties change, that is, *it captures a process.*"[64]

> *Despite the fact that of all the types of equations available to physicists the linear type is the least typical, it happens to be the type that became dominant in classical physics. The vector fields of [linear] equations are extremely simple, the only possible attractor of a linear dynamical system is a fixed point. Furthermore, this fixed point is unique— a linear dynamical system cannot have more than one basin of attraction.*[65]

Australian artist Daniel Crooks has developed a highly successful methodology for reconfiguring and re-presenting spacetime. Crooks uses open source software of his construction to analyse and reconstruct the temporal coding of digital video. In his acclaimed *Time slice* series Crooks extracts frames from a video of a passing train and recombines them "using temporal and spatial displacement".[66]

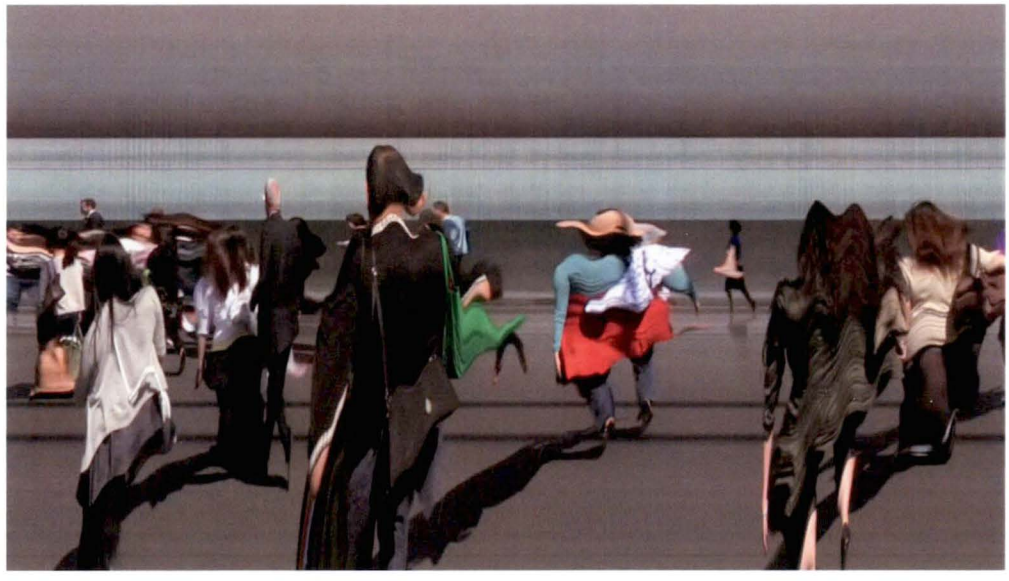

Figure 23. *Study for Intersection*, HD video, 2008, Daniel Crooks.

Crooks' prints and video works are intriguing and beautiful, and highly organic in their composition despite their digital origin. Crooks describes the works as "photographs that progress through time and videos of frozen moments that move,"[67] and says "*Time slice* exploits

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64 Ibid. p.14.

65 Ibid. p.33.

66 National Gallery of Australia. "Timeslice". Artists statement from National Gallery.

http://www.nationalgallery.com.au/fullscreen/06/crooks.pdf. Accessed January 2009

67 Ibid.

motion to chart graphs of change over time."[68] Crooks uses his movement through spacetime whilst on the train to "scan" his environment, moment by moment, as he passes through it; at other times his camera remains stationary and the subject scans itself as it moves past his recording device. Logical repeatable steps produce the resultant images, but the output has an unnerving quality, perpetually hovering on the threshold of being understood; my intuition recognises these forms as authentic, and somehow familiar, and yet even when explained, they never actually settle into predictability for me. Crooks offers alternate perceptions of spacetime; his prints and videos work to spatialise time, and temporalise space. He opens up perceptual realms that derive from new chronologies, where the once linear arrow of times narrative multiplies and spreads through processes of dilation and compression and folding.

Crooks clearly demonstrates that time based computational drawing machines can extend and redefine conventional mapping procedures. Digital drawing machines provide the ability for an artist to transcend the creative constraints defined by previous linear analog systems, that were unable to model the temporal and spatial changes that characterise the subtlety, diversity and complexity of the natural world and its non-linear and dynamic immanence.

68 Ibid

The Computational Beauty of Nature:

> *Any discrete piece of information can be represented by a set of numbers. Systems that compute can represent powerful mappings from one set of numbers to another. Moreover, any program on any computer is equivalent to a number mapping. These mappings can be thought of as statements about the properties of numbers; hence, there is a close connection between computer programs and mathematical proofs. But there are more possible mappings than possible programs; thus, there are some things that simply cannot be computed.*[69]

This section explores the way in which natural and computational processes are related, and can therefore be visualised with digital drawing machines. The medium of translation between these two apparently unconnected realms is the language of mathematics; and in this role it shows us the how the virtual world of numbers and their inter-relations define the actual states of matter, energy and information. In 2002 Stephen Wolfram published a remarkable text entitled *A New Kind of Science*, in it he presents a detailed and well exampled discussion of the relationship between the behaviour of simple systems, and the rules that govern them. Using cellular automata as his working environment, Wolfram demonstrates the appearance of complex visual patterns from extremely simple rules, many of which bear striking similarities to the visual patterns we are familiar with encountering in animals and plants and other natural systems and their processes. Wolfram establishes his "Principle of Computational Equivalence" by describing how all processes can be described as computer programs, and then demonstrating that, beyond the linear behaviour exhibited by systems with extremely simple rules, there exists an equivalent level of computational sophistication. The following quote details the ramifications of this equivalence:

> *[I]f meaningful general predictions are to be possible, it must at some level be the case that the system making the predictions be able to outrun the system it is trying to predict. But for this to happen the system making the predictions must be able to perform more sophisticated computations than the system it is trying to predict.*
>
> *In traditional science there has never seemed to be much problem with this. For it has normally been implicitly assumed that with our powers of mathematics and general thinking the computations that we use to make predictions must be almost infinitely more sophisticated than those that occur in most systems in nature and elsewhere whose behaviour we try to predict.*

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69 p 9 Flake, Gary William The Computational Beauty of Nature: Computer Explorations of Fractals, Chaos, Complex Systems, and Adaptation.

But the remarkable assertion that the Principle of Computational Equivalence makes is that this assumption is not correct, and that in fact almost any system whose behaviour is not obviously simple performs computations that are in the end exactly equivalent in their sophistication.

So what this means is that systems one uses to make predictions cannot be expected to do computations that are any more sophisticated than the computations that occur in all sorts of systems whose behaviour we might try to predict. And from this it follows that for many systems no systematic prediction can be done, so that there is no general way to shortcut their process of evolution, and as a result their behaviour must be considered computationally irreducible.[70]

This limitation has very real ramifications for the study of natural environments and the prediction of their behaviour, and this returns me to my starting point; geometry. Whilst the Euclidean geometry of 3 D Cartesian space can describe the orbit of the moon around earth with enough confidence to predict its future position, and therefore land people on it; this was a geometric solution that required *accuracy* for success, rather than complex nonlinear equations. The math of the problem is relatively simple; therefore a program can predict the positions of the two objects at a future point of time with great accuracy, without having to run through every step in the evolution of the system to arrive at a solution. Such straight forward Euclidean solutions it turns out, are the exception rather than the rule in nature; though it is hardly surprisingly that historically we have given them such great emphasis; having exploited their simplicity and utility over thousands of years. Old habits die slowly. What recent research like Wolfram's can tell us, is that science's best attempts at modeling and predicting the future behaviour of complex natural systems are always approximations due to their reliance on shorthand information about initial conditions. In contrast, step-by-step simulation of the system's behaviour can offer greater accuracy, but can never run fast enough to offer predictions.

My personal interest is with the ability of computational drawing machines to model and simulate behaviors rather than attempt predictions. Open source computing software has enabled many artists to interact with the "stuff" of digital imaging according to their own programmatic desires. Cameras become sampling devices, still and moving imagery are broken down and reformed, and images can be linked to other types of spatial, textual, and demographic information for example. What is different is that the tools are now available for artists to create works about natural environments that share the accuracy of commercial Geographic Information Systems, and yet make their poetic claims in response to, and as a reaction against, these conventional systems of mapping the environment. Open source

70 p 741 Wolfram, Stephen A New Kind of Science

communities operate within an information ecology that supports the exchange of ideas and sharing of technologies for group gain. Open source computing moves mapping beyond the exclusive control of governments, the military, and large corporations with strong financial backing, and encourages expression of the diversity and particularity of the 'many stories' of the human and non-human environment. This new democratic approach to information and knowledge sharing has its benefits and its risks, depending on your interests. In the words of John Pickles;

> *In this way digitality opens up again the question of participation and provides new opportunities for interactivity lost to an earlier nineteenth-century information revolution. It is to this issue that we now turn. In so doing, I want to begin to read digital mapping, especially geographic information systems and remote sensing as new forms of line drawing; new cartographies for new worlds. That is, I want to ask how these new forms of mapping presuppose and foster new ontologies and practices of transparency and malleable depth; digital information in bits and bytes, 1s and 0s, arranged and rearranged to construct mapped layer upon layer, thematic abstraction on abstraction, enabling filial vectors of association and relation to be mapped one on another; the world rendered as layers, curtains, constellations and flows of potentially infinite manipulability.*[71]

In relation to the questions Pickles' poses regarding the fostering of new ontologies of transparency and malleable depth, it is my aim through my art work, to offer relevant methods for underpinning the potential of this new paradigm within forms of personal "ground truth" that are subjective and conditional, whilst still being empirically located. This approach facilitates "squeezing the poetry" out of the gaps that appear when empirically driven systems are contrasted with aesthetically driven ones.

> *If maps precede and produce territories and social identities, what then are the objects and identities being produced in the digital transition? And what forms of territorialisation are at work in the new projects of digital mapping?*[72]

71 Pickles, op cit., p.160.

72 Ibid. p 148.

Chapter 3: Project Development:

Whilst the previous section dealt with the context of my investigations, this section deals with the development of the work and the ways in which those contextual concerns evolved from personal reactions into strategies for producing and critically reflecting upon the work. My aims were centred on creating a series of time-based maps that would address aspects of my relations to the environments of Tasmania including, if possible, its Aboriginal spaces. In addition I wanted to explore the representation of locations in ways that where able to convey the intimacy and reciprocity of my interactions with them over time, whilst also being locatable within an empirical framework.

During the project development I undertook a range of technical experiments with optical devices including the camera lucida. Detailed technical descriptions of these investigations are contained in Appendix I.

Figure 24. Camera lucida version 1 in use.

Figure 25. Camera lucida version 2 in use.

Origin 2004 - 2008:

Origin 2004 - 2008 is a 25-minute standard definition video projection of an animation constructed using time-lapse photographs recorded over the entire period of my PhD candidature. As such, it has evolved from a series of small experiments linked to drawing on paper, into a finished work that uses an algorithm to draw photographs to screen at a rate determined by the degree of change between each image.

The work began with a simple desire to photographically record what was happening in the "world view" I see from my sunroom, and to integrate these images with drawings of the same scene. I marked permanent points on my wooden floor in order to locate the feet of my tripod, and thus provide a consistent point of view from which to photograph and to draw. Drawings were made using a light weight drawing board I made myself from laminated aluminium,[73] and fitted with a camera quick release plate on the back, to enable a quick and consistent method of attachment of either the camera or the drawing board to the tripod head, and hence the same point in space.

Initially a number of drawings were completed without any optical devices, using only my pencil held at arms length to guide the scale of the resultant image. These were later scanned and re-scaled to match one another, and to match photographs of the view using Adobe Photoshop. They were then over-layed upon the time-lapse sequence of digital photographs taken from the same vantage point, using Adobe After Effects to control the changes in opacity of the various layers. This was the beginning of a work titled *Overdrawn*, and the second stage of its development spanned the period in which I was also re-constructing the camera lucida. The resultant animation is therefore a record of my visual investigation, and my developing ability to draw my view in perspective. It reveals major changes in the development and construction of the way I drew each image, changes which take on a noticeably different character when the camera lucida is introduced.

Figure 26. Still frames from *OverDrawn*. Digital video animation. 2004-05.

73 Alucobond laminated aluminium.

The early drawings completed without the lucida reveal my struggle with maintaining consistent scale across the visual field; some areas are finely worked, and correctly scaled in themselves, however the overall construction is often inconsistent due to local variability, and thereby acquires a rather naive, almost cartoonish quality.

After this successful series of experiments my focus shifted to working with the lucida in the field, however I felt that I had started an important series of observations in the time-lapse photographic record I had begun, and so I continued to record photographs from that single vantage point in the sun-room. Over time, and in relation to other experiences away from home, I began to understand this archive of images as being equivalent to the records of an observatory, gradually mapping change over time in one locality. The experience of drawing it over and over had literally opened my eyes to details in my environment that I had never previously been consciously aware of, despite the fact I had been viewing that same scene daily, for close to a decade, photographing it made me aware of the more subtle and general shifts that were occurring.

During this period my friend Frank Harris and I kayaked across Mercury Passage to Maria Island. I mapped our passage with my GPS, and later located our track on the current 1:100 000 TASMAP topographic map series. After a trip to Canberra and some research at the National Library of Australia, I secured a digital reproduction of a map of Maria Island, made during the explorations of the French explorer Nicolas Baudin. By overlaying my track on the contemporary topographic map, and then laying these over the French map of 1802, I was able to learn a surprising amount from the correspondences and divergences that existed between the worldviews that had created them. The French map was quite accurate overall; the expedition anchored in Mercury Passage and took time to carefully survey their latitude and longitude. Their track from this point, (and hence the subsequent mapping), increasingly suffers distortions, that I infer to have been caused by compounding errors in logging distance at sea whilst affected by current. However, without doubt the most revealing insight was that the French maps showed the navigators defined their point of zero longitude as running through Paris, rather than Greenwich, as their Prime Meridian. The map offers not just a definition of the location of zero longitude for navigators, but also a political statement about the origin of their world. This realisation of the political importance of defining the centre of one's experiential world became the corner stone of *Origin 2004-2008.*

Figure 27. Still frame from *Origin: 2004 – 2008 (constant change)*. Digital video animation. 2004-08.

Its primary function is to "benchmark" and to "background" my life, and all the other artwork I have produced, during the last five years. I see it as a time map that seeks to give the viewer a sense of the original axis of my existence, the place to which all other actions have re-turned during that time. Despite travels overseas, regular trips interstate as well as field trips into the Tasmanian environment, my home in Hobart is the place in which I have spent the most time, the place with which I have the most intimate connection, and it has the view I know best. In its compression of observations made over five years, *Origin 2004-2008* makes the seasons pulse like days; from the shortest to the longest, from equinox to solstice, from bush fires and rain squalls to spring rain again, the work exhibits the constant local variations that help define the particularities of a place, the foreground variations that paradoxically become our background environment, as they merge over longer periods of time and form the context of an engagement with a particular environment.

The early test versions of the work had a constant time scale, that is they used a consistently scaled playback rate of one sec of animation for every 25 minutes of real time recorded by the camera. Some sequences were shot at one-minute intervals, and others at five, 10 and 15 minutes; however the playback rate remained unvaried. The result was an animation of that made the view appear very flat and predictable.

Apart from some selections being made according to astronomical markers, (equinox etc), the sample times were generally selected according to very subjective criteria. Some days the view appeared beautiful, or spectacular, or grim. Other days I was just compelled to set up the camera to keep making a record. I was at least partially motivated by astronomical concerns, wanting to record and measure the shortest day and the longest, the equinoxes and their gales, an eclipse of the moon; I wanted these extremes of light and dark, and the rhythms that fall between them, to provide a global framework for the piece in contrast to its site specific nature. This change and variability over the year is one of the delights of living between a mountain and the southern ocean. As an active participant in the continuing processes of understanding my locality, I was

often moved to record unusual events: smoke haze from forestry burns, a tree being lopped in a nearby street, or a bush fire smoking during the day and sparkling by night as it moved slowly along the opposite bank of the Derwent River.

In light of these observations, I reconfigured this work, and took a more lateral approach to its structure. I had been giving sustained consideration to the notion of time as movement (on the quantum level of physical reality, if nothing moves between moments, no time can be said to have elapsed); this is also time seen as change, that is, change is the perceivable quality of times passage, of its duration. Another aspect of this way of thinking is that change, and therefore time, are indicated by movement. No movement-no time. Rather than create a piece that was a scaled reference to the duration between empirically recorded moments, and thus reinforcing conventional perceptions of time, I determined to make a work that would emphasise the quality and quantity of change in my environment. Thus the work was re-configured with all the sampled moments occupying equal duration, despite the varied quantities of time that had elapsed between them. The aim was to concentrate not on temporal scaling, but on spatial displacement of elements within the image. The changes between the images indicated only what had moved between samples, and again these had an equal weighting, one sample per frame. The result came closer to representing the subjective experience of change in the environment, but lacked any transitions with poise or grace; I felt it was frantic and incomplete.

Further reflection led to the final resolution of the piece. I was considering the ramifications of change as it influenced subjective perceptions of elapsed time. When I am involved with periods of high activity (lots of movement or concentration), my perceptions of events often feel as if they contained more elapsed time than was actually involved. It seems that the more that happens, the more time I feel must have elapsed in order to contain those events. Similarly the passage of time appears to drag when there is nothing going on, no events to measure duration against. Thus I reflected, it appears that the pace of a period of time is directly influenced by the quantity of change experienced within it. This led me to the logic for the final reconfiguration of the work. I realised that if I could devise an algorithm that would compare each photograph in the series with the next, and determine to what degree the image had changed between samples, I could express this value as a number, and then use that number to vary the rate of change between images to the play back rate of the image sequence. This would have the effect of evening out the rate of change of playback, and thus have the effect of smoothing out variations and overall normalising the rate of change. I discussed the idea with Bill Hart and a week later he presented me with an elegant Python code that performed the task beautifully.[74] Bill's architecture formed the basis of the program I used to create blends between frames, with

74 Appendix C See ImageMetric.py

the number of "inter-frames" determined by the degree of variation in contrast between each image.

In everyday life we seem to witness change occurring in bursts, a new house appears, a storm passes, then nothing changes for weeks, except in the details. The original photographic sequence shows this character: sometimes not much is happening; at other times the changes are more dramatic. When viewed over longer and longer time scales, change appears far more constant; its the old cliché 'the more things change the more they stay the same' in action. Thus I determined to construct the final animation accordingly. In order to generate the final animation the program goes through a number of steps; after analysing all the frames in the sequence, and determining the standard deviation across the entire series, the algorithm then creates a number of new inter-frames to fit in between images that have high degrees of difference, (typically from two to approximately 100 frames), similar frames from the original series are simply run one after the other at 30 frames per second. The program varies the rate of change between images in order to present a more constant degree of change per unit of time. Thus when not much is happening the animation runs at 30 frames per second and presents a remarkably smooth flow. When the degree of change between images increases, the playback rate is subsequently slowed and more gradual transitions are used to keep the rate of change per second at a constant value.

I feel the work succeeds in revealing an intimate and ongoing relationship with a place that is significant to me, and that it emphasises the procedural nature of the environment we inhabit; the fact that natural systems embody processes that move on around us, whether we notice them or not. Meditation on the work has helped reinforce to me the importance of noticing the frequent subtle changes and alterations in the short term, that yield major shifts in the long term character of my original field of significance.

Range 2006:

Range 2006 is the most complex of my computer-generated visualisations, and takes 25 minutes to create a drawing of all my movements during 2006. After my initial researches led me to the insight of understanding the Global Positioning System (GPS) as a global drawing machine, I determined to use GPS tracking as drawing strategy that could represent the activities of my life as a natural phenomena, in a similar manner to the way in which scientists use GPS for animal tracking. The title refers to my "home range", specifically the range of my movements during 2006, which were recorded as positional information using a hand held GPS unit.[75] I carried the unit with me day and night during that year. At times the logistics of this were challenging; ensuring I always had a constant supply of recharged batteries with me and waiting for the unit to get a fix before starting travel, were two of the more onerous characteristics of making this work. My aim was to visualise my movements in such a way that I might compare my motion with that of other humans or animals, or for that matter electrons or planets. Central to my intention with *Range* was to create a companion piece to *Origin*, a work that would literally originate from it, and show how I explore and inhabit the environment that enfolds and assimilates me, and which contains my home.

It was a long journey from that initial idea, to the finished work, and one that has fundamentally retrained and refocused my skills and knowledge. Had I known quite how challenging it would be to learn to extract, manipulate and visualise data, I might have chosen an easier strategy, but I can only say that in hind sight I am extremely glad I didn't know, because it has most certainly been worth the effort. Although I didn't realise it at the time, I was about to start learning a series of new languages that have actually changed the way I think.

The first stage of the process with the new and unfamiliar device was to go somewhere and start acquiring some data. I decided to visit Frenchmans Cap, a spectacular peak in Western Tasmania that my great grandfather had cut the first track into, in 1910. This was a four-month job for Ernie and his three co-workers, and they worked hard to negotiate the major challenges presented by the weather and terrain of the region. Most significantly for me, 'Ernie', as he was known then, kept a daily track diary, as well as a detailed survey log that includes compass bearings and distances, and from which he later prepared his own map. This material now resides with the Archives Office of Tasmania.

In late November 2005 Ben Booth and I spent 4 days walking the Frenchmans track, and looking for signs left behind by the original party. We discussed what might have changed, and what

75 Magellan Meridian Gold GPS

might have stayed the same, during a century of storms and growth. What became apparent as we re-read Ernie's diary, and then looked about us, was that in general, little appeared to have changed. Despite severe erosion in parts of the track, as well as impacts from wild-fire in the local area, the track still followed Ernie's original route, and the vegetation we encountered matched his descriptive notes; around Barron Pass the original blazes from Ernie's axe in 1910 still mark the King Billy Pines that border the track. The environment seemed much as he described it, and like him we encountered Tiger snakes and Tiger Cats, (Spotted Quolls), and bountiful bird life. It was a great experience to sit next to Lake Vera, (named by Ernie after my Great Grandmother, who unfortunately never actually saw it), and read Ernie's words out loud; it felt like I was completing part of his journey, bringing his words back to their source, there in the shadow of Philps Peak.

Figure 28. A blaze in a King Billy Pine left by the original 1910 J.E.Philp track making party. Barron Pass, Frenchmans Cap. 2005.

By our return, I had amassed a library of photographs, some sound recordings, and four days worth of GPS tracks. That was the easy part. The next step was learning how to get the data out of the GPS unit and how to read it. The Magellan Meridian Gold has an internal memory card, and this was easily removed and mounted as an external drive using a card reader. Some hours of searching Magellan's website also paid dividends when I finally discovered the specification for their Track data, and was greatly appreciative of their openly publishing this information. The GPS unit saves each positional fix as a date and time stamped location with a latitude, a longitude and an altitude value. Each track is a list of fixes, each saved as a line of text and numbers, and saved in comma separated value (CSV) format. These simple transportable files may be read or imported into any text editor or spreadsheet program.

So good so far, I had data and I could read it. Next step was to work out how to convert the latitude and longitude values (which derive from the surface of a sphere) into Universal Transverse Mercator (UTM) values. UTM coordinates are specified in metres of Easting and Northing, and derive from a system that divides the surface of the globe into a series of small zones, and then applies a Transverse Mercator grid to each zone, (this minimises the distortion associated with the Mercator Projection). The chief advantages of using the UTM projection are its compatibility with metric unit systems, and its wide spread use in contemporary topographic

mapping systems including local Tasmanian topographic maps. After much searching I discovered the work of Professor Steven Dutch, of the University of Winsconsin - Green Bay who has developed an Excel spreadsheet with embedded formulae that allows conversion of latitude and longitude to UTM coordinates.[76] The formulae are free to use and modify and are based on those developed by the US Military when designing the current GPS system,[77] and provide accuracy to plus or minus one metre within a given grid zone. Using this tool I was able to work on an individual fix, or to batch convert short tracks by cut and paste, but such a laborious manual system is error prone and not ideal. The technique requires copying and pasting of large columns, (a GPS track may have up to 2,000 fixes), from one spreadsheet to another; any errors of alignment when dragging and dropping result in incorrect positions.

Despite these limits, (which I later over-came), the technique was effective enough for me to extract and manipulate the data from the Frenchmans trip. With eastings and northings and altitude now all in metres, I had my information in a form that I could import into a 3D modeling program and begin to visualise. At this point in the project I spent a considerable amount of time building up a 3D model of the Frenchmans Cap terrain, and then applying accurately scaled textures derived from a range maps, including contemporary topographic maps, and Ernie's hand drawn map from 1910. Finally the GPS track model and the surface model were aligned and combined, and I could then begin to study the relationships that appeared between these various elements from the last one hundred years. The animation I produced shows clearly how the GPS track varies in sometimes subtle, and sometimes quite dramatic ways, from the baseline provided by the surface map, and the track marked on it.

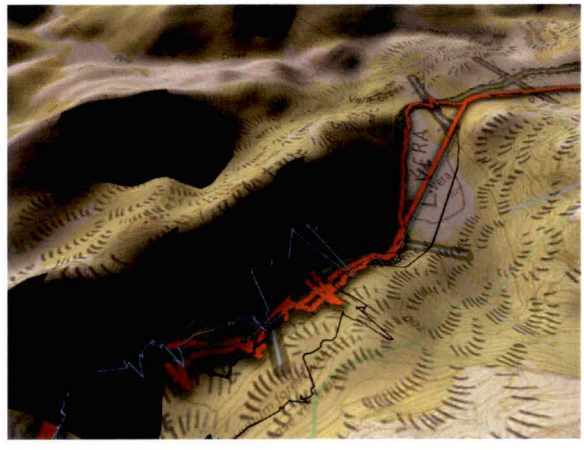

Figure 29. 3D modelling of GPS track (light blue), against landform model of Frenchmans Cap region. 2006.

Immediately obvious was the way in which the GPS track "wandered" depending on the amount of sky that was visible at any point on the walking track. Since GPS satellites work by line of sight, structures like trees and deep valleys affect the accuracy of the calculated position. I was later to discover that this was also the case with buildings, with accuracy also being degraded by

76 University of Wisconsin - Green Bay. "Steve Dutch". Natural and Applied Sciences. http://www.uwgb.edu/DutchS/. Accessed January 2009.

77 Army, Department of, 1973; Universal Transverse Mercator Grid, U. S. Army Technical Manual TM 5-241-8, 64 p.

the GPS signals being reflected by some surfaces. Altitude is the least accurate of the coordinates calculated by the GPS system, and this is evident in the way the track seems to rise above and sometimes sink below the surface of the model; however in situations with a clear view of the sky, (positions with a low visual horizon), where up to 12 satellites may be in view, the accuracy is very good, and the GPS track aligns well with the model in all three axis.

Further to this are the plan views I produced that incorporate all the maps into one image. These were produced using Photoshop for its accurate scaling and layer control, in the same manner as the textures for the 3D model. These images show my track in red, with Ernie's track (calculated by me from his survey diary) in green, (the blue lines are his river crossings); behind this are Ernie's sketch map of the area, as well as a 1:25 000 Topographic map which also has the walking track marked. Comparison in this way allows different stages in the spatial mapping of one area to differentiate themselves from one another. Set against the topographic background (that which has the greatest claim to accuracy and "truth" in the objective sense), Ernie's maps display a very different aesthetic to mine. My red GPS track exhibits a definite random jitter, a kind of "Brownian" motion related to the availability of sky and satellites, plus there is also an obvious error induced by battery failure, (the section where my track appears to cross Lake Vera). In contrast Ernie's green track is deliberate and only vaguely accurate due to the accumulated errors in his methodology. Since he only rarely records bearings as exact degrees, and generally used notation like NNW or NW etc. (he was not equipped with a theodolite), recreation of his track was bound to be inaccurate. In light of this fact I was surprised by the high degree of correspondence Ernie's survey shows in relation to the 1:25 000 scale map.

Behind the red and green tracks lies Ernie's topographic map, immediately recognisable from the 'hatchuring' style of line work he used to describe the relief of the terrain. This map is vague; it does little more than describe a sequence of 'lumps' with unknown heights and few rivers in between. It is thus very difficult to develop any sense of the complex shape of the actual terrain from this map. I can only assume that this was the limit of Ernie's skill in drawing, and that he saw himself as a writer, a maker of images with words, rather than a visual artist. Unfortunately none of the group carried a camera, and there is no visual record of their trip.

Figure 30. Detail from comparative mapping of Philp (1910 – green line), versus Walch (2005 – red line).

It was this set of experiences, experiments and reflections in late 2005 that led me to decide to carry the GPS throughout 2006. I wanted to generate a large data set of tracks that could spatially map my lived experience, without having the bias of being focused on any single excursion. Whilst I dealt with the pragmatics of carrying the device everywhere; of keeping it charged, of waiting to get a fix when starting it up; I began learning how to deal with the large amount of information I was already collecting. It became obvious to me at this point that I needed to automate the data acquisition and manipulation, and fellow artist Bill Hart advised me to start learning the Python programming language. Bill helped "reverse engineer" the Steven Dutch spreadsheet, slowly extracting the formulae from the cells, and revealing the procedural flow between the elements of the spreadsheet. Bill then embedded this formulation in a Python programming module. With this start I launched myself into learning the language and slowly building up other modules that could sort and filter the information, as well as visualise it.

I attribute part of my success in this venture to attending one of only two high schools in Tasmania that offered computer studies in 1976. We had a Visual Display Unit, (a monochrome cathode ray tube-VDU), and a Teletype printer. We learned the fundamentals of computers and programming, developing flow-charts and then writing short programs using the BASIC language. It was a lot of fun, and a great preparation for the understanding the logical structures I needed to create, despite my not having written a program in almost 30 years. The other key element was having an experienced and generous teacher whom I could call when I hit the limits of my knowledge. Python is a very flexible open source language that comes pre-installed with the operating system of Macintosh computers. The Python website describes it this way, "Python is a dynamic object-oriented programming language that can be used for many kinds of software development. It offers strong support for integration with other languages and tools, comes with extensive standard libraries, and can be learned in a few days."[78] I think that should read "learned in a few days *if you already know another language*".

78 Python Programming Language. "Official Website." Python. http://www.python.org/. Accessed January 2009.

Python became a very useful tool for acquiring, parsing and filtering data. It allowed me to acquire the files from the GPS, and to parse the data by converting latitudes and longitudes to UTM coordinates, and Universal Time Codes to local ones. It also allowed me to apply numerical transformations to any of these values, enabling changes of scale, or time sampling rate, for example. In addition Python was excellent at filtering the data, sorting fixes according to time and date or spatial parameters, and removing duplicates. With the knowledge and confidence gained to this point I began experiments with an open source imaging environment called Nodebox.[79] Nodebox is a Python based programming environment aimed specifically at artists and graphic designers who wish to use computational methods to create images and output PDF documents or movies. Using it, I began my first attempts at representing the data that I had acquired, and for these experiments I chose the visual model of an aerial map.

I was very pleased with these drawings. I find the energy and buzz contained within the layered days visually compelling. There is an 'artless' authenticity to the line that seems to deny any over-riding self-consciousness in the acts from which it derives; something I was very keen to avoid. I had no desire to draw something on the land, using it simply as a conceptual canvas, as just another incarnation of the blankness of terra nullius; my aim was to show myself as drawn into and through an engagement with my environment. At this point I then experimented with 3D representations, generated from within Cinema 4D. These were attempts to investigate further the extended spatial quality compressed into the 2D maps. Creating these animations was not without difficulty, as the very high number of individual elements within the scene meant that render times were very high. Depending on the quality and complexity of the lighting, texture and reflectance models being used, animations would take anything from hours, up to days, to render into a movie file for viewing. Significantly the tracks also lost some of their artlessness, the 3D perspectival ray-tracing of the animation software gave them a volumetric presence, and this seemed to diminish the raw appeal of their lines. These limitations influenced me to think of alternate approaches to visualisation.

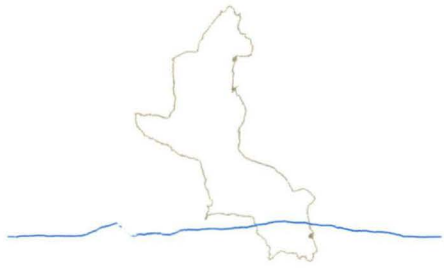

Figure 31. GPS tracking of my movements for September 16, 2007.

79 NodeBox. "NodeBox Home." NodeBox Official Website. http://www.nodebox.net/. Accessed January 2009.

As my programming ability improved, so did my capacity to imagine what was possible with the new tool kit I was building. I began experiments with animating the GPS data according to the time stamps embedded within it, but quickly came up against the speed limitations inherent with the way that Nodebox and Python are implemented.

As I later discovered on the Nodebox website, even thought it has the tools for animated and interactive programming, the developers of Nodebox actually recommend using another environment called Processing for such work. This is because Processing uses Just In Time Compiling (JITC); that is, instead of the computer reading each line in a program, executing its instructions, then stepping on to the next line etc, JITC allow the computer to compile all of the variables and values used in the execution of the program before it runs. This means a JITC program is slower to start, but it manages to do much of the heavy computations prior to actually running the animation, which is correspondingly much faster. It was late 2007 by the time I was ready to make that leap and rewrite *Range* in Processing, which is based on the java language developed by Sun Microsystems. Having learned Python, Java was not like starting from scratch.

The final version of *Range* is the result of many iterations of program development, over almost three years. However it now exceeds what I imagined as my goal when I started. The artless authenticity of the lines, the flow of their movement, and the fading depth of time they contribute to are all aspects that compel my attention. Despite (or perhaps because of), having drawn those four-dimensional lines and having lived the events they represent, I find the clustering and knotting of the entire web deeply intriguing. In those braids are revisits and one offs; the end of a relationship, and a year of spacetime filled with love, work and recreation with all their chaotic accompaniments.

Figure 32, 33. Stills frame from *Range: 2006 (strange attractor).*

Sticks and Stones:

Sticks and Stones is a real-time generated video stream that takes approximately 30 minutes to run through the full cycle place names officially listed by the Nomenclature Board of Tasmania at June 2007. Each element appears in the list on the left, and simultaneously on the map on the right, then fades over a period of about 30 seconds. The result is a dynamic map of Tasmania that is being constantly formed and dissolved.

This work has its foundation in an investigation of the ways in which practices of naming have been used to colonise the Australian landscape. My initial fascination was with the suburb of Lyons in Canberra's Woden Valley that was named after Joseph Lyons, a Tasmanian politician who became Premier of his state, and later Prime Minister of his country, the only Tasmanian to do so. Aboriginal people have lived in the Canberra area for over 21,000 years, and early pastoralists began settling the area from 1824. However Canberra is not a city that has evolved, rather it was created as a solution to post Federation arguments raging between Sydney and Melbourne as to where the new Federal Capitol should be located. In 1912, Chicago born architect Walter B. Griffin was selected as the winner of an international competition to design the new city. His 'wheel and spoke' pattern was a radical departure from the grids that dominated the new cities of his homeland; and Canberra was the opportunity for Griffen to realise a vision for an ideal city that he had been developing over the previous two decades.[80]

Griffen created a plan of the proposed city based on the information in topographic maps supplied for the competition, and it was not until 1913 that he visited the site. Canberra was a drawing; a master plan for a perfect example of a 'top down' development enabled by a synergy between Griffen's personal vision, and the new Federation's dreams of creating a model city for the central administration of Federal Government. Federal Parliament moved to Canberra in 1927, with the districts of North and South Canberra settled during the 1920's to 1960's. Woden Valley was the next area to be settled beginning in 1963.

On the 12th March 1913 Canberra was given its name; derived from the Aboriginal word Kanbarra meaning meeting place in the local Ngunnawal language. The Woden Valley in which Lyons is situated, gained its name from the homestead of Dr James Murray, which was named after the Nordic God of Wisdom in 1837. Born in Stanley in North-western Tasmania in 1879,

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80 Commonwealth of Australia Design for the lay-out of the Federal Capital City, Walter Burley Griffin, Commonwealth of Australia. Report from the Senate Select Committee Appointed to Inquire and Report upon the Development of Canberra September, 1955. Appendix B, 93-102, Copy of Federal Capital Design No 29 by W B Griffin Original Report.

Joseph Lyons' family were originally Irish immigrants, and their family name is likely to also have roots in Scotland.

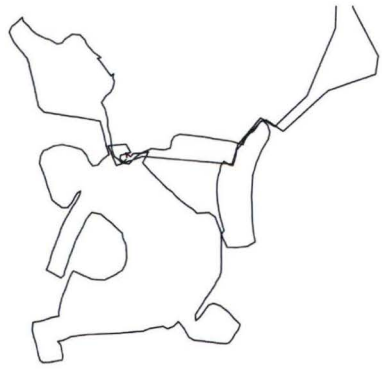

Figure 34. GPS tracking of Lyons documentation path. March 2006.

So, in 1964 when the suburb of Lyons was created, the nomenclature of its features was derived from Joseph Lyons' associations with Tasmania. In 2006 I visited Lyons with the aim of discovering how these names physically related to the land they had been grafted on to.

Figure 35. Pillar Street in Lyons, Canberra March 2006, and Cape Pillar and Tasman Island.

On a hot March day I walked the streets of Lyons with my digital camera and GPS, following a route I had plotted on the Canberra Street Directory. My choice of path was derived from the shortest route I could take in order to walk all the roads and their intersections without backtracking. It was a strange experience to wander the quiet streets; alien to me at first encounter, and yet familiar in the quintessential Australian suburban character they possess. At the core of my experience was awareness that for me an associative disruption was occurring. Powerful images of places I loved would rise up inside me as I read the street signs; whilst initially St Clair Place conjured up associations with tranquil water, and days spent kayaking in remote serenity, these impressions evaporated when challenged by dusty concrete and asphalt. I began feeling annoyed, I felt an indignant; what right did 'they' have to devalue my icons this way, and what values were 'they' trying to highjack by association? Did anyone who lived here have any idea of the fiction they were part of? As I continued the feeling morphed and matured, I was amused by Risdon Place and its associations with a Hobart suburb renowned for its high crime rate and maximum-security prison. Port Arthur Street also had connotations of colonial

violence and post-modern mass-murder. These feelings were compounded by my uneasiness when confronted with the use of Tasmanian Aboriginal words; was the massacre at Quamby being commemorated by Quamby Place? And what homes could Yolla (mutton-bird), and Corinna (thylacine) find in this land?

The photographs I made that day have a gloriously banal quality that is undercut by the street nomenclature. I conducted some small visual experiments using pairings of the Canberra streets with photographs I had taken of their Tasmanian namesakes. The resulting image had the desired effect of illustrating the gulf between the locations, but I realised the project would not be easy to complete within the timeframe and budget of my PhD. The main reason for my decision to put this approach on hold, was that for the work to succeed it needed to be comprehensive, with a pairing of photographs for every street; however many of the Tasmanian locations are remote, (Mt Ossa and Swan Island for example), and will no doubt take considerable effort to reach. This is now a longer-term project that I will complete post PhD.

Still keen on the idea of a visual investigation of Tasmanian nomenclature, I began researches into available data, and soon discovered the Tasmanian Nomenclature Board, which maintains an active database of over 32 000 Tasmanian Place Names. After contacting Tony Naughton, Secretary of the Office of the Surveyor General of Tasmania, I was granted access to, and the use of, the database in the development of artwork. Due to continual changes in the state's infrastructure, the database is always a snapshot of a constantly evolving document.

This was delivered to me via email as an Excel spreadsheet, and so began the task of imagining the information. In his wonderful book *Visualising Data*, Ben Fry details what he calls "The seven stages of visualising data", and I think it worth quoting at length.

> *The process of understanding data begins with a set of numbers and a question. The following steps form a path to the answer:*
>
> | | |
> |---|---|
> | *Acquire* | *Obtain the data, whether from a file on a disk or a source over a network.* |
> | *Parse* | *Provide some structure for the data's meaning, and order it into categories.* |
> | *Filter* | *Remove all but the data of interest.* |
> | *Mine* | *Apply methods from statistics or data mining as a way to discern patterns or place the data in mathematical context.* |
> | *Represent* | *Choose a basic visual model, such as a bar graph, list or tree.* |

Refine — *Improve the basic representation to make it clearer and more visually engaging.*

Interact — *Add methods for manipulating the data or controlling what features are visible.*

Of course, these steps can't be followed slavishly. You can expect that they'll be involved at one time or another in projects you develop, but sometimes it will be four of the seven, and at other times all of them.[81]

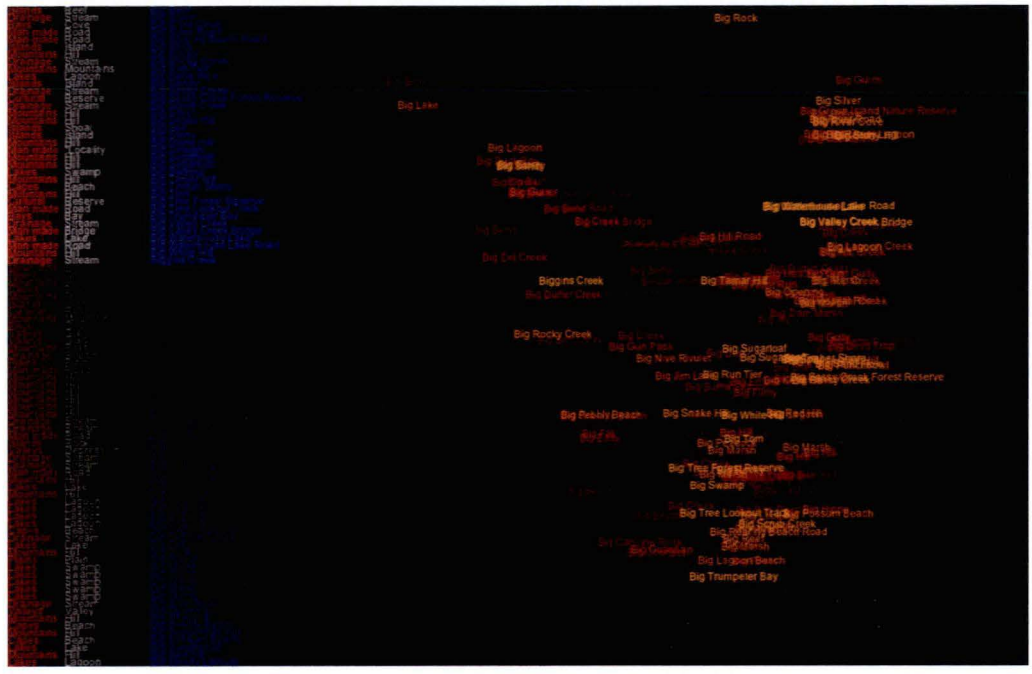

Figure 36. Still frame from *Sticks and Stones.*

Fry's book was not published until this year, but in it he details what is essentially the same methodology that I had developed through trial and error. Fortunately however, by the time I began to make this work, I was approaching the question of how to represent the nomenclature database from a position of far greater knowledge and experience than when I started learning Python. Using the Processing environment allowed me to do all the data and file manipulation tasks I had used Python for in the past, as well as allowing a high frame rate, and therefore a smooth visual appearance; and all this despite holding the 32,000 element list in memory.

The visual form and behaviour of the work was the result of extending some of the questions I had been asking about Canberra, to Tasmania as a whole. In Canberra I was intrigued by the invisible structures that linked the names and places, the abstract links between nation building,

81 p.5. Fry, Ben. Visualizing Data. Sebastopol: O'Reilly Media Inc, 2008.

patronage and political success. With the complete nomenclature of Tasmania in my hand I realised I had the opportunity to let the postcolonial naming history of Tasmania visualise *itself.* The nomenclature database had UTM coordinates for each named location embedded in it, and so it was a fairly simple task to extract that information and to scale and draw it on screen.

I decided to run through the list alphabetically and to draw them to the screen in a "fish shop window" effect, where the names flow down the screen and slowly dissolve over a preset interval. The red, white and blue were chosen for their imperial over-tones. As each name appears in the list on the left it also appears on the right of screen; each individual naming helping to build up the shifting layer of language in space that "literally" defines the shape of Tasmania. I selected the yellow/orange/red transition for its association with fire, and the shift from naked flame to coals. I was thinking of the naming of Tasmania as ephemeral, as transitory but still transformational wave, like a bush fire moving across the surface of the land. It was not until I had made these selections and floated them on the black ground for contrast that I noticed the obvious similarities to the colours of the Aboriginal flag. Also, embedded within the database are the same names contained within Gough's *Driving Black Home,* and during the animation the many forms of "Black" momentarily map out their own island. The title of the work makes reference to a child hood rhyme; sticks and stone may break my bones, but names will never hurt me. Ultimately the work is a meditation on the way in which naming mediates the world we live in, and over-writes the history of the environments we experience, as well as the ways in which the nomenclature both reflects and constructs political and social structures through naming. The work references the power of naming to locate us within the world. It imagines the top town imposition of language structures by post-colonial power, as well as the transitory nature of all language and culture.

Drowning by Numbers:

Drowning by Numbers is a projected video animation constantly generated by a computer program written in the open source Java programming environment "Processing". The program builds the image differently every time, picking random points on the image plane to draw each set of coordinates, and this process produces the visual rhythm of falling rain or snow as each set of numbers appears. The coordinates are GPS derived Eastings and Northings of my positions while exploring the Lake King William area over two years. My aim was to visualise a time-based image of the actual places that exist within the area described by the coordinates.

This work evolved from a desire to turn a "map inside out"; to construct an intimate poetic space from the abstract language of cartography. The way we see the world influences the way we value it and when all we know of a landscape is derived from a map, we miss the details and specifics that constitute variety and diversity on the ground. *Drowning by Numbers* inverts this process, and instead uses the language of mapping to re-create images of a specific locality, and the way it changes. The area depicted is a now drowned river valley, upstream from a large dam on the Upper Derwent. The lake supply level varies seasonally according to rainfall and electricity usage, alternately revealing and drowning the land, covering it and then scouring it on retreat.

No research trajectory is straightforward of course, and while *Drowning by Numbers* came together quite quickly once I had conceptualised its structure, gathering the knowledge and tools required to imagine it, had taken years. Many of my investigations were based on a clear intention to answer a particular question, but some were not; rather they were driven by an innate curiosity and/or intuition. These intuitive projects evolved in parallel with the more formal ones, and only later revealed their significance. A prime example of this, and directly related to the work, was my investigation of Aboriginal stone tools. About five years ago I was with a group of my students, standing on a small beach on Tasman Peninsula in southeastern Tasmania. Greg Lehman, a local academic and writer descended from the Ben Lomond people of the Tasmania's northeast, dropped a bag of stones in the sand in front of us. These we were told were stone cores and tools that Greg had collected from mainland Australian tribes. He asked us all to have a go at making tools using the materials. It was incredibly challenging just to chip a flake of any size from the core, let alone to create something that would serve as the foundation for a sophisticated tool.

That experience had a profound effect that has stayed with me. I realised that in Aboriginal cultures even the technological dimension of life is still in direct connection with the land, and that the knowledge base of where the right rock types surface is equally important as the ability

to manipulate the material. In November 2006, whilst walking up an old bulldozed track on the way up Mt King William, I discovered an outcropping of "smokey" quartz in a cutting. This was a material that closely resembled Greg's cores, and so I picked some up on the return to the car, but clumsily left it behind on the track while repacking the back of the vehicle. Finding the material and then leaving it behind was incredibly frustrating. It was not until March 2007 that I was able to return to pick up the quartz chunks, and when I got them home I spent the next two days reducing them to gravel. I did have some success with making crude edges and points, and my skills have improved much since then, but the most significant thing I developed was a first hand understanding of the materials, their reaction to internal shock waves induced by striking, and a recognition of the characteristic "conchoidal" shapes generated in both the final tools, and their by-products; that is, in the flakes left on the ground from the tool making process. The significance of these discoveries did not become apparent until a month later, and I must provide a wider context for them before they are tackled.

Close to Lake St Clair and at the foot of Mt King William is the Navarre Plain, an expansive network of rivers, creeks, button grass and open woodland. It was an area I had developed a particular attachment to since regularly driving through it on my way to and from Queenstown, whilst working there as an artist in residence during the years 1998 - 2003. The open savannah-like appearance of the country had always attracted me, as well as the fact that this area had changed little since the arrival of Europeans, it had never been heavily grazed or farmed, and still had regular fires through it. There is a particular visual magic associated with the late afternoon sun slanting across the damp trunks during a rain shower; a fretwork of golds and chromes and deep vibrant greens punctuated by the dark blue background of the receding front. Many years ago I had promised myself that it was a place I would one day explore. In April of 2006 Erin Tappe was artist in residence at Lake St Clair. During her two-month stay I visited a number of times, and took those opportunities to explore the region in greater depth.

But how much freedom do we really have in the choices we make? How much of our nature is inherited and how much built by experience? I ask this question because my interests in exploring regions of Tasmania have repeatedly led me to discover that my great grandfather John Ernest (Ernie) Philp has been there before me. In 1995, during the second year of my Masters by Research, I decided to focus on the Mt Lyell Mine in western Tasmania. This is a contested landscape with a long and difficult history, a rich case study for working through some of the philosophical and aesthetic impacts of industrial mining and the western relationship to wilderness, and land as resource. When she became aware of the project, my great aunt Anne Rood informed me that Ernie had worked at the mine and been part of the team that surveyed the route of the ABT Railway during 1893 and 1894; what is more, she had his daily journals from the period in a box at home. I was astounded, and also glad that I had not known this before my own passion for Mt Lyell was evident. I felt like I still owned my own journey, but there was this now a deeper layer behind everything I saw and did.

To recap, up to 2004 I knew of Ernie's Frenchmans Cap Diaries from 1910, as well as those from his period at Mt Lyell in 1890s; however, during the five years that I regularly drove through the Navarre Plains on the way to and from my stints at Queenstown, I never dreamed that this area was another of his haunts.

After completing the Frenchmans Cap trip in late 2005, I decided to ask Anne if there was anything else lurking in that box in the attic, and she agreed to let me borrow the collection. And that is when I discovered Ernie's connection with the Navarre. In 1907 he had spent four months in the area, as part of a track cutting party tasked with finding a route starting from the West Coast Road, (or Linda Track as it was then known), near Mt Arrowsmith, and skirting down the eastern margin of the King William Range before entering the country of the Upper Gordon River. Again Ernie kept wonderful daily records of this trip, including his observations about the country, the plants and the animals they encountered (native animals formed a significant portion of their diet), as well as meteorological recordings of wind direction, temperature and barometric pressure etc. He seemed interested in everything around him, and his diaries record his enthusiasm in spite of the physical hardships he was enduring. The following two excerpts mention major structures in the area 100 years ago, and the suggestions they contain became the start of my contemporary search for remnants of the "landscape" he was living in at the time, leading directly to my discovery of the area that is the subject of the work.

Monday Dec 16th 1907

Left Temple's about 7 a.m. Had rained heavily during the night and the road was rather sloppy. At Pearce's (a mile along road) we met Drays returning after leaving our stores at Navarre River along Tate's Road. Came on to rain heavily when we reached Traveller River. Killed a big lively Black Snake – just off road when making a short cut across a bend in the road. Hills round Lake St Clair and heights to westward still carrying some of the winter snow.

Killed a Porcupine Ant-eater which we carried along with us for the larder. Picked up a couple of flints (Tas Aboriginal) on road to Derwent. Crossed Derwent by Bridge. A fine body of water making its passage to the sea. Weather Cold. S.W & W. breeze blowing. Arrived at Store Depot about 2 p.m. Started at once to pitch Camp on other bank of Navarre. I slung Billy and cooked some Bacon for the crowd. Our carrier had left us some bread. Rained heavily off and on till night, but we got fixed up in two tents fairly satisfactorily; considering all things. The Navarre is a fine stream running fairly rapidly and is, where we crossed the bridge near which our Camp is, about 12 yards wide.

All hands turned in early. I was the last to get into blankets about 10 p.m. All stiffness was worked out by today's tramp and feel O.K. Except for a slight ricked knee. So far we have walked a total distance of 61 miles (98kms).

Monday Jan 6th 1908

After breakfast went to Iron Store across country about 4 miles to see if any mail there, but after a hot walk found nothing or no-one there. The Black Currants are just turning colour; Gooseberries not so forward. Pansies and Carnations in flower. Looks strange to see these evidences of civilisation so far away and in such a desolate part. Returned along the Overland Track and met Innes beyond 20 mile peg. (20 miles from where? we don't know). Made a connection from 19 mile peg and traversed and chained towards and down Tate's Road which is now to be our starting base. It was so hot that we found our butter at Camp just like Salad Oil. The snow still clings to mountain peaks, and the patch Innes and I were on, on King William on Dec 21st is apparently as thick as ever. Navarre and other creeks getting lower every day. On returning to Camp in evening found Ted there. He tells us that a Tiger has been paying their Camp a nightly visit. The dogs however do not shape at tackling this visitor. Ted has caught some more fine fish (Salmon Trout) and makes our mouths water when he tells us about them.[82]

I was struck by his descriptions of the "strange evidences of civilisation", and his whimsical speculation about the placement of the 20-mile peg, "20 miles from where? we don't know". His diary entry observes an improbable foot hold of culture that seems to be holding its own against the natural world, in an uncivilised and desolate region, a region where measurement has begun to fail. It was at this point I recognised the unique opportunity that had presented itself. Here was an area I could explore for myself, a palimpsest of open country, crisscrossed by tracks and roads of varying antiquity which I might draw myself into, and develop a familiarity over time. A relationship that I could ultimately contrast with the one I had found in the echo of Ernie's voice. What I was to find exceeded my imagination.

My first attempt to get to know the area began from the modern bridge that crosses the Lyell Highway near Harback's Road. On a cold 5th May in 2007, Erin and I left my car near the bridge and began walking north through the open eucalypt woodland. Ernie described their first camp as being on the banks of the Navarre River, just below the point where the bridge crosses. We walked up stream along the Navarre until meeting the bridge after about 10 minutes. There being no obvious signs of previous occupation at this site, we then headed back down stream, finding old fence lines from the high country cattle days, as well as subtle evidence of selective

82 Philp, J.E. - *Diary of Western Exploration*, 1907-08. Philp family archive

logging from the 1940s. Finally we left the river and traversed the surrounding button grass in a large loop back to our start.

There had been no sign of the Store Depot, but the mostly untouched quality of the country had me entranced. It was a strange zone, so near to the highway the sound of air-brakes would occasionally waft over the plain; and in the opposite direction, only a couple of kilometres distant, lurked a Hydro Electric impoundment. Yet there was a peace and a gentle calm to the country that made me feel at home in the light of the late afternoon.

The next opportunity to visit came on 3rd June 2007. Accompanied by Erin, and her two friends Frank Toman and Sophie Bestly, we again started from the present Navarre Bridge, this time attempting to follow the river until it emptied into Lake King William. This we did not achieve, the distance being too great to cover over rough terrain in the limited time. We did glimpse the Lake in the distance, across a strange barren plain. We also encountered signs of wombats and I found a bettong nest residing amongst the tangle of tree trunks and roots in the centre of one of the intermittent copses.

The fourth trip was the next day. Sophie and Frank had gone back to Hobart, leaving Erin and I to try yet another tack. From studying 1:25 000 scale maps of the area, I had identified a number of alternate lines of exploration. There was an old four-wheel drive track shown as emerging from a bend in the new road. Its curve had a natural relationship to the current road, and I surmised this might be a shadow of an earlier route that was linked to the Linda Track. Again it was very cold and clear winters day. Numbing after a while, even with thermals, gloves, overpants, and down jackets covered by gore-tex raincoats. But the low angled winter light and beautiful bush kept us enthralled. We followed the old tracks along a slight ridge, through more open woodland that blocked our distant views westward to Mt King William and eastward to the Wentworth Hills. At its end we came abruptly into the open on a slight downhill slope; before us was the shocking reality of a dry lake bed, kilometres of rust stained rocks spread in all directions before us, an environment that looked and felt like the slopes of Mt Lyell, and the NASA images of mars. It was a brutal and alien landscape.

Immediately obvious was the continuation of the track we were on, as it dipped toward the Navarre River and then crossed it on the old bridge I had been looking for. The day was getting late and we were by this stage very cold, so after briefly crossing and examining the bridge, we decide to continue the loop that would take us back to the car. Our route would take us along the margins of the dry lakebed, leaving the small valley of the Navarre, and moving north along the dry lake's western shore. Suddenly I was seeing something familiar in this weird world of gravel and erosion, there were flakes at my feet, tiny flakes from somebody making tools. I called to Erin and showed her the scatter, alerting her to what might be about, then as we walked north she spotted the first of a series of large stone tools that we were to find, a beautiful scraper lying

free on the wind scoured surface of the lake bed. Over the next 500 metres we found a number of beautifully preserved artifacts, uncovered by the scouring action of the lakes annual cycle of rise and retreat.

Figure 37. Old bridge and stone tool. Lake King William. June 2007.

My first reaction was a kind of perceptual glee, a joy at having taught myself to make tools and from that experience being able to see where other people had performed the same activity in the landscape, hundreds, if not thousands, of years ago. It was humbling and there was a sudden sense of my world opening up backward through deep-time. But there were other ramifications; I couldn't suppress the sense of hollowness in me that came from the land and all that had been taken from this area, once vibrant and loved by its people for a thousand generations. As I stood in that apocalyptic twilight, the deep time of aboriginal occupation was suddenly apprehend-able as a partner to the geological pace of change in which I could see myself embedded. I thought of the changes before me, the things that had occurred in the last two hundred years, and then I thought of what the people of this country were seeing fifteen thousand years ago, during the last ice age, when they avoided the forested valleys, and moved along the frozen tundra of the ridges that looked down upon this plain.

My first responsibility upon return to Hobart was to alert members of the local aboriginal community to my discoveries, and so I contacted Greg Lehman. He informed me, that as far as he was aware, the site was previously unrecorded and currently unknown to the contemporary Aboriginal community. Greg recommended I contact Colin Hughes (then Heritage Officer with The Tasmanian Aboriginal Land and Sea Council), and Dr Kim Ackerman (Archaeologist and Anthropologist), who has worked extensively with indigenous communities of the Kimberly region, and is also an international expert on the history and manufacture of stone tools. Greg and Colin both felt that my images revealed a highly significant cultural landscape, and when I took them to Kim, he expressed his opinion that the site was also significant in archaeological terms.

I visited the site again with Ben Booth, under five inches of August snow, and we spotted a snowy roofline in the distance across the Navarre. Later that month my kayaking partner Frank Harris accompanied me on a trip up the Lake from the Butler's Gorge end, and we had lunch at the hut I had seen. It was not until October that I was able to take Greg to the site. We left town on an extremely windy Friday afternoon, walking in the last few kilometres on a track that

wasn't on the map, following it with GPS as back up if we needed to beeline our way cross-country in the dark. After a good feed and a cozy night in the hut, the next day dawned bright and clear, and we were able to visit some of the areas where I had discovered artifacts. We found more as we walked, with Greg finding an outcropping of ochre, which he ground to a paste and daubed on his rucksack. It was satisfying to be there with Greg in his duel role as my friend and as my bridge to the Aboriginal cultural landscape I had re-found. I felt welcomed and valued as a person who was developing an intimacy with a place where the pre-colonial space of Aboriginal Tasmania is so close to the surface. I am still searching for the remains of that garden in the bush that Ernie described over 100 years ago, 20 miles from somewhere. Even if I never find it, the journey has already been rewarding beyond imagination. I have found a cultural landscape that stills rests on the deep time of Aboriginal space; and despite its use for grazing and selective logging, and despite its inundation under a hydroelectric impoundment; much of the country maintains this character. *Drowning by Numbers* was my first attempt at a computational representation of an intimate dialogue with a space as I was transforming it into a familiar locale.

As a result of my explorations in the country around the lake during twelve trips conducted over a period of two years, I have constructed an archive of over two thousand photographs. These images are a small, but spatially concentrated selection from the more than twenty-five thousand images I have taken during my PhD candidature. *Drowning by Numbers* draws from this visual record of my personal encounter with the country mentioned in one of my great grandfathers diaries.

Figure 38. Still from *Drowning by Numbers.*

Source:

Source is a work that derives its inspiration from an intense engagement with place. As detailed in the previous section, over the course of the last two years I have made regular visits to the Mt King William area and *Source* is a meditation on this extended engagement. Key to the inspiration for the work was a five-day trip into the area by myself during Easter 2008. Being immersed in the place by myself and for such a long period was the central aim of the trip; I wanted to see what the place felt like when there was no one else around to divert my attention from it. What impact would it have, I wondered, as I made the two and a half hour drive to the area?

I arrived and loaded myself up with my pack full of five days food, plus tripod strapped to the outside; on my chest I carried a day pack loaded with the video camera, tapes, batteries and more food. What I found when I arrived was awe inspiring and quite terrible; the lake was its lowest level in years and was nowhere to be seen from the shack, the valley was a battlefield littered with dead trees, their dark remains mummified by the cold waters of the winter lake and now bleaching in the late summer sun. It was a truly surreal experience to wander around in this place. At times it was like a try out for a Mars mission; at other times I expected a haze of mustard gas to drift through the trees, or a sniper to report. At one point the ground gave way beneath my feet, and from then on, all assumptions of solidity were gone. I felt I was witness to something no one else saw, that no one else wanted to see; the fishermen never come to this region when it is dry.

Figure 39. Lake King William, 10 metres below full supply level. March 2008.

Those five days were a remarkable experience. It the first time I had taken a video camera out for a field trip, and the rhythm of working alone with it was a pleasure. When I photograph I move and pause, move and pause, following my eyes and my curiosity from moment to moment,

but using the video camera was quite different. I would stop and wait as I was setting up, considering the shot, and then just sit in silent awe as the moments rolled past in front of me and the camera. I found myself in a state close to the one I enter whilst drawing, a calm quiet intensity pervaded everything. Sitting and watching real time unfold left me delighting in the way things slowly shift their forms, their outlines, and their shadows in such subtle ways that moment-to-moment I was left wondering if anything was happening at all.

With the lake level at historic lows I used my time to explore as much of the exposed lake bed as I could; searching for more stone tools and ancient camp sites, checking to see where the Navarre River met the Derwent, and how the Derwent, now exposed and running within its original banks, originally found its way here from Lake St Clair. It felt like I was operating on borrowed time, both at the level of the environmental damage around me, and because good rain would see the lake fill in spring, and it might not be this low again for years. As I traversed that blasted plain each day and returned to the hut at night the silence began overtaking me. At dawn the birds around the hut made a brief chorus in the surrounding woodland—but the lakebed stillness was unbroken. Two crows watched from the tops of dead trees as I walked through what was once a vibrant environment with only the sound of my boots on the river gravel.

Figure 40. Stone tool, Navarre River, December 2007.

When Frank and I had kayaked through these trees, (at a level now two metres above my head), we had been struck by the absence of birds, and the ironic manner in which our kayaks glided through the trunks and branches with avian trajectories. It is at times a very sad space. Indeed by the fourth morning I had decided to move camp. I had risen before dawn and walked in "the zone" with the video camera.[83] Fog enveloped everything in greys, but it was shifting, slowly breaking until I could perceive its movement downstream; it was chilled damp air emanating from the source of the Derwent, running trapped in the valley by the forces of gravity that were draining its dense mist. This really did look like gas warfare in a trenched landscape. I was captivated and haunted by what I saw, the beauty and the horror; broken fragments of beer bottles glistening in the sharpness of the early morning light.

83 "The Zone" is the name of the wilderness area cordoned off by the government, in Andrei Tarkovsky's 1979 motion picture Stalker.

After this experience I changed my plan, I had had enough of the dead zone, so I packed my gear, cleaned up the hut and hit the track. I struck out northwards and away from the "lake", following the Navarre River up to where it meets the lake when it is at full supply level. At this critical altitude the world changes, a vast button grass plain runs off to the north, northeast and the west, linking the King William Range with the Cheyne Range and the peaks of Mt Rufus and the shores of Lake St Clair. The place was alive with birds and wombats and the river held fish - arriving was a transformational moment; I removed my boots, drank from the stream and celebrated the life around me - but again the contrast to the sullen ambience of the hut by the dry lake bed was so dramatic that more than once I felt a sudden rush of sadness for all the life that had been lost in the valley below.

That afternoon I made long video recordings of the view across the plains, the sun and shadow rolling across the golden syrup redness of the buttongrass stems, their heads bobbing in front of my lens like the notes in a psychedelic symphony. I wandered barefoot on the marsupial lawn and drank cocoa as the moon rose above the shoulder of the Wentworth Hills. When I awoke predawn, the outside world was frosted and blanketed with mist. And the sunrise was worth the sacrifice of getting out of a warm sleeping bag when I realised that all around me, receding to the horizon, was an immense field of spider webs, dew encrusted and glinting in profusion. The whole five-day expedition felt like a trial by ordeal, a journey from the desert into the oasis, the sanctuary.

Figure 41. Early morning mist.
Navarre River, March 2008.

I have since visited the lake three more times, shooting still photographs and some time-lapse photographic sequences, but the experiences I gained whilst by myself have remained very present. After logging and viewing the almost eight hours of HD 1080i "footage" I had captured, there were two particular sequences that seemed to distill the tension in the environment; the buttongrass sequence and the river of fog sequence I have previously mentioned. I began to see them as "benchmarks" for my range of experiences, one view across the buttongrass plains to the source of the Derwent in its original state, the other view down stream, across a wasteland that stretched toward my local industrial centre, the hub that powers my camera and GPS, my oven and hot-water cylinder, and which constantly drains this lake.

In parallel with editing the video I had begun building an image sequence from my photo-archive that would form a visual diary of my journeys into the lake. I was able to test the series as a PowerPoint prototype during a number of public forums and guest lectures. The final

version of the work uses three screens, with the two ambient real-time representations of the locale sitting either side of a time-lapse image stream of my two years of exploration. The image stream is strictly chronologically organised, and was edited according to the aesthetic appeal of each image, as well as its ability to help tell the story of my track. This has been a really challenging process, as part of what has engaged me about the locality is its diversity and profusion, however I believe the work in its current form manages to retain the sense of this richness, without being verbose and losing its overall integrity. The spatial framework is defined by the locality, but the temporal framework for the image sequence is derived from the time dilation algorithm I developed for *Origin*. This means that the pacing and rhythm are determined by the degree of similarity each image in the sequence shares with the one following it. Early experiments with this approach resulted in animations of around 17 minutes duration, and consisting of up to 50,000 frames, and were generated from approximately 800 original photographs. The experience of viewings these iterations led me to slow the pace even further, but to do so in combination with a radical reduction in the number of original photographs used as input. This approach has enabled me to retain particular sequences of images that formed the most surprising and revealing transitions, and to remove many of those that began to appear as unnecessary repetitions of each other.

The sound track was recorded live during the taping of the lakebed sequence. The metronomic ticking is the sound of the cameras tape drive as it transports the HDV tape over the recording head. The ticking is a technical fault in the camera that annoyed me greatly when I first discovered it as I logged my tapes. Strangely, after listening to it repeatedly whilst editing I have come to appreciate the way in which it fluctuates and changes in light of its metaphoric resonance as literally the sound of the electricity dripping out of the camera, and by extension dripping out of the lake through its electrical turbines. The sound-scape becomes the unexpected music of the machine, mixed with the background calls of the invisible wattlebirds and honeyeaters, projected ghost-like onto the petrifying bones of their current field of significance.

Figure 42. Still frames from *Source*.

Chapter 4: Conclusions:

My aim was initially to develop and refine analog drawing techniques for the three and four-dimensional representation of environments. My objective was the exploration of the potential of stereo drawing to reveal poetic aspects of the experience of place. This approach was an extension of the analog and digital forms of three and four dimensional of imaging I had developed while undertaking my Masters by Research, and my subsequent art practice in the six years prior to my commencing this project.

The initial phase of my making led me to a reconsideration of this approach, and I embarked on an open ended series of readings and experiments, aimed at understanding the role of "the line" (which was the basic unit of my analog stereoscopic drawings), in constructing the way we see the world. Whilst modeling an analog optical device in the computer I recognised the program I was using as a contemporary incarnation of the drawing machines I had been making. The result of this was that I broadened the focus of my project, as I began to see the potential of digital drawing machines to facilitate making art in new ways.

Consequently I developed a series of sketches in the form of digital stills, models and animations, and began exploring the possibilities of using digital drawing devices to draw in real spaces over extended periods of time. My use of a GPS device to record my position led to the necessity of learning to write simple computer programs that could extract and manipulate the locational data. Once embarked upon this path of programming, it was only a short matter of time before I began understanding the potential of this approach to visualise that same information. This has led to an exciting and often challenging journey into the abstract worlds of object oriented programming and the mathematics of geometry, and one that has resulted in the creation of new works that I didn't have the tools to even imagine at the start of this project.

Working with open source computing and digital imaging has enabled me to synthesise a variety of media into new forms, without being constrained by the limitations that are built in to conventional software. The project has completely transformed my art making processes and my understanding of human interactions with the natural environment. The knowledge, skills and tools I have developed have allowed me to begin working in a way that facilitates the synthesis of what were previously parallel investigations located in separate media. I am an artist who originally qualified in 'wet' photography during the 80's, and then embraced digital media in the early 90's, and have since worked across a range of media including sculpture, installation and 3D digital animation; yet despite my previously broad range of skills and tools, it is only now that I have gained the knowledge and toolkits to bring these elements together.

The thesis is the result of applying alternative mapping strategies to the systematic representation of environmental experience. Still very much an inexperienced programmer, I look forward to continuing to build my knowledge of computational drawing machines, at the same time as I experience and learn more of the computational beauty of nature.

Through making this series of artworks I have worked toward a synthesis of two approaches during my candidature; I have produced a range of works which reconfigure the changes in my home view and in my home range, as well as representing entirely new places that I invested the time required to engage and develop familiarity with. The aim of my work has been to represent my engagement with the dynamic processes that make up the flow of matter, energy and information that I experience within my environment—and to construct these mappings according to a mode of treatment that is founded on an understanding of the computer as a drawing machine uniquely capable of presenting non-linear and topological relationships that offer alternatives to the distanced contemplation and temporal fixity of cartographic objectivity, its past focused linearity, and its narrative impulse that tends to order events into a single chronological stream, rather than a braided network of processes occurring in parallel.

I consider my contribution to the field to lie in the construction of intimate and poetic spaces that arise within the abstract boundaries of empirical systems. The application of computer drawing methodologies to visualising local environment has resulted in artworks that present a new way of recording changes that can be spatially and temporally located, and referred to in future studies. The works comprising the thesis represent new ways of perceiving Tasmania's environment from within, and of documenting an intimate connection with an incredibly diverse mix of natural and cultural locations.

Appendix A: List of Submitted Work:

Origin: 2004 – 2008, (Constant Change).
Digital video projection at standard definition, 25 minutes length, dimensions variable. Run by 20-inch iMac under Mac OS 10.5.

Range: 2006, (Strange Attractor).
Single screen digital animation, 25 minute duration, run live from *Processing 157* on 42inch LCD screen, at Full Hi-Definition 1920 by 1080 pixels by 20-inch iMac under Mac OS 10.5.
Wooden frame on screen designed and constructed by Bill Hart.

Sticks and Stones.
Digital video projection, 30 minute duration, run live from *Processing 157*, Hi-Definition 1320 by 768 pixels by 20-inch iMac under Mac OS 10.5.

Drowning by Numbers.
Digital video projection, 18 minute duration, run live from *Processing 157*, Hi-Definition 1320 by 768 pixels by 20-inch iMac under Mac OS 10.5.

Source.
Three screen digital video, 15 minute duration, Full Hi Definition 1920 by 1080 and 1600 by 1200, on 22-inch screens. Run by 20-inch iMacs under Mac OS 10.5.

Appendix B: Technical and Field Notes:

This section offers a more detailed account of key technical developments and field activities. The first part relates to the reconstruction and use of optical drawing machines, whilst the latter section relates to field research.

Phase 1: Drawing in Space:

My initial experiments were directed at making stereoscopic drawings for use in a standard stereoscope, of the kind generally found in antique stores. These early stereoscopes were sold across the globe, and utilised a pair of stereo images, each photograph being approximately 70 mm square. My first attempts to draw stereo-pairs brought me face to face with a challenging reality; working with pencil at this small scale was incredibly exacting and would prove grueling over the long term. The chief difficulties were associated with the extreme accuracy required in the placement of lines within the stereo space. Using a 0.5 mm clutch pencil allows a nominal 140 lines within the 70 mm frame of the image (this is like a 140 x 140 pixel image – a 0.01 megapixel image), but even at this rather coarse resolution, my hands and eyes were unable to reliably position lines with anywhere near this tolerance. It rapidly became clear that such an approach would result in a limited range of expressive possibilities, due to the attendant restrictions that related to the method being studio bound and very taxing on the eyes and posture.

Rather than give up entirely on this approach, I decided to explore the possibility that there were optical devices that might increase my speed and accuracy, and hence allow transportable methods that could actually be used to make stereo drawings in the field. I then began researching the history of optical devices and "drawing machines". The camera obscura and the camera lucida appeared to be the most applicable; the obscura for its simplicity and ease of construction, and the lucida for its minimal weight and portability. Both were developed in parallel, however I will discuss the obscura first, in line with its historic precedent.

Camera obscura:

I first began making small-scale versions of the camera obscura using cardboard, fibreboard and a hot glue gun. This allowed rapid prototyping in order to determine the best size of aperture and external dimensions of the box that would deliver the brightest and sharpest image. I soon discovered that even when I replaced the circular aperture of the obscura with a lens, the brightness of the projected image was marginal at best, and required the artist to cover the device and themselves, with a "dark cloth" of the kind associated with old field-cameras. In

addition the image is formed upside down and back to front, and this in turn makes image composition more difficult. Overall my impressions of using the device at this scale left something to be desired. It was certainly portable, but did not have the accuracy I required for my proposed stereo drawings in the field. As a final experiment I decided to convert my north facing studio at the School of Art into a room sized obscura, in the tradition of the earliest models of this type.

This was a fun process, apart from the vacuuming and painting required to turn my dusty old painters' studio into a white cube. Whilst painting the walls with a matt white that would allow projection of the brightest image, I was struck by the profound similarities between the obscura and the gallery; both strange, neutral locations that facilitate reflection upon isolated projections originating from the "real world" outside. By far the most pleasing aspect of being inside the obscura was the profound sense of peace and calm it projected; the internal boundaries of the physical device dissolve, the walls melt away and the world sails majestically past, seemingly in slow motion, and yet without a frame-rate, without the pulsing strobe of a mechanical shutter to remind us we are viewing an image, a representation. Even today, there is an unavoidable sense of magic associated with seeing the world make an image of its self in this way.

Camera lucida:

Re-development of the camera lucida was somewhat more challenging than that associated with the obscura. I managed to find copies of William Hyde Wallaston's original patents for his device from 1806.[84] The optical drawings he provided to the patent office were an invaluable aid in understanding how the device functioned, as well as how it was used. Wallaston's highly successful design employed a very small prism supported by a slender arm. By aligning the prism with both the centre of the paper, and the centre of the horizontal view to be recorded; an artist was able to see an upright projection of the scene in the prism. In order to see the paper as well, to complete the illusion by superimposing the view on the paper; the artist was required to place their eye very close to the edge of the prism, so close that they could see into it, and past it, at the same time. The result of this requirement is to force the artist to keep their eye completely still in relation to the device; failure to do so shifts the centre of perspective for the entire scene!

Having researched, designed and built a number of optical devices during the last two decades, I have found a primary source of local specialist knowledge in Longman Optical, and so it was to them that I first turned in my search for a similar prism. Longman Optical design and

84 Wallaston, William Hyde (1776-1828) Patent No 2993, A D 1806

manufacture optics, but were unsure whether their grinding machine could achieve the accuracy required of such a prism. I was advised that if the faces of the prism were not perfectly aligned the image would be significantly distorted. I had in the past commissioned Longman Optical to produce small first surface mirrors for use in mirror stereoscopes, and they suggested cannibalising some of these to replicate the surfaces of the prism at the correct scale. This I did, cutting up small sections and mounting them in a wooden frame that replicated the functionality of the lucida. This construction was painstaking to create, and even harder to use. Despite its rather different look to a camera lucida of Wallaston's design, it is essentially the same, allowing a double reflected (and therefore upright) view of the scene to be combined with a view of the paper; its reflecting mirrors are also the same scale as the reflecting surfaces of the prism in Wallaston's patent. Even in the calm of the studio, with a chair and table to support me, and brace against, I found the device extremely tiring to use. The rigorous requirement to keep one's eye, and therefore one's head and neck, absolutely still, resulted in cramp and muscle tension. The device requires that the eye remains fixed in the position it held when the drawing was begun. As previously mentioned, movement of the eye shifts the perspectival centre of the scene being viewed, and perspective centre and relative position of the drawing on the paper. Once a drawing is begun, and the lines within it begin building up, any movement of the eye is obvious to the lucida operator, as the drawing itself appears to shift relative to the position of the background scene being traced. Consequently the degree of vigilance required in operation is very tiring, with fine motor coordination constantly needed to suppress movement of the head and neck, and even to suppress the movement of breathing. I have nothing but great respect for the artists that used the device in its original form.

A breakthrough came when I reconsidered my original research on the lucida. Both in Wallaston's original patent application, and in other optical treatise I found references to a design that used mirrors instead of prisms. Here I found an optical design that could be readily prototyped from existing materials, while also offering potential advantages in functionality and ease of use over the original. Using two mirrors, one of which reflects 100% of incident light, with the other reflecting 50% and transmitting 50%, it is possible to create a device that is larger, easier to use, and has a wide field of view. The semi-reflective mirror acts as a beam splitter, and is the crucial element that allows the superimposition of scene on paper. I have created three prototypes over the course of my candidature. The *Mark 1* is constructed from medium density fibreboard, *Mark 2* is made using the inside of an old 35 mm camera, and the *Mark 3* places the *Mark 2* into a head mounted configuration.

OverDrawn:

I was very satisfied by the performance and relative ease of use of the mirror lucida. It still required fine motor control and sustained concentration in use, but its design allowed it to rest

against the boney structures of the nose and eyebrow, and thus minimise head movement and fatigue.

Up to this point I had been making time-lapse sequences of digital photographs that recorded the changing environment outside my home sunroom window. These photographs were the genesis of the piece *Origin*. At that stage I had done some preliminary the drawings of the view as well, but it was now with exciting accuracy of the new lucida, that I decided to make a series of drawings with the lucida set up with exactly the same optical centre as the digital camera. This became the work titled *OverDrawn.* Creating this piece was a lot of fun, the drawings were done over a period of months, and they demonstrate the way in which my facility with the lucida improves over time.

The first drawing in the animation (22 seconds into *Overdrawn*) clearly shows these attributes, which seem to result from the process of mental "zooming in" that drawing encourages. Objects of attention tend to be rendered with greater size due to their perceived importance in the scene represented. The second drawing (52 sec) was the result of a very determined attempt to draw with correct perspective, again using only the hand and eye, and the construction lines show that the bottom of the drawing conforms well to the 'photographic' perspective. However, the further the drawing extends from these foundation lines, the greater its divergence from the photographic perspective. Despite this, when viewed without the photograph in direct comparison, the drawing appears to have a plausible perspective that is internally consistent, since any distortion varies at a steady rate across the picture plane. The third drawing (1 min 20 sec) was approached in the same manner, but not taken to completion as a distortion was already becoming dominant.

The fourth drawing appears at the 2 minute 4 second point, and marks the first use of the camera lucida. I was so excited when I first constructed the device that I initially used it without any supporting armature, that is, I was holding it in front of my face with my left hand, while rapidly drawing with the right, and all the while trying to keep my head completely still in relation to central axis of the view and the page. Despite my head having moved, I was struck by the manner in which the rapidly drawn impression had an authenticity that defied the simplicity and economy of its construction. It looked right; friends who saw it could immediately recognise 'the view'. The fifth drawing (2 min 56 sec) was also done 'hand held', but by now I was learning to use my awareness of the parts of the drawing I had already completed, to realign my eye and the lucida, with the page as I progressed. Again, despite its 'sketchiness', the drawing has a plausible perspective, and some sense of authenticity, of being the result of direct observation. The sixth drawing (3 min 35 sec) is the first completed with the lucida firmly attached to the baseboard via a support arm. This fixes the position of the lucida in relation to the paper and the subject, with the eye unable to vary its viewing position by more than a few millimetres. The result is a dramatic improvement in the correspondence between the drawn and photographed

images. Suddenly the drawing can be worked on over a longer period; it can be left and returned to, when the drawing process becomes physically tiring.

By the time drawing seven (3 min 58 sec) was completed in colour pencil, my confidence with the device had grown considerably. I had learned to reduce the somewhat variable position of my eye in relation to the device, through resting the bridge of my nose against it during use. This required simple modification of the device with a file to round of a few sharp corners. I was actually rather surprised that the device was proving to be so accurate, and comparatively simple to use. Drawing eight (4 min 40 sec) used water-soluble pencils and incorporated colour washes in the sky. Drawing nine (5 min 20 sec) was executed with charcoal and white chinagraph pencil on a rough grey paper stock, and drawing ten (5 min 46 sec) with pencil, as were eleven (6 min 25 sec), and the final drawing twelve (6 min 50 sec).

In the process of re-constructing and using the camera lucida I taught myself a great deal about optics, drawing and visual perception. I learned about the device itself, its strengths and weaknesses, as well as its effect on my perception of the environment about me. Two revelations stand out; the first was realising that what I "knew" to be *straight lines* in the 3D environment were projected as *curved lines* on two dimensional plane of the paper; and secondly after weeks of using the device, it had re-calibrated my spatial perception and markedly improved my ability to correctly scale and proportion drawings when I wasn't using the device. The drawing of Crescent Beach was completed without the device in an afternoon, and the Mt Lyell panorama in one hour.

The experience of producing the Mt Lyell panorama warrants a discussion. I stood with a small A3 drawing board mounted on a tripod, next to the edge of the Mt Lyell Open Cut. Around the tripod I made twelve small rock piles, each four metres distant from the tripod, and being in the position of the hours on the clock. I then organised my stack of twelve sheets of paper, and began five minutes of furious drawing covering the view between each pair of rocks. An hour later I had the drawing *One Hour Mt Lyell Panorama.* What amazed me most about this drawing was its scalar consistency across the joins between the sheets. This proved in no uncertain terms that extended use of the lucida had markedly improved my spatial drawing skills. At this point I also began remaking my optical devices in a 3D computer modeling and animation environment called Cinema 4 D. My aim was to document my design process to that point, whilst also allowing the virtual testing of different design parameters, and thereby the optimisation of their function. This is possible because the 3D modeling environment uses what is known as a "ray tracer" to trace the path of virtual light rays used to illuminate the model. It was at this stage that I realised the significance of the computer and its ray tracing geometry. I now understood the computer as the contemporary incarnation of the drawing machines I had been making.

Phase 2: Beyond Euclid's Fifth:

This realisation sent me off on another line of investigation. I began a reconsideration of the historical development of optics; both in natural systems and human technological and representational systems; as regards the concept of the ray; that perfectly straight one-dimensional entity with no thickness or breadth and potentially infinite length.
This was a turning point. Although, in the camera lucida, I now had access to a traditional drawing machine that might have sufficient accuracy to create A4 stereo pairs, (which was more than I had initially hoped for), I no longer considered this an appropriate way of responding to and representing my environment. It seemed limited and closed in, inflexible and blinkered in its approach, unresponsive and painstaking in its construction. My investigation into the history of geometrical drawing had led me to conclude that; a public understanding of Euclidean geometry, with its wonderful accuracy and utility, its ability to measure and predict (honed over millennia), had crystalised at the zenith point of Cartesian Perspectivalism. This model works well in defining the behaviour of linear systems, but can only provide a simplistic and ultimately misleading glimpse into the behaviour of non-linear and dynamic systems. Despite the limitations of Euclidean geometry, and the remarkable evolution of non-Euclidean geometry in the 400 years since Descartes, this linear view is how most people think of space and the processes occurring within it.

My research had led me to begin reconsidering the aesthetics of natural environments, and the ethical basis for their valuation and appreciation. Thus, in a moment of insight, I realised that I wanted to draw with contemporary technologies in a way that would be flexible and responsive. I realised that I wanted to draw in real time and space with a GPS unit, and that linking this track to other data sets in a computer would allow me to explore and respond to my environment in ways I had not yet imagined. In October of 2005 I purchased a hand held GPS unit, and began the daunting task of learning how to navigate with the unit, get data out of it, and then to manipulate that data, combine it with other data sets, and visualise the result.

The first project in this new phase was to visit Frenchmans Cap and record my passage through that country. The track into the mountain follows its original path cut by my great grandfather Ernie, and three other men, over a four-month period, in 1910.[85] Some of the party's original blazes still mark the King Billy pines at Barron Pass, and the land is full of names that resonate with me. Lake Vera, after my great grandmother, Philps Peak after my great grandfather and Lake Tahune; also named by Philp using the Aboriginal name for the part of the Huon River where he grew up. "Tahune Linah" was also the pen name he wrote under for the local papers, and even, occasionally *The Bulletin*. Ernie kept a daily track diary of the entire trip as well as a

85 Philp, J.E , *Frenchmans Track Diary*, 1910. Archives of Tasmania, NP 21/4/1.

small surveyors note book in which he recorded the compass headings and chained lengths of the track, as well as observations relating to the surrounding country, its plant and animal life, and the surrounding features. It was my aim to make a record of my own traverse of the track, and to compare this with Ernie's from 1910.

Artist Ben Booth and I undertook the trip in November 2005, being very lucky with the weather, and even bivouacking for the night just below the summit of the Cap itself. We awoke under our ledge to an approaching storm front and the half-awake descent we made in the late dawn left us both with sore shins. That night, as we camped in the valley next to Lake Vera, the front transformed itself into electrical storm that centred itself on the Cap. For hours we lay in the dark of our "bivvy" under the trees, the lightning flashes glowing white even through our closed eyelids, and the thunder was explosive; we could actually feel the shock waves striking our chests as we lay on the ground!

This was my first approach to making a work that investigates my family history and our involvement with the environment. I made many photographs, as well as audio recordings of Ben and me reciting extracts from Ernie's diary in the Lake Vera Hut, a place great grandmother Vera had never seen. It allowed me directly compare his maps with mine, and to directly connect my experience with his, through an engagement with the land we have shared.

This was also the point where I decided to carry my GPS with me for the entire duration of 2006. It was the originating idea for the work that eventually became *Range 2006*, with the central idea to treat myself like a natural element of the environment, and to track my movements through the range of my various territories. During that year I tried as much as possible to avoid self-conscious manipulation of my path. I was not interested in making recognisable or aesthetically pleasing shapes, only capturing my movements as they reflected my changing motivations and habits. I would still allow my curiosity to take me down new roads, but that is how I have always worked.

Appendix C: Programming Code:

Raw Data:

An example of raw data from Magellan Meridian Gold handheld GPS unit:

$PMGNTRK,4252.283,S,14718.532,E,00117,M,024445.33,A,,020106*6B
$PMGNTRK,4252.258,S,14718.836,E,00136,M,212023.11,A,,020106*64
$PMGNTRK,4252.231,S,14718.825,E,00136,M,212024.11,A,,020106*6E
$PMGNTRK,4252.231,S,14718.815,E,00136,M,212027.11,A,,020106*6E
$PMGNTRK,4252.231,S,14718.803,E,00136,M,212029.65,A,,020106*64
$PMGNTRK,4252.224,S,14718.798,E,00136,M,212030.11,A,,020106*66
$PMGNTRK,4252.217,S,14718.787,E,00136,M,212031.62,A,,020106*6D
$PMGNTRK,4252.212,S,14718.780,E,00136,M,212032.72,A,,020106*6D
$PMGNTRK,4252.208,S,14718.773,E,00136,M,212033.74,A,,020106*6D
$PMGNTRK,4252.204,S,14718.767,E,00136,M,212034.62,A,,020106*64
$PMGNTRK,4252.199,S,14718.759,E,00136,M,212035.11,A,,020106*6B
$PMGNTRK,4252.193,S,14718.746,E,00136,M,212036.62,A,,020106*68
$PMGNTRK,4252.188,S,14718.737,E,00136,M,212037.62,A,,020106*65
$PMGNTRK,4252.187,S,14718.726,E,00136,M,212039.11,A,,020106*60
$PMGNTRK,4252.183,S,14718.717,E,00136,M,212040.11,A,,020106*68
$PMGNTRK,4252.176,S,14718.704,E,00136,M,212041.62,A,,020106*65
$PMGNTRK,4252.172,S,14718.695,E,00136,M,212042.62,A,,020106*6B
$PMGNTRK,4252.165,S,14718.684,E,00136,M,212044.62,A,,020106*6B
$PMGNTRK,4252.166,S,14718.676,E,00136,M,212046.11,A,,020106*63
$PMGNTRK,4252.170,S,14718.663,E,00136,M,212048.11,A,,020106*6E

TRKCLEANER.py

```
#!/usr/bin/python
#Martin Walch 2004-2008
import csv
from math import *
import sys
import glob
import os
from datetime import datetime, timedelta
import pytz

#This program opens all the files in the same folder as it is located.
#The folder must contain only unprocessed Magellan GPS track files and TRKCLEANER.py
#First Track Cleaner creates a single file from all the Tracks in the folder.
#This product is the file called 1_RAWGPS.
#Second operation is to order all GPS fixes by Time UTC.
#The product is the file 2_RAWTIME.
#Third operation checks for duplicate fixes and produces the files
#3_CLEANUTC and 4_UTC_duplicates.txt
#Fourth operation converts UTC to Local Time according to UTC Timezone offset
#and produces 5_LocalLonLat. This requires the module 'pytz' available from
#http://pytz.sourceforge.net/
#The output name includes the start and end dates

utc = pytz.utc
timezone = pytz.timezone
local = timezone('Australia/Hobart')
sys.argv = [item for arg in sys.argv for item in glob.glob('*')]

output = open('1_RAW_GPS','w')
for n in range (0, len(sys.argv)-1,1):
                filename = sys.argv[n]
                sys.stdin = (open(filename, "r"))
                data = sys.stdin.readlines()
                for line in data:
                        output.write(line)
output.close()

sys.stdin = (open("1_RAW_GPS" , "r"))
data = sys.stdin.readlines()
output = open ('2_RAW_TIME','w')

xx = -1
for line in data:
        xx += 1
        cols = line.split(',')
        P0 = cols[0][0]
        P1 = cols[1][0:2]
        P2 = cols[1][2:]
        P3 = cols[2]
        P4 = cols[3][0:3]
        P5 = cols[3][3:]
        P6 = cols[4]
        P7 = cols[5]
        P8 = cols[7]
        P9 = cols[8],
        P10 = cols[10][0:6]
        P11 = cols[10][0:2]
        P12 = cols[10][2:4]
        P13 = cols[10][4:6]
```

```
            linenum = int(xx)
            latDeg =   int(P1)
            latMin = float(P2)
            north = P3
            lonDeg = int(P4)
            lonMin = float(P5)
            east = P6
            height = str(P7)
            timeUtc = str(P8)
            dataValid = P9
            dateUtc = str(P10)
            year = str(P13)
            month = str(P12)
            day = str(P11)

            output.write( str(20) + str(year) + str(month) + str(day) + "," + str(timeUtc) + "," + str(cols[1]) +
"," + str(north) + "," + str(height) + "," + str(cols[3]) + "," + str(east)    + "," + str(xx)    + "\n")
output.close()

sys.stdin = (open("2_RAW_TIME" , "r"))
data = sys.stdin.readlines()
output = open ('3_CLEAN_UTC','w')
lastdate = 0
lasttime = 0

xx = -1
for line in data:
            xx += 1
            cols = line.split(',')
            date = str(cols[0])
            time = str(cols[1])
            newdate = int(cols[0])
            newtime = float(cols[1])

            lat = (cols[2])
            north = (cols[3])
            alt = (cols[4])
            lon = (cols[5])
            east = (cols[6])
            linenum = str(xx)

            if xx == 0:
                  firstdate = date
            if newdate > lastdate:
                        output.write( str(date)+ "," + str(time)+ "," + str(lon) + "," + str(east) + "," + str(alt) + ","
+ str(lat)    + "," + str(north) +"\n")
                        lasttime = newtime
                        lastdate = newdate
            elif newdate == lastdate and newtime > lasttime:
                        output.write( str(date)+ "," + str(time)+ "," + str(lon) + "," + str(east) + "," + str(alt) + ","
+ str(lat)    + "," + str(north) +"\n")
                        lasttime = newtime
                        lastdate = newdate
            else:
                        sys.stdout = open('3_UTC_dupes.txt','a')
                        print str(newdate) , str(newtime) , linenum, xx
output.close()

fd = str(firstdate)
ld = str(lastdate)
DateChangeList = []

sys.stdin = (open('3_CLEAN_UTC', "r"))
data = sys.stdin.readlines()
output = open ('4_Local_LL_'+fd+'_'+ld,'w')
fmt2 = '%Y%m%d,%H%M%S'
```

```
xx = -1
for line in data:
        xx += 1
        cols = line.split(',')
        date = str(cols[0])
        time = str(cols[1])
        y = int(date[0:4])
        mo = int(date[4:6])
        d = int(date[6:8])
        h = int(time[0:2])
        m = int(time[2:4])
        s = int(time[4:6])
        utc_dt = datetime(y,mo,d,h,m,s, tzinfo=utc)
        loc_dt = utc_dt.astimezone(local)
        lon = (cols[2])
        east = (cols[3])
        alt = (cols[4])
        lat = (cols[5])
        north = (cols[6])
        linenum = str(xx)

        output.write( loc_dt.strftime(fmt2) + "," + str(lon) + "," + str(east) + "," + str(alt) + "," + str(lat)    +
"," + str(north) )

output.close()
```

CLEAN2ARRAY.py

```
#!/usr/bin/python
#Martin Walch   2004-2008
import csv
from math import *
import sys
import glob
import os

from XZ import *
from XYZ import *
from XYZT import *
from LL2UTM import *
from UTC2TDS import *

madexz = 1
madexyz = 1
madexyzt = 1

#Takes file with Local Time plus Latitude and Longitude
filename = '5_LocalLL_20060102_20061231'

    #Clean_UTC format
    #Cols[0]     = 310506                    Date UTC
    #Cols[1]     = 231807.28                 Time UTC
    #Cols[2]     = 14718.532                 split lonDeg from lonMin
    #Cols[3]     = E                             East
    #Cols[4]     = 00115                     Altitude
    #Cols[5]     = 4252.297                  split latDeg from latMin
    #Cols[6]     = S                             South

(madexz) = XZ(filename)
(madexyz) = XYZ(filename)
(madexyzt) = XYZT(filename)

    #Original Magellan Track Format
    #Cols[0]     = $PMGNTRK                  change to line number, starting at 0
    #Cols[1]     = 4252.297                  split latDeg from latMin
    #Cols[2]     = S                         South
    #Cols[3]     = 14718.532                 split lonDeg from lonMin
    #Cols[4]     = E                         East
    #Cols[5]     = 00115                     Altitude
    #Cols[6]     = M                         Metres
    #Cols[7]     = 231807.28                 Time UTC
    #Cols[8]     = A                         Valid (V = Invalid)
    #Cols[9]     = Empty
    #Cols[10]    = 310506*6E\r\n             Date UTC
```

LL2UTM.py

```
#!/usr/bin/python
#Martin Walch    2004-2008
#Extremely Accurate Function for transforming
#Latitude and Longitude to Metric Eastings and Northings
#Includes offset for custom origin point.

from math import *

def LL2UTM(latDeg,latMin,lonDeg,lonMin,north,east):
        #Datum =                        WGS 84
        #Datum list at bottom of this code
        a = 6378137.000
        #equatorial radius
        b = 6356752.314
        #polar radius
        f=   0.003352811
        #flattening
        invf = 298.2572236
        #inverse flattening
        rm = (a*b)**(1/2)
        #Mean radius
        k0 = 0.9996
        #scale factor
        e = sqrt(1-(b/a)**2)
        #eccentricity
        e1sq = e*e/(1-e*e)
        n = (a-b)/(a+b)

        #Meridional Arc Constants
        A0 = a*(1-n+(5*n*n/4)*(1-n) +(81*n**4/64)*(1-n))
        B0 = (3*a*n/2)*(1 - n - (7*n*n/8)*(1-n) + 55*n**4/64)
        C0 = (15*a*n*n/16)*(1 - n +(3*n*n/4)*(1-n))
        D0 = (35*a*n**3/48)*(1 - n + 11*n*n/16)
        E0 = (315*a*n**4/51)*(1-n)

        #Calculation Constants
        sin1 = pi/(180*3600.00)

        F3 = latDeg
        G3 = latMin
        H3 = lonDeg
        I3 = lonMin

        #Calculations
        if north == 'N':
                nn = 1
        else:
                nn = -1

        #convert to decimal Lat
        L3 = nn*(F3+(G3/60.0))
        if east == 'E':
                ee = 1
        else:
                ee = -1

        #convert to decimal Lon
        M3 = ee*(H3+(I3/60.0))
        Z3 = L3
        AA3 = M3
```

```
        AB3 =   31+int(AA3/6.0)
        #Longitude Zone
        AC3     =       6*AB3-183
        #Longitude Zone CM
        AD3     =       (AA3-AC3)*3600.0/10000.0
        #Delta Longitude (secs)
        AE3     =       Z3*pi/180.0
        #Latitude Radians
        AF3     =       AA3*pi/180.0
        #Longitude Radians
        AG3     =       a*(1-e*e)/((1-(e*sin(AE3))**2)**(3/2.0))
        #r curv 1 = rho
        AH3     =       a/((1-(e*sin(AE3))**2)**(1/2.0))
        #r curv 2 = nu
        #Calculate Meridional Arc Length
        AJ3     =       A0*AE3 - B0*sin(2*AE3) + C0*sin(4*AE3) - D0*sin(6*AE3) + E0*sin(8*AE3)
        #Meridional Arc S
        #Coefficients for UTM Coordinates
        AL3     =       AJ3*k0
        #Ki
        AM3     =       AH3*sin(AE3)*cos(AE3)*sin1**2*k0*(100000000)/2.0
        #Kii
        AN3     =
        ((sin1**4*AH3*sin(AE3)*cos(AE3)**3)/24)*(5-tan(AE3)**2+9*e1sq*cos(AE3)**2+4*e1sq**2*co
s(AE3)**4)*k0*(10000000000000000.0)
        #Kiii
        AO3     =       AH3*cos(AE3)*sin1*k0*10000
        #Kiv
        AP3     =
        (sin1*cos(AE3))**3*(AH3/6)*(1-tan(AE3)**2+e1sq*cos(AE3)**2)*k0*(1000000000000)
        #Kv
        AQ3     =
        ((AD3*sin1)**6*AH3*sin(AE3)*cos(AE3)**5/720.0)*(61-58*tan(AE3)**2+tan(AE3)**4+270*e1s
q*cos(AE3)**2-330*e1sq*sin(AE3)**2)*k0*(1E+24)
        #A6 cant see what this line does AQ3 does not appear again, could be part of Grid Zone
        AR3     =       (AL3+AM3*AD3*AD3+AN3*AD3**4)
        #Raw Northing
        if AR3 < 0:
                AS3 = 10000000 + AR3
        else:
                AS3 = AR3
        AT3     =       500000 + (AO3*AD3+AP3*AD3**3)
        offEast = 525228
        offNorth = 5253427

        # 1/35 is at 55G E525228 N5253427    Alt 117 metres
        # 1/35 Elphinstone, front verandah, left window, facing NE
        #offset to bring XZ zero point nearer centre of home range i.e. nearer Hobart

        #print " Easting: ", (AT3 - offEast)," Altitude: ", height," Northing: ", (AS3 - offNorth) ," Grid Zone:
", AB3,
        return  AT3 - offEast, AS3 - offNorth , AB3
```

#Datum	a	b	f	1/f
#WGS 84	6,378,137.0	6,356,752.3	0.003352811	298.257
#NAD 83	6,378,137.0	6,356,752.3	0.003352811	298.257
#GRS 80	6,378,137.0	6,356,752.3	0.003352811	298.257
#WGS 72	6,378,135.0	6,356,750.5	0.003352783	298.260
#Australian 1965	6,378,160.0	6,356,774.7	0.003352895	298.250
#Krasovsky 1940	6,378,245.0	6,356,863.0	0.003352333	298.300
#North American 1927				
	6,378,206.4	6,356,583.8	0.003390075	294.979
#Interntional 1924				
	6,378,388.0	6,356,911.9	0.003367011	296.999
#Hayford 1909	6,378,388.0	6,356,911.9	0.003367011	296.999

#Clarke 1880	6,378,249.1	6,356,514.9	0.00340755	293.466
#Clarke 1866	6,378,206.4	6,356,583.8	0.003390075	294.979
#Airy 1830	6,377,563.4	6,356,256.9	0.003340853	299.325
#Bessel 1841	6,377,397.2	6,356,079.0	0.003342774	299.153
#Everest 1830	6,377,276.3	6,356,075.4	0.003324444	300.802

UTC2TDS.py

```
#!/usr/bin/python
#Martin Walch  2004-2008

from LL2UTM import *
from math import *
from XYZ import *
from XYZT import *
from XZ import *
from datetime import datetime, timedelta
import pytz

utc = pytz.utc
timezone = pytz.timezone
local = timezone('Australia/Hobart')

def UTC2TDS(Xp1,Xp2,Yp1,Yp2,Zp1,Zp2,Tp1,Tp2,Dp1,Dp2):

        hour2 = Tp2[0:2]
        mins2 = Tp2[2:4]
        secs2 = Tp2[4:6]
        day2 = Dp2[6:8]
        month2 = Dp2[4:6]
        year2 = Dp2[0:4]
        hour1 = Tp1[0:2]
        mins1 = Tp1[2:4]
        secs1 = Tp1[4:6]
        day1 = Dp1[6:8]
        month1 = Dp1[4:6]
        year1 = Dp1[0:4]

        D1 = Xp2 - Xp1
        D2 = Zp2 - Zp1
        D3 = sqrt((D2*D2) + (D1*D1))
        D4 = Yp2 - Yp1
        D5 = sqrt((D4*D4) + (D3*D3))

        seconds2 = (int(hour2)*3600) + (int(mins2)*60) + float(secs2)
        seconds1 = (int(hour1)*3600) + (int(mins1)*60) + float(secs1)

        Timegap = (seconds2 - seconds1)
        if Timegap < 1:
            Timegap = -1*Timegap

        distance = D5

        if Timegap <= 0:
                distance = 0
                speed = 0
                kmph = 0
        else:
                Timegap = Timegap
                metrespersec      = (distance / Timegap)
                kmph = (metrespersec/1000)*3600

        return Timegap, distance, kmph
```

XYZ.py

```
#!/usr/bin/python
#Martin Walch   2004-2008
from math import *
from LL2UTM import *
import sys

def XYZ(filename):
        sys.stdin = (open(filename, "r"))
        data = sys.stdin.readlines()
        newname = str(filename)+str('_XYZ')
        output = open (newname,'w')

        xx = -1
        for line in data:
                xx += 1
                cols = line.split(',')
                P1 = cols[0]
                P2 = cols[1]
                P3 = cols[2][0:3]
                P4 = cols[2][3:]
                P5 = cols[3]
                P6 = cols[4]
                P7 = cols[5][0:2]
                P8 = cols[5][2:]
                P9 = cols[6]

                linenum = int(xx)

                date = str(P1)
                time = str(P2)
                lonDeg = int(P3)
                lonMin = float(P4)
                east = P5
                height = float(P6)
                latDeg =   int(P7)
                latMin = float(P8)
                north = P9

                (easting,northing , AB3,) = LL2UTM(latDeg,latMin,lonDeg,lonMin,north,east)
                easting = round(easting)
                northing = round(northing)

                output.write("\n" + str(xx) + "," + str(easting) + "," + str(height) + "," + str(northing))

                madexyz = 1
        output.close()
        return madexyz
```

XYZT.py

```
#!/usr/bin/python
#Martin Walch   2004-2008
from math import *
from LL2UTM import *
from UTC2TDS import *
import sys

def XYZT(filename):
        sys.stdin = (open(filename, "r"))
        data = sys.stdin.readlines()
        newname = str(filename)+str('_DTXYZ')
        output = open (newname,'w')

        xx = -1
        for line in data:
                xx += 1
                cols = line.split(',')
                P1 = cols[0]
                P2 = cols[1]
                P3 = cols[2][0:3]
                P4 = cols[2][3:]
                P5 = cols[3]
                P6 = cols[4]
                P7 = cols[5][0:2]
                P8 = cols[5][2:]
                P9 = cols[6]

                linenum = int(xx)

                date = str(P1)
                time = str(P2)
                lonDeg = int(P3)
                lonMin = float(P4)
                east = P5
                height = float(P6)
                latDeg =   int(P7)
                latMin = float(P8)
                north = P9

                (easting,northing, AB3,) = LL2UTM(latDeg,latMin,lonDeg,lonMin,north,east)

                easting = round(easting)
                northing = round(northing)

                Xp2 = easting
                Yp2 = height
                Zp2 = northing
                Tp2 = str(time)
                Dp2 = str(date)

                if xx == 0:
                        Xp1 = Xp2
                        Yp1 = Yp2
                        Zp1 = Zp2
                        Tp1 = Tp2
                        Dp1 = Dp2
                else:
                        Xp1 = easting2
                        Yp1 = height2
                        Zp1 = northing2
```

```
                    Tp1 = time2
                    Dp1 = date2
                (Timegap, distance, kmph) = UTC2TDS(Xp1,Xp2,Yp1,Yp2,Zp1,Zp2,Tp1,Tp2,Dp1,Dp2)

                Timegap = round(Timegap, 2)
                distance = round(distance, 2)
                kmph = round(kmph, 2)

                #output.write("\n" + str(date) + "," + str(time) + "," + str(easting) + "," + str(height) + ","
+ str(northing) + "," + str(Timegap) + "," + str(distance) + "," + str(kmph))

                output.write(str(date) + "," + str(time) + "," + str(easting) + "," + str(height) + "," +
str(northing)+ "," + str(Timegap) + "," + str(distance) + "\n")

                easting2 = Xp2
                height2 = Yp2
                northing2 = Zp2
                time2 = Tp2
                date2 = Dp2

                madexyzt = 1
        output.close()

        return madexyzt, line
```

XZ.py

```
#!/usr/bin/python
#Martin Walch   2004-2008
from math import *
from LL2UTM import *
import sys

def XZ(filename):
        sys.stdin = (open(filename, "r"))
        data = sys.stdin.readlines()
        newname = str(filename)+str('_XZ')
        output = open (newname,'w')

        xx = -1
        for line in data:
                xx += 1
                cols = line.split(',')
                P1 = cols[0]
                P2 = cols[1]
                P3 = cols[2][0:3]
                P4 = cols[2][3:]
                P5 = cols[3]
                P6 = cols[4]
                P7 = cols[5][0:2]
                P8 = cols[5][2:]
                P9 = cols[6]

                linenum = int(xx)

                date = str(P1)
                time = str(P2)
                lonDeg = int(P3)
                lonMin = float(P4)
                east = P5
                height = float(P6)
                latDeg =   int(P7)
                latMin = float(P8)
                north = P9

                (easting,northing , AB3,) = LL2UTM(latDeg,latMin,lonDeg,lonMin,north,east)
                easting = round(easting)
                northing = round(northing)

                #print P0,P1,P2,P3,P4,P5,P6,P7,P8,P10
                #AB3 = Longitude Zone

                output.write(str(linenum) + ',' + str(easting) + "," + str(northing) + "\n" )
                #str(timeUtc) + "," + str(dateUtc))

                madexz = 1
        output.close()
        return madexz
```

TimeFilter.py

```
#!/usr/bin/python
#Martin Walch   2004-2008
import csv
from math import *
import sys
import glob
import os

#TIME Filter
#opens file and remove points that do not fit within the time span set by 'filter_period'
#Filter_period is defined in seconds. A new filtered file, and a list of rejects are created.
#Also removes leading zeros "0's" from number fields for JAVA compatability

filename = 'UTM_20070119_20071231_DTXYZ'
sys.stdin = (open(filename , "r"))
filter_period = 10
output = open (filename+"_"+str(filter_period)+"_"+"secs",'w')
lastdate = 0
lasttimesecs = 0

data = sys.stdin.readlines()
xx = -1
for line in data:
        xx += 1
        cols = line.split(',')
        date = str(cols[0])
        #time = str(cols[1]) retains leading zeros
        time = int(cols[1])
        hours = int(cols[1][0:2])
        mins = int(cols[1][2:4])
        secs = int(cols[1][4:6])
        timesecs = secs + (mins*60) + (hours*3600)
        newdate = int(cols[0])
        newtime = float(cols[1])
        newhours = int(cols[1][0:2])
        newmins = int(cols[1][2:4])
        newsecs = int(cols[1][4:6])
        newtimesecs = newsecs + (newmins*60) + (newhours*3600)
        easting = (cols[2])
        alt = (cols[3])
        northing = (cols[4])

        linenum = str(xx)
        if newdate > lastdate:
                output.write( str(date)+ "," + str(time) + "," + str(easting) + "," + str(alt) + "," +
str(northing))
                lasttimesecs = newtimesecs
                lastdate = newdate
        elif newdate == lastdate and newtimesecs > (lasttimesecs + filter_period):
                output.write( str(date)+ "," + str(time) + "," + str(easting) + "," + str(alt) + "," +
str(northing))
                lasttimesecs = newtimesecs
                lastdate = newdate
        else:
                sys.stdout = open(filename+"_"+str(filter_period)+"_rejects.txt",'a')
                print str(newdate) , str(newtime) , linenum

output.close()
```

DAY_MAKER.py

```
#!/usr/bin/python
#Martin Walch  2004-2008

import sys
import os
import pickle
"""
This program opens a file in the format:
20060901,  174016,  492.0,  55.0,  -189.0,  29.0      ,  219.39
date     ,  time  ,  east,  alt,  north,  time gap,  distance
it loads the lines into a nested dictionary that holds
the lines in sets of DAYS and then pickles them to file.
"""
filename = "2006_DTXYZ_Test"
startdate = 0; TRKpoint = (); TRK = []; DateChangeList =[]; DAY = []
sys.stdin = (open(filename, "r"))
data = sys.stdin.readlines()
xx = -1
for line in data:
    xx += 1
    cols = line.split(',')
    D = cols[0]
    T = cols[1]
    E = cols[2]
    A = cols[3]
    N = cols[4]
    TG = cols[5]
    DIST = cols[6]
    d = str(D)
    t = str(T)
    e = float(E)
    a = float(A)
    n = float(N)
    tg = float(TG)
    dist = float(DIST)
    TRKpoint = (D,T,e,a,n,tg,dist)
    TRK.append(TRKpoint)

firsttime = TRK[0][1]; firstdate = TRK[0][0];
lasttime = TRK[-1][1]; lastdate = TRK[-1][0]; TRKpoint_count = len(TRK)
print 'firstdate', firstdate, 'firsttime', firsttime,'lastdate',lastdate,'lasttime', lasttime,  'TRKpoint_count',
TRKpoint_count

for i in range(0,len(TRK)):
    date = TRK[i][0]
    if date > startdate:
        startdate = date
        DateChangeList.append(i)
Daycount = len(DateChangeList); DateChangeList.append(len(TRK))
print 'Daycount', Daycount
print 'Date Change List', DateChangeList
for x in range(Daycount):
    v = DateChangeList[x]
    v1 =DateChangeList[x+1]
    DAY.append(TRK[v:v1])
outputday = DAY[0]
alldays =DAY
file = open(filename +'_pickle','w')
pickle.dump(alldays, file)
file.close()
```

ImageMetric.py

```
#!/usr/bin/python
#Martin Walch and Bill Hart  2008
#ImageMetric.py requires EXIF.py to run

import glob
from PIL import Image
from PIL import ImageStat
from PIL import ImageChops
import time
import os
import sys

jpegs = glob.glob("*.jpg")
filedata = {}
outputfn = "./output/"
imgsize = (1440, 1080)

#interframescale determines the speed of animation: 29.0 = fast: 119.0 = slow
interframescale = 119.0
#interframehold is the fraction (i.e. 1/interframehold) of the blend time, for which the full image is then held at the end of the transition
interframehold = 7



def interframes(metric):
    imin = min(metric)
    #iscale = 15.0/(max(metric) - imin)
    #iscale = 29.0/(max(metric) - imin)
    iscale = interframescale/(max(metric) - imin)
    interframes = []
    for mm in metric:
        interframes.append(iscale * (mm - imin))
    return interframes

for jpeg in jpegs:
    exifdata = Image.open(jpeg)._getexif()
    datetime = exifdata[306]
    epochsecs = time.mktime(time.strptime(datetime,"%Y:%m:%d %H:%M:%S"))
    #epochsecs = int(epochsecs)
    print epochsecs
    filedata[epochsecs] = jpeg

fileorder = filedata.keys()
fileorder.sort()

mean = []
rms = []
var = []
stddev = []

#does stats on 'L' = luminance.
im0 = Image.open(filedata[fileorder[0]]).convert('L').resize(imgsize, Image.BICUBIC)
for key in range(1, len((fileorder))):
    im1 = Image.open(filedata[fileorder[key]]).convert('L').resize(imgsize, Image.BICUBIC)
    imstat = ImageStat.Stat(ImageChops.difference(im1, im0))
    mean.append(imstat.mean[0])
    rms.append(imstat.rms[0])
    var.append(imstat.var[0])
    stddev.append(imstat.stddev[0])
```

```
    print "filename", filedata[fileorder[key]], ":", "gap_secs" , fileorder[key] - fileorder[key-1], ":", "mean",
imstat.mean[0], ":", "rms" , imstat.rms[0], ":", "var" , imstat.var[0], ":", "std dev" , imstat.stddev[0]
    im0 = im1

interfram = interframes(stddev)
imagecnt = 0
fname = outputfn + "00000.jpg"
im0 = Image.open(filedata[fileorder[0]]).resize(imgsize, Image.BICUBIC)
im0.save(fname)
print "fname", fname
for key in range(1, len(fileorder)):
    im1 = Image.open(filedata[fileorder[key]]).resize(imgsize, Image.BICUBIC)
    ikey = int(round(interfram[int(key-1)]))
    for inter in range(ikey):
        imagecnt += 1
        fname = outputfn + str(imagecnt).rjust(5).replace(' ','0') + '.jpg'
        blend = (inter + 1.0) / (ikey + 1.0)
        imi = Image.blend(im0, im1, blend)
        imi.save(fname)
        print "blend", blend, "fname", fname
    fname = outputfn + str(imagecnt).rjust(5).replace(' ','0') + '.jpg'

    for i in range(int(round(ikey/interframehold))):
                imagecnt += 1
                fname = outputfn + str(imagecnt).rjust(5).replace(' ','0') + '.jpg'
                im1.save(fname)
                print "blend - 100", "fname", fname
    imagecnt += 1
    fname = outputfn + str(imagecnt).rjust(5).replace(' ','0') + '.jpg'
    im1.save(fname)
    print "fname" , fname
    print "input_file_#      " , key , "/ " , len(fileorder)

    im0 = im1
```

Range: 2006

Written with Processing 135.

Range_Final

```
//MapScreen sets and draws the "map safe" area of the screen
//It takes screen Width and Height as variables, well as
//width and height margins - these are the percentages of the screen
//dimension that will remain clear surrounding the track drawing
//Bias is an extra few percent added to the bottom of the frame for visual balance

import processing.opengl.*;

//mapscreen border variables
int width_margin = 3;
int height_margin = 5;
int bias = 10;

//Draw_datetime variables
int width_datescreen = 5;
int height_datescreen = 7;
int datescreen_bias = 25;

String filename = "2006_15_secs";
int i;
int v;
int w;
int dayNum = 0;
int toDay = 0;
int oldDay = 0;

float scalefactor;
int startx = -30;
int starty = -35;
int startscale = 8;
int endx = -135;
int endy = -155;
float endscale = 3.55;
float scalechange = 0.0000025;

int cx =  (250+width/2)+startx;
int cy =  (250+height/2)+starty;

int centrex = int(scalefactor*5)  + cx + cx/2;
int centrey = int(scalefactor*10) + cy + cy/2;

MapScreen MS = new MapScreen(1920,1200,width_margin,height_margin,bias);
Draw_DateTime DT = new
Draw_DateTime(1920,1200,width_datescreen,height_datescreen,datescreen_bias);
File_cruncher FC = new File_cruncher(filename);

void setup(){
  size(1920, 1200, OPENGL);
  frameRate(45);
  smooth();
  makedays();
  scalefactor = startscale;
  //scalechange = (startscale - endscale)/FC.TRK_points.length;
```

```
  PFont fontA = loadFont("Optima-Regular-48.vlw");
  PFont fontB = loadFont("ArialMT-48.vlw");
  PFont fontC = loadFont("HelveticaNeue-UltraLight-48.vlw");
  PFont fontD = loadFont("Monaco-48.vlw");
  textFont(fontD, 15);
}

void draw(){
  background(215,210,190);
  smooth();
  noFill();
  //scalefactor = scalefactor- scalechange;
  println(scalefactor);
  MS.drawMS();
  FC.daylist[toDay].drawOld();
  FC.daylist[toDay].drawDay();
  DT.drawDT();

  if(key == CODED){
    if(keyCode == UP){
      centrey = centrey +3;
    }
    else if(keyCode == DOWN){
      centrey = centrey -3;
    }
    else if(keyCode == LEFT){
      centrex = centrex +3;
    }
    else if(keyCode == RIGHT){
      centrex = centrex -3;
    }
    else if(keyCode == CONTROL){
      scalefactor = scalefactor/1.02;
      if (scalefactor < 1){
        scalefactor = 1;
      }
    }
    else if(keyCode == ALT){
      scalefactor = scalefactor*1.02;
    }
  }
}

class Day_list{

  int[][]pointlist;
  int Daylength;
  int Date;
  int starttime;
  int endtime;
  int old = 0;
  int fade = 0;
  float thick = 1.5;
  float opacity;

  int mini_scale = 325;
  int mini_x = -400;
  int mini_y = -2100;
  int mini_centrex = 405;
  int mini_centrey = 415;

  int i = 0;
  int v;
  int w;

  int[]TIMES = new int[Daylength];
```

```
int[]XS =      new int[Daylength];
int[]ZS =      new int[Daylength];
int[]YS =      new int[Daylength];

int minX, maxX;
int minZ, maxZ;
int minY, maxY;
int minT, maxT;

int [] bounds;

int distance;
int offE, offN;
float autoscale;

Day_list(int[][] newday){

   this.pointlist = newday;

   this.Daylength = this.pointlist.length;
   this.Date = this.pointlist[0][0];
   this.starttime = this.pointlist[0][1];
   this.endtime = this.pointlist[Daylength-1][1];
   println("starttime   " + starttime + " endtime   " + endtime);
}


void drawDay(){
   stroke(180,35,22);
   strokeWeight(3);
   smooth();
   noFill();

   beginShape();
   for(int v =0; v<i; v++){
      vertex(FC.daylist[dayNum].pointlist[v][2]/scalefactor+centrex,
FC.daylist[dayNum].pointlist[v][4]/scalefactor*-1+centrey);
   }
   endShape();

   scalefactor = scalefactor - scalechange;
   if(scalefactor< endscale){
      scalefactor = endscale;
   }

   strokeWeight(1.5);
   beginShape();
   for(int v =0; v<i; v++){
      vertex(FC.daylist[dayNum].pointlist[v][2]/mini_scale +mini_centrex+1200,
FC.daylist[dayNum].pointlist[v][4]/mini_scale*-1+mini_centrey+500);
   }
   endShape();

   stroke(20,135,32);
   ellipse(FC.daylist[dayNum].pointlist[v][2]/mini_scale +mini_centrex+1200,
FC.daylist[dayNum].pointlist[v][4]/mini_scale*-1+mini_centrey+500,12,12);

   if (i == FC.daylist[dayNum].Daylength){
      i = 0;
      dayNum++;
      //oldDay = dayNum -1;

      if(dayNum == FC.daylist.length){
         dayNum = 0;
         scalefactor = startscale;
      }
```

```
    }
    else{
      text(FC.daylist[dayNum].pointlist[i][1], 980, 77);
      stroke(10,27,222,150);
      ellipse(FC.daylist[dayNum].pointlist[i][2]/mini_scale +mini_centrex+1200,
FC.daylist[dayNum].pointlist[i][4]/mini_scale*-1+mini_centrey+500,10,10);
      i++;

      //println(i);
    }
  }


  void drawOld(){
    smooth();
    noFill();

    for(int x=0; x<dayNum; x++){
      fade = (dayNum -x);
      if(fade> 254){
        fade = 255;
      }
      stroke(fade);
      strokeWeight(thick);
      scalefactor = scalefactor - scalechange;

      beginShape();
      for(int w =0; w<FC.daylist[x].Daylength; w++){
        vertex(FC.daylist[x].pointlist[w][2]/scalefactor+centrex,
FC.daylist[x].pointlist[w][4]/scalefactor*-1+centrey);
      }
      endShape();

      strokeWeight(1);
      beginShape();
      for(int w =0; w<FC.daylist[x].Daylength; w++){
        vertex(FC.daylist[x].pointlist[w][2]/mini_scale +mini_centrex+1200,
FC.daylist[x].pointlist[w][4]/mini_scale*-1+mini_centrey+500);
      }
      endShape();
    }
  }



}
//Constructs frame for datetime rendering within
//Can be visible or only use to calculate placement of each day

class Draw_DateTime{
  //SC screen variables, etc set when called from DAY_Fader

  int SC_Width, SC_Height;
  int up_left_X, up_right_X, dwn_left_X, dwn_right_X;
  int up_left_Y, up_right_Y, dwn_left_Y, dwn_right_Y;
  int width_margin;
  int height_margin;
  int bias;

  Draw_DateTime(int SC_Width, int SC_Height, int width_margin, int height_margin, int bias){

    this.width_margin = width_margin;
    this.height_margin = height_margin;
    this.bias = bias;
    this.SC_Width = SC_Width;
    this.SC_Height= SC_Height;
```

```
    this.up_left_X = (SC_Width/100)*width_margin;
    this.up_left_Y = (SC_Height/100)*height_margin;
    this.up_right_X = SC_Width-((SC_Width/100)*width_margin);
    this.up_right_Y = (SC_Height/100)*height_margin;
    this.dwn_left_X = (SC_Width/100)*width_margin;
    this.dwn_left_Y = SC_Height-((SC_Height/100)*height_margin)-bias;
    this.dwn_right_X = SC_Width-((SC_Width/100)*width_margin);
    this.dwn_right_Y = SC_Height-((SC_Height/100)*height_margin)-bias;
  }

  void drawDT(){
    stroke(50,50,80,50);
    noFill();

    beginShape();
    vertex(up_left_X,up_left_Y);
    vertex(up_right_X,up_right_Y);
    vertex(dwn_right_X,dwn_right_Y);
    vertex(dwn_left_X,dwn_left_Y);
    vertex(up_left_X,up_left_Y);
    endShape();

    fill(0,7,127,100);
    text(FC.daylist[dayNum].Date, 900, 77);
    }
  }

//this program generates a nested list of track points
//accessible as TRK_points[trk_point #][date,time,x,y,z]

class File_cruncher{

  String filename;
  String [] TRK;
  int [][] TRK_points;
  String [] TRK_line;
  int [][][] DAY_points;
  int [] DateChangeList = {0};
  int [][] newday;
  int Daycount;
  Day_list [] daylist;

  File_cruncher(String filename){

    this.filename =  filename;
    this.TRK = TRK;
    this.TRK_points = TRK_points;
    this.TRK_line = TRK_line;
    this.DAY_points = DAY_points;
    this.DateChangeList = DateChangeList;
    this.newday = newday;
    this.Daycount = Daycount;
    }
    //Loads file and creates TRK_points[][] 2D array
    //TRK_points[0][0] = line 0, column 0 = firstdate

    void setTRK_points(){
      this.TRK = loadStrings(this.filename);
      this.TRK_points = new int[TRK.length][5];

      for(int i= 0; i < this.TRK.length; i++){
        this.TRK_line = split(this.TRK[i],',');
        for(int j= 0; j < 5; j++){
          this.TRK_points[i][j] = int(this.TRK_line[j]);
        }
```

```
    }
  }

  int[][] getTRK_points(){
    return this.TRK_points;
  }

  //Constructs a list that contains the start line "zero"
  //plus the line number for the end of each day
  void setDateChangeList(){

    int xx = (this.TRK_points.length);
    int firsttime =   this.TRK_points[0][1];
    int firstdate = this.TRK_points[0][0];
    int lasttime = this.TRK_points[xx-1][1];
    int lastdate = this.TRK_points[xx-1][0];

    for(int i= 0; i < xx; i++){
      int date = (this.TRK_points[i][0]);
      int [] linecount = {i};
      if (date > firstdate){
        firstdate = date;
        this.DateChangeList = append(this.DateChangeList, i);
        }
      }
     // DateChangeList starts with 0, and then records the LAST line of each day
     this.Daycount = (this.DateChangeList.length);
     println("day count >> " + this.Daycount);
     //adds value of last line number to end of list
     this.DateChangeList = append(this.DateChangeList,xx-1);
  }
  int[] getDateChangeList(){
    return this.DateChangeList;
  }
      int getDaycount(){
    return this.Daycount;
  }
  void setDays(int [][]TRK_points, int[]DateChangeList, int Daycount){

    int i;
    int j;
    int k = 0;
    int[][] newday;
    Day_list [] daylist = new Day_list[Daycount];
    int[]ChangeList;
    this.TRK_points = TRK_points;
    this.DateChangeList = DateChangeList;
    this.Daycount = Daycount;
    this.daylist = daylist;

    //loop for number of days
    for (i=0;i<DateChangeList.length-1; i++){
      //start a new array to contain this first day
      this.newday = new int[(DateChangeList[i+1])-(DateChangeList[i])][5];
      //arraycopy loops through daylength to copy points
      arraycopy(TRK_points,DateChangeList[i],this.newday,0,(DateChangeList[i+1]) -
(DateChangeList[i]));
      this.daylist[i] = new Day_list(this.newday);
      println("day "+ i + "   date " + daylist[i].Date + "   length " + daylist[i].Daylength );
    }
  }
   Day_list[] getDays(){
     return this.daylist;
  }
}
```

```
//Constructs frame for map rendering within
//Can be visible or only use to calculate placement of each day

class MapScreen{
  //SC screen variables, etc set when called from DAY_Fader
  //
  int SC_Width, SC_Height;
  int up_left_X, up_right_X, dwn_left_X, dwn_right_X;
  int up_left_Y, up_right_Y, dwn_left_Y, dwn_right_Y;
  int width_margin;
  int height_margin;
  int bias;

  MapScreen(int SC_Width, int SC_Height, int width_margin, int height_margin, int bias){

    this.width_margin = width_margin;
    this.height_margin = height_margin;
    this.bias = bias;
    this.SC_Width = SC_Width;
    this.SC_Height= SC_Height;

    this.up_left_X = (SC_Width/100)*width_margin;
    this.up_left_Y = (SC_Height/100)*height_margin;
    this.up_right_X = SC_Width-((SC_Width/100)*width_margin);
    this.up_right_Y = (SC_Height/100)*height_margin;
    this.dwn_left_X = (SC_Width/100)*width_margin;
    this.dwn_left_Y = SC_Height-((SC_Height/100)*height_margin)-bias;
    this.dwn_right_X = SC_Width-((SC_Width/100)*width_margin);
    this.dwn_right_Y = SC_Height-((SC_Height/100)*height_margin)-bias;
    }

  void drawMS(){

    stroke(50,50,50,50);
    noFill();
    beginShape();
    vertex(up_left_X,up_left_Y);
    vertex(up_right_X,up_right_Y);
    vertex(dwn_right_X,dwn_right_Y);
    vertex(dwn_left_X,dwn_left_Y);
    vertex(up_left_X,up_left_Y);
    endShape();
    }
}

  void makedays(){
    FC.setTRK_points();
    FC.getTRK_points();
    FC.setDateChangeList();
    FC.getDateChangeList();
    FC.setDays(FC.TRK_points, FC.DateChangeList, FC.Daycount);
    FC.getDays();
    FC.getDaycount();
  }

class pointFix{

  int date;
  int time;
  float daysecs;
  int east;
```

```
    int alt;
    int north;

    pointFix(int date, int time, int east, int alt, int north){

        this.date = date;
        this.time = time;
        this.east = east;
        this.alt = alt;
        this.north = north;
        }

    void pointFix(){
        stroke(50,50,80,50);
        noFill();

        ellipse(this.east, this.north, 5, 5);

        fill(157,12,7);
        text(this.time, this.east, this.north);
        }
}
```

Sticks and Stones:

```
//Object oriented version 2
// MapScreen used for setup only

Loader L1;
String filename = "TASNAMES_2.csv";
int i = 0;
int offy = 10;
MapScreen MS = new MapScreen(5,1440,900,3,3,10);

void setup(){
  size(1440,900);
  background(0,1);
  stroke(255);
  frameRate(17);
  smooth();
  noCursor();

  PFont fontA = loadFont("ArialMT-48.vlw");
  textFont(fontA, 15);

  L1 = new Loader(filename);
  L1.setPlaces();
  L1.getPlaces();
  L1.setBounds();
  L1.getBounds();
  println(L1.bounds);

  println(L1.places[0].name);
}

void draw(){

  fill(0,1);
  rect(-1,-1,width+1,height+1);
  MS.drawMS();

  //L1.update();

  //location on map
  //fill(212,123,27);
  //text(L1.places[i].name, L1.places[i].easting, L1.places[i] northing);

    //feature
    fill(157,12,7);
    text(L1.places[i].type1, 0, offy);
    //feature type
    fill(155,155,155);
    text(L1.places[i].type2, 80, offy);
    //feature name
    fill(10,52,123);
    text(L1.places[i].name,200, offy);

    // Go to the next line for the next run through draw()
    i = i + 1;
    if (i == L1.places.length){
      i = 0;
    }

    if(offy < height){
     offy = offy + 10;
```

```
    }else{
      offy = 10;
    }
}
//Loads data in file "filename"
//getBounds determines min and max values of data for scaling to screen

class Loader{

  String filename;
  int x;
  int y;
  String f;
  String f1;
  String f2;
  String[] lines;
  String[] pieces;
  PLACE[] places;
  int[] bounds;
  int[]Xs;
  int[]Ys;

  Loader(String filename){

    this.filename = filename;
    this.x = x;
    this.y = y;
    this.f = f;
    this.f1 = f1;
    this.f2 = f2;
    this.lines = lines;
    this.pieces = pieces;
    this.places = places;
    this.Xs = Xs;
    this.Ys = Ys;
    this.bounds = bounds;
  }
  void update(){
    //println(
  }

  void setBounds(){

    int[]Xs = new int[this.lines.length];
    int[]Ys = new int[this.lines.length];

    this.lines = loadStrings(this.filename);

    for (int i=0; i < this.lines.length; i++){
        this.pieces = split(this.lines[i], ',');
        Xs[i] = int (pieces[3]);
        Ys[i] = int (pieces[4]);
    }
    int minX = min(Xs);
    int maxX = max(Xs);
    int minY = min(Ys);
    int maxY = max(Ys);
  }
 int[] getBounds(){
    return this.bounds;
  }

  void setPlaces(){

    this.lines = loadStrings(this.filename);
    this.places = new PLACE[this.lines.length];
```

```
    for (int i=0; i < this.lines.length; i++){
        this.pieces = split(this.lines[i], ',');
        //println(this.lines[i]);

        this.x = int(pieces[3]);
        this.y = int(pieces[4]);
        this.f = (pieces[0]);
        this.f1 = (pieces[1]);
        this.f2 = (pieces[2]);

        this.places[i] = new PLACE(x,y,f,f1,f2);
    }
  }

  PLACE[] getPlaces(){
    return this.places;
  }


}
//Constructs frame for map rendering within SCREEN WIDTH + HEIGHT
//Can be visible or only use to calculate placement of each element

//**Constructor Variables**
//int SC_Width = full screen width in pixels
//int SC_Height = full screen height in pixels
//int width_margin =   % of screen to reserve as border
//int height_margin = % of screen to reserve as border
//int bias = % added to bottom border

class MapScreen{
  //SC screen variables, etc set when called
  //
  int border_stroke;
  int SC_Width, SC_Height;
  int up_left_X, up_right_X, dwn_left_X, dwn_right_X;
  int up_left_Y, up_right_Y, dwn_left_Y, dwn_right_Y;
  int width_margin;
  int height_margin;
  int bias;

  MapScreen(int border_stroke, int SC_Width, int SC_Height, int width_margin, int height_margin, int bias){

    this.border_stroke = border_stroke;
    this.width_margin = width_margin;
    this.height_margin = height_margin;
    this.bias = bias;
    this.SC_Width = SC_Width;
    this.SC_Height= SC_Height;

    this.up_left_X = (SC_Width/100)*width_margin;
    this.up_left_Y = (SC_Height/100)*height_margin;
    this.up_right_X = SC_Width-((SC_Width/100)*width_margin);
    this.up_right_Y = (SC_Height/100)*height_margin;
    this.dwn_left_X = (SC_Width/100)*width_margin;
    this.dwn_left_Y = SC_Height-((SC_Height/100)*height_margin)-bias;
    this.dwn_right_X = SC_Width-((SC_Width/100)*width_margin);
    this.dwn_right_Y = SC_Height-((SC_Height/100)*height_margin)-bias;
    }

  void drawMS(){

    stroke(border_stroke);
    noFill();
    beginShape();
```

```
        vertex(up_left_X,up_left_Y);
        vertex(up_right_X,up_right_Y);
        vertex(dwn_right_X,dwn_right_Y);
        vertex(dwn_left_X,dwn_left_Y);
        vertex(up_left_X,up_left_Y);
        endShape();
        }
}
class PLACE{

   String name;
   String type1;
   String type2;
   int easting;
   int northing;

   PLACE(int x, int y, String f, String f1, String f2){
      easting = x;
      northing = y;
      name = f;
      type1 = f1;
      type2 = f2;
   }
}
```

Drowning by Numbers:

Written with Processing 135.

```
//Martin Walch 2008
//Drowning by Numbers
//set timeLimit
//background images cycled after 180 secs (180000 millisecs) each

static public void main(String args[]) {
  PApplet.main(new String[] { "--present", "Drowning_by_Numbers_PhD" });
}
ImageChanger IC1;
PImage   img ;
PImage [] pix = new PImage[7];

String[] lines;

int index = 0;
int firsttime = 0;
int newtime = 0;
int nexttime = 0;
int timeLimit = 180000;

void setup(){
  IC1 = new ImageChanger(0);

  pix[0] = loadImage("LKW_HCC_ArtPrize - 04.jpg");
  pix[1] = loadImage("LKW_HCC_ArtPrize - 05.jpg");
  pix[2] = loadImage("LKW_HCC_ArtPrize - 14.jpg");
  pix[3] = loadImage("LKW_HCC_ArtPrize - 16.jpg");
  pix[4] = loadImage("LKW_HCC_ArtPrize - 20.jpg");
  pix[5] = loadImage("LKW_HCC_ArtPrize - 31.jpg");
  pix[6] = loadImage("LKW_HCC_ArtPrize - 36.jpg");

  size(1280, 768);
  noStroke();
  background(0);
  frameRate(150);
  smooth();
  noCursor();
  lines = loadStrings("LKW_UTM_XZ");
  PFont fontA = loadFont("ArialMT-48.vlw");
  textFont(fontA, 10);
}

void draw(){

  if (index < lines.length) {
    String[] pieces = split(lines[index], ',');

    String east = (pieces[1]);
    String north = (pieces[2]);
    int x = int(random(img.width));
    int y = int(random(img.height));
    color pixel = img.get(x, y);
    fill(pixel, 126);
    text(north,x-15, y+5);
    text(east, x-15, y-5);
    index = index + 1;
  }
```

```
  if(index==lines.length){
    index = 0;
  }
  if(millis()>nexttime){
    IC1.update();
    println(millis());
  }
}
class ImageChanger{
  int x;
  ImageChanger(int imagenum){
    x = imagenum;
    img = pix[x];
  }
  void update(){
    background(0);
    newtime = millis();
    nexttime = newtime + timeLimit;
    x = x + 1;
    if (x > 6){
      x = 0;
    }
    img = pix[x];
  }
}
```

Appendix D: Metric Space:

The concept of "length" (as well as related ones, like "area" or "volume") is what is called a metric concept, so the spaces of Euclidean Geometry are known as metric spaces. There exist other spaces however, where fixed distances cannot define proximities since distances do not remain fixed. A topological space, for example, may be stretched without the neighbourhood which defines it changing in nature. To cope with such exotic spaces, mathematicians have devised ways of defining the property of "being nearby" in a way that does not suppose any metric concept, but only nonmetric concepts like "infinitesimal closeness". However one characterizes it, the distinction between metric and nonmetric spaces is fundamental in a Deleuzian ontology. Moreover, and this is the crucial point, there are well defined technical ways of linking metric and nonmetric spaces in such a way that the former become the product of the progressive differentiation of the latter. To explain how such a symmetry breaking cascade would work in this case, I will need to take a brief detour through the history of nineteenth-century geometry.

Although in that century most physicists and mathematicians thought the structure of physical space was captured by Euclidean geometry, many other geometries, with very different properties, had come into existence. Some of them (such as the non-Euclidean geometry developed by Lobatchevsky) shared with the geometry of Euclid the property of being metric. There were, however, other geometries where metric concepts were not in fact fundamental. The differential geometry of Gauss and Riemann which gave us the concept of the manifold is one example, but there were several others (projective geometry, affine geometry, topology). Moreover, and despite the fact that Euclidean geometry reigned supreme, some mathematicians realized that its basic concepts could in fact be derived from the nonmetric concepts which formed the foundation of the newcomers. In particular, another influential nineteenth-century mathematician, Felix Klein, realized that all the geometries known to him could be categorized by their invariant under groups of transformations, and that the different groups were embedded one into the other. In modern terminology this is equivalent to saying that the different geometries were related to each other by relations of broken symmetry.

In Euclidean geometry, for example, lengths, angles and shapes remain unaltered by a group containing rotations, translations and reflections. This is called the group of rigid transformations. These metric properties, however, do not remain invariant under the groups of transformations characterizing other geometries. There is one geometry, called affine geometry, which adds to the group characterizing Euclidean geometry new transformations, called linear transformations, under which properties like the parallelism

or the straightness of lines remain invariant, but not their lengths. Then there is projective geometry, which adds to rigid and linear transformations those of projection, corresponding to shining light on a piece of film, and section, the equivalent of intercepting those light rays on a screen.

If we picture these three geometries as forming the levels of a hierarchy (projective - affine - Euclidean) it is easy to see that the transformation group of each level includes the transformations of the level below it and adds new ones. In other words, each level posses more symmetry than the level below it. This suggests that, as we move down the hierarchy, a symmetry breaking cascade should produce progressively more differentiated geometric spaces, and, vice versa, that as we move up we should lose differentiation. For example, as we ascend from Euclidean geometry more and more figures become equivalent to one another, forming a lesser number of distinct classes. Thus, while in Euclidean geometry two triangles are equivalent only if their sides have the same length, in affine geometry all triangles are the same (regardless of lengths).[86]

86 p22, DeLanda, Manuel *Intensive Science and Virtual Philosophy.*

Appendix E: Bibliography:

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Appendix F: List of Illustrations:

All images are by the author, Martin Walch, unless otherwise stated.

Background to the Project:

Figure 1. *Prince Lyell Workshop Tunnel,* 1998. Single image scanned from stereoscopic pair. Shot on 35mm Fuji Velvia slide film.

Figure 2. The Optical system of the eye, from Descartes's *Discours de la methode plus la dioptrique, les meteors et la geometrie,* Leiden, 1637. Kemp, Martin. *The Science of Art.* New Haven and London: Yale University Press, 1990.p.130.

Chapter 1:

Figure 3. Plan views of Newgrange showing solar alignment. Scanned from Stout, Geraldine. *Newgrange and the Bend of the Boyne.* Cork University Press, 2002.p.42.

Figure 4. Survey of a sea island, from *The Sea Island Mathematical Encyclopaedia.* Liu Hui. China (circa 300). Wikipedia, *"The Sea Island Mathematical Encyclopaedia".* http://en.wikipedia.org/wiki/The_Sea_Island_Mathematical_Manual. Accessed January 2009.

Figure 5. The *radio astronomico* used to measure the width of a façade from Germa's Frisius's *De Radio astronomico...,* Antwerp, 1545. Kemp, Martin. *The Science of Art.* New Haven and London: Yale University Press, 1990.p.169

Figure 6. Cross-staff device for perspectival projection, from Cigoli's 'Prospettiva practica', (c.1600). Kemp, Martin. *The Science of Art.* New Haven and London: Yale University Press, 1990.p.178.

Figure 7. A draughtsman using a net to draw a nude in foreshortening, and Draughtsman using Jacob de Keyser's perspective device. (1538) Woodcuts from Durer's *Underweysung der Messung,* 2nd edn., Nuremberg. Kemp, Martin. *The Science of Art.* New Haven and London: Yale University Press, 1990.p171-2.

Figure 8. Raytracing of GPS signal in atmospheric analysis. From X. Zou,1 F. Vandenberghe,2 B. Wang,1,3 M. E. Gorbunov,4 Y.-H. Kuo,2 S. Sokolovskiy,4 J. C. Chang,5 J. G. Sela,6 and R. A. Anthes7. *A ray-tracing operator and its adjoint for the use of GPS/MET refraction angle*

measurements. Journal Of Geophysical Research, VOL. 104, No. D18, Pages 22,301–22,318, September 27, 1999.

Figure 9. Topological map of electrical transmission for the Derwent hydro-electric development, circa 1920, from Waddamana 'A' Power Station, central Tasmania. 2005.

Figure 10. Raytracing a map from an oblique aerial photograph. Smith, H.T.U. *Aerial Photographs And Their Applications.* New York: D. Appleton-Century Company Inc, 1943.p.182.

Chapter 2:

Figure 11. *Pipra M&F. Spotted Manikins (Pardalotes),* Hunter Island and the Derwent from Hospital Hill. G.P.Harris,1806 water colour. Original in Mitchell Library, Sydney, NSW.

Figure 12. *Explanation of a View of Hobart Town, Exhibiting at the Panorama, Strand.* Printed guide for Robert Burford's Panorama, London, 1831. Allport Library of Museum and Fine Arts.

Figure 13. *Panoramic sketch from the summit of St. Valentine's Peak, Feb. 14 1827.* Henry Hellyer (1790-1832). National Library of Australia. http://nla.gov.au/nla.map-f214.

Figure 14. *Tasmania: A Slow Journey 1979 Four works: Hand Outlines, Four Rocks; Rain, leeches, mud; Parrot, wallaby, wombat; Looking back from the seventh day, two crows.* (1979). Hamish Fulton. Gelatin silver photographic prints with lettering. Total size of each work (includes frame) 105.5 x 87.0 x 2.5 cm. Collection: National Gallery of Australia.

Figure 15. John Wolsleley in conversation with Peter Hylands. Still image from *The John Wolseley Australian Art Resources Pack* - Creative Cowboy Films - 2006.

Figure 16. Detail from *Military Operations Against the Aboriginal Inhabitants of Van diemen's Land: No 9, Field Plan of Movements of the Military.* (1831). W.L. Crowther Library, State Library of Tasmania.

Figure 17. *Map of Anmatyerre Country,* (1988). Clifford Possum Tjapaltjarri. Pencil on paper, 56.0 x 76.0 cm: Private Collection. Scanned from Johnson, Vivien. *Clifford Possum Tjapaltjarri.* Adelaide: Art Gallery of South Australia, 2004.

Figure 18. *Mt Denison Country* (1978). Clifford Possum Tjapaltjarri. Synthetic polymer paint on linen, 200.0 x 170.0 cm, The Kelton Foundation. Scanned from Johnson, Vivien. *Clifford Possum Tjapaltjarri.* Adelaide: Art Gallery of South Australia, 2004.

Figure 19. Postcard image from *Driving Black Home.* (2000). Julie Gough. Image copied from http://homes.jcu.edu.au/~jc156215/DrivingBlackHome.htm. Accessed January 2009.

Figure 20. Section 10 of *TERRA SPIRITUS...with a darker shade of pale.* (1993–1998). Bea Maddock. Incised drawings, hand-ground ochre pastels, blind letterpress, on fifty-one sheets of paper. Private collection. http://nga.gov.au/Landscapes/Pano2.htm. Accessed January 2009.

Figure 21. Map of sections drawn for *TERRA SPIRITUS...with a darker shade of pale.* (1993–1998). Bea Maddock. Incised drawings, hand-ground ochre pastels, blind letterpress, on fifty-one sheets of paper. Private collection. http://nga.gov.au/Landscapes/Pano2.htm. Accessed January 2009.

Figure 22. *George W. Bush, Harken Energy, and Jackson Stephens*, c. 1979-90 (5th Version), 1999, Mark Lombardi, graphite on paper, 61.0 x 122.0 cm. Scanned from Emma Dexter., ed. *Vitamin D: New Perspectives in Drawing*. New York: Phaidon, 2006.p.177.

Figure 23. *Study for Intersection*, HD video, 2008, Daniel Crooks. http://www.dlab.com.au/. Accessed January 2009.

Chapter3:

Figure 24 and 25. Camera lucida versions 1 and 2 in use.

Figure 26. Still frames from *OverDrawn.* Digital video animation. 2004-05.

Figure 27. Still frame from *Origin: 2004 - 2008 (constant change).* Digital video animation. 2004-08.

Figure 28. A blaze in a King Billy Pine left by the original 1910 J.E.Philp track making party. Barron Pass, Frenchmans Cap. 2005.

Figure 29. 3D modelling of GPS track (light blue), against landform model of Frenchmans Cap region. 2006.

Figure 30. Detail from comparative mapping of Philp (1910 - green line), versus Walch (2005 - red line).

Figure 31. GPS track of my movements for September 16, 2007.

Figure 32 and 33. Stills frame from *Range: 2006 (strange attractor).* Open source computer generated digital video stream generated with *Proccessing 135.*

Figure 34. GPS tracking of Lyons documentation path. March 2006.

Figure 35. Pillar Street in Lyons, Canberra March 2006, and Cape Pillar and Tasman Island. September 2008.

Figure 36. Still frame from *Sticks and Stones.* (2008) Open source computer generated digital video stream generated with *Proccessing 135.*

Figure 37. Bridge and tool. Lake King William. June 2007.

Figure 38. Still from *Drowning by Numbers.*

Figure 39. Lake King William, 10 metres below full supply level. March 2008.

Figure 40. Stone tool, Navarre River, December 2007.

Figure 41. Early morning mist. Navarre River, March 2008.

Figure 42. *SOURCE.* Three channel HD 1080 video. 2008.

Appendix G: Curriculum Vitae:

MARTIN WALCH

www.martinwalch.com

EDUCATION

2004-08	PhD studies, Tas School of Art, University of Tasmania, Hobart.
1994-98	Masters of Fine Art by Research, Tas School of Art, University of Tasmania, Hobart. Digital Stereoscopic Photography and Landscape, 'An Archaeology of Space in Representation'.
1993	Bachelor of Fine Arts, Honours, Photography Major, Tas School of Art.
1990-92	Bachelor of Fine Arts, Photography Major, Tas School of Art.
1984-86	Certificate of Photography, Hobart Technical College

EMPLOYMENT

2002-2008	Course Coordinator and Lecturer – Natural Environment and Wilderness Studies, Tas School of Art.
1998-2008	Self employed artist, writer, consultant and guide, working across a range of activities, (including commissions, residencies, art for public buildings projects, community arts projects), in a wide range of media (including animation, stereo-photography, digital imaging and drawing)
1996-1997	Freelance photographic work and part time study.
1995	Computing Technician Digital Imaging Studio, Tas School of Art. Part time Lecturer in Digital Imaging, Tas School of Art.
1990-1993	Freelance photographic work and full time study.
1984-1989	Professional Photographic Technician, Hobart.
1982-1983	Laboratory Technician, Quality Control – Tasmania.

SELECTED EXHIBITIONS

2008 My Favourite Australian National Portrait Gallery, Canberra. An exhibition of commissioned video portraits. SODA_JERK, Steve Thomas. Hugh Atkin, Martin Walch and Raef Sawford, TV Moore, Pat Fiske, Bruce Petty, Merilyn Fairskye, Natasha Gadd and Rhys Graham, Peter Kennedy, Sasha Grbich, Robert Nugent, Randall Wood, Shannon Owen, Andrew Taylor, Kimberly West, Sophie Hyde and Bryan Mason, Lynette Wallworth, Erin Coates, Craig Walsh.

Repetitions Plimsoll Gallery, School of Art, University of Tasmania. Ciara Moore, Leigh Hobba, Daniel von Sturmer, Martin Walch. An exhibition of recent video works. Curated by Seán Kelly & Paul Zika.

2006 Remote Plimsoll Gallery, School of Art, University of Tasmania. An exhibition of artists working with locative media. Curated by Vince Dziekan. Martin Walch, Nancy Mauro-Flude, Derek Hart, Pete Gomes, Susan Collins.

2005 The Place Where Three Dreams Cross Tasmania, WA and Queensland. An exhibition curated by Bryony Nainby for Contemporary Art Services Tasmania. Susanna Castleden, Mark Datodi, Chantale Delrue, Dulcie Greeno, Bevan Honey, Irrunytju Community, David Stephenson, Holly Story, Martin Walch.

Isolation / Solitude Long Gallery, Hobart. Tasmanian Wilderness Residencies Exhibition. Anthony Curtis, Ben Booth, Christl Berg, Denise Ava Robinson, Harry Atkinson, Jenny Burnett, John Lendis, Julie Gough, Kim Kerze, Maria McDermott, Martin Walch, Michael Schlitz, Peter Gouldthorpe, Philip Wolfhagen, Ron Nagorka, Telford Rigg, Tim Burns, Tim Pugh, Veronica Steane.

2004 ARTV-NOW 2004 Australian Centre for the Moving Image Federation Square, Melbourne. An exhibition of film and animation commissioned by ACMI and SBS Independent. Curated by Clare Stewart, ACMI. Vernon Ah Kee, Daniel Crooks, Cherine Fahd, Simryn Gill, Shaun Gladwell, Helen Grace, Guo Jian, Janet Merewether, Scott Redford, Julie Rrap, Daniel von Sturmer, Arlene Texta Queen, Hossein Valamanesh, Martin Walch, Craig Walsh, Guan Wei.

2003 FotoFestival Naarden Naarden, Nederlands. An international photographic festival including selected works by Australian photographers curated by Alisdair Foster, Director ACP. Joachim Froese, Max Doyle, Deborah Paauwe, Martin Walch, Anne Zahalka, Glenn Sloggett.

Photographica Australis Bangkok, Singapore, Bangladesh. Asia Link Tour

2002 2002 Adelaide Biennial of Australian Art Art Gallery of South Australia. An exhibition of selected contemporary Australian Visual Artists, curated by Linda Cooper for the Art Gallery of South Australia.Oron Catts and Ionat Zurr, Justine Cooper, Rebecca Cummins, Adam Donovan, Fiona Hall, Jason Hampton, Nigel Helyer, Joyce Hinterding, Jon McCormack, Mangkaja artists, Patricia Piccinini, Lynne Sanderson, Mari Velonaki, and Martin Walch.

Photographica Australis ARCO 2002 International Art Fair, Madrid. An exhibition of works by selected Australian photographers, curated for the Australia Council by Alisdair Foster, Director ACP. Pat Brassington, Brown & Green, Brenda L. Croft, Max Doyle, Farrel & Parkin, Anne Ferran, Joachim Froese, Philip George, Deborah Paauwe, Polixeni Papapetrou, Scott Redford, Michael Riley, Glenn Sloggett, Darren Sylvester, Martin Walch and Anne Zahalka.

Proto-type Experimenta BlackBox, Victorian Arts Centre. An exhibition of selected interactive multi-media, curated by Liz Hughes for Experimenta Media Arts Inc 2002, as part of the Interact 2002 Asia Pacific Multimedia Festival. Stephen Barrass, Richard Brown, Jane Crappsley, Chris Henschke, Isobel Knowles & Haima Marriott, Christopher Mether, Ben Morieson, Mott Raszewski & Sosnin, Bruce Mowson, Simon Norton, Martin Walch, Amy Youngs, Elizabeth Vander Zaag.

2001 Seeing through Landscape Australian Centre for Photography, NSW. An exhibition of selected contemporary Australian artists working with landscape, curated by Alisdair Foster. for the Australian Centre for Photography. Cath Bowdler, Jason Davidson Hampton, Phillip George, Ian North, Patricia Piccinini, Juha Tolonen, Martin Walch, Gary Weber, Pamela Lofts, and Heather Winter.

Between Phenomena Plimsoll Gallery, School of Art, University of Tasmania. An exhibition of panoramic imagery curated by Raymond Arnold for the Ten Days on The Island.

2000 Ingress RMIT Access Gallery, Melbourne. Simon Cuthbert, Michael Schlitz and Martin Walch – A three man exhibition of photography, printmaking and digital imaging linked by a concern with reworking historic sources.

Exploding the Myth Hunter Street Gallery, Queenstown, Western Tasmania. A solo touring exhibition of stereoscopic imagery from the Mt Lyell Mine residency. Regional tour of Tasmania, South Australia and Victoria by Tas Regional Arts.

1999 SOFA New York & Chicago. An exhibition of work from 11 selected Tasmanian artists working in a variety of media. Organised by Tourism Tasmania, and E.A. Joyce-Despard Gallery.

1998 Living In / Living Out The Royal Derwent Hospital, New Norfolk, Tasmania. A collaborative exhibition of sound, text and stereo images, drawn from the experience of work at the Royal Derwent Mental Hospital, created by Poonkhin Khut, Miranda Morris and Martin Walch and installed in the disused maximum security Ward C of Willow Court. Curated by John McQueenie, Arts Project Officer for the Tasmanian Trades and Labour Council.

GRANTS, AWARDS and COMMISSIONS

2008 Winner of 2008 City of Hobart Art Prize.
Commissioned by the National Portrait Gallery and ABC Television, to produce a video portrait for the 'My Favourite Australian' Project.

2004 Australian Postgraduate Award Scholarship, PhD, University of Tasmania.

2003 City of Hobart Art Prize – Winner of the Moorilla Prize for a Tasmanian Artist.
Commissioned to create a suite of 10 stereoscopic images and stereo-viewers for the IXL Henry Jones Art Hotel, Hunter Street, Hobart.

2001-2002 Art in Public Buildings Scheme. Design of a climbing wall with integrated artwork, Claremont College Gymnasium. Architects DesignInc.
Commissioned by Tas Govt to develop Interpretation Master Plan and design and install custom viewing devices at Coal Mines Historic Site, Tasman Peninsular.

2001 Commissioned by Tas Heritage Council as photographer, west coast location guide, and Conference speaker, for Cultural Landscapes Report.

2000 Arts Tasmania Grant to undertake a portrait project at Mt Lyell.

1999 Australia Council New Media Development Grant to enable the making of a multi-media artwork, focusing on mining at Mt Lyell on Tasmanias west coast.

1998 Selected by Arts Tasmania to attend Australian Film Commission's Multimedia Conference "Being Connected", at Royal Melbourne Institute of Technology.
Began self established Artist in Residence with Copper Mines of Tasmania, Queenstown.

1997 Arts Tasmania Grant to undertake stereo-photographic documentation of Mt Lyell and the Mt Lyell Mines, West Coast Tasmania.

	Co- Winner of Siglo Magazine's National Collaborations Prize for Writers and Photographers with writer Lisa Morissett.
1995	Selected by Arts Tasmania to attend Design Winter School at Royal Melbourne Institute of Technology. Information Technologies and their impact upon Ecology.
1994	Selected by Arts Tasmania to attend Australian Network for Art and Technology Summer School in Computer Aided Art and Design, Perth, West Australia.

PUBLICATIONS & PRESENTATIONS

2007	Essay	p214, Visual Communication, vol 6, number 2.
2005	Architecture Australia	p79, Issue #6, Vol 94, Nov/Dec 2005
2004	Refereed Paper	Imaging Nature Conference, Cradle Mountain, Tas
2003	Refereed Paper	ACUADS Conference, Hobart.
	Art Forum	Royal Melbourne Institute of Technology
	Art Forum	Deakin University
	Interview	ABC Radio
	Artist Profile	ABC Net www.abc.net.au
2002	Invited speaker	New Visions Forum, Interact 2002 Asia Pacific Multimedia.
	Artlink	p36 & 37, Vol 22 #2, June.
	Invited speaker	ConVerge Symposium, AGSA + Adelaide Festival 2002.
2002	Adelaide Biennial	ConVerge, where Art + Science meet. ISBN 0-7308-3013-6
	Photographica Australis	ISBN 0-9093-3915-5
	Art Forum	School of Art, Uni of Tas.
1999	Art Forum	College Of Fine Art, Sydney.
	PhotoFile	p25 – 28, Issue #57 Oct. ISSN 0811-0859
	40 Degrees South	p59, 60 & 62, Issue #13 Winter. ISSN 1325-1058-13
	Siglo Journal for the Arts	p20, 32 & 33, Issue 11. ISSN 1320-8411-11
1998	40 Degrees South	p4 & 5, Issue #8 Autumn. ISSN 1325-1058-08
	Siglo Journal for the Arts	p30 – 34, Issue 10. ISSN 1320-8411-10

COLLECTIONS

2008	National Portrait Gallery of Australia. ABC Television. Hobart City Council.
2004	Australian Centre for the Moving Image. Art Gallery of South Australia. Moorilla Collection Tasmania. Tasmanian Museum and Art Gallery.
1992-	Private Collections.

COMMITTEE INVOLVEMENT

2003-05	Member of the Visual Arts and Crafts Board of the Australia Council for the Arts.
2000-03	Co-founder and Board Member of KickStartArts; Tasmanian Arts Development Organisation with a Community Cultural Development focus.
1997-99	Member of Salamanca Arts Centre Arts Sub-Committee.
1994-96	Member of Visual Art, Craft and Design Panel, Arts Tasmania.
	Member of Youth Sub-Committee, Arts Tasmania.
1992-94	Member of Plimsoll Gallery Committee, Tasmanian School of Art, Hobart.