Orthogonal Orthodoxy

Exegesis presented for PhD

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Abstract

In this investigation, drawing and sculpture will occupy (highly mobile and permeable) positions as respectively; ideal, abstract, perfect system in two dimensions, and actual, tenuous, compromised and contingent reality in three. The systems explored here will have their basis in the diagram, a mathematical system for the delineation, quantification and occupation of physical space. The translation of this system into the compromised, imperfect real world will be the main strategy used to investigate these drawing technologies, a three dimensional investigation of two dimensional methods and media. How can a sculptural practice, utilising drawing media as material and geometric formalism as methodology, undertake an investigation of systems (specifically abstract spatial systems, but with wider ramifications too), manipulating those systems so that the audience may experience a bodily affect of dread at the prospect of imminent collapse? I aim to confront the viewer with static object that are felt, understood immediately, viscerally, as being in a process that will systematically lead to its own decay, it is untenable. The research will demonstrate new knowledge in the discipline of sculpture, specifically the effect of gravity as an activating force, producing kineticism in static objects and the affect gravity can induce in the audience when adroitly manipulated as a physical sculptural force.

Introduction

> *'A 'sculpture' that physically reacts to its environments and/or affects its surroundings is no longer to be regarded as an object. The range of outside factors influencing it, as well as its own radius of action reach beyond the space it materially occupies. It thus merges with the environment in a relationship that is better understood as a 'system' of interdependent processes (…) a system is not imagined; it is real.' Germano Celant, 1969,(1*)

This thesis asks: 'How can sculpture offer new insights into the territory of what appear to be contingent systems and subsequently trigger visceral responses to their apparently inevitable decay? This research project investigates and utilises interlinked drawing based systems for the delineation, codification and navigation of space; the diagram, trigonometry and the map; employing a number of sculptural objects constructed from 0.5mm graphite mechanical pencil leads. These components are joined together to form large, geometric structures that push into space. Both of these works are investigations of the diagrammatic system's ability to occupy real, three-dimensional space, to exist in a world that it usually only influences from its privileged haven in two dimensions. *survey* is an irregular, techno-organic assemblage based on the trigonomic system. While occupying space the system, in order to accommodate gravity, necessarily reproduces and references the land forms the trigonometric system has for so long modelled and made malleable. The second work *span* is similar to *survey*, though it is more regular and ordered. Where *survey* is complex and convoluted, *span* is sparse and simple, a tentative bridging of space, a fragile, three dimensional diagram.

In this thesis I examine many facets, from the micro in the diagram, to the macro world of the map, of a huge geometric edifice designed to enable human manipulation of space. A two dimensional system, traditionally confined to paper but increasingly inhabiting electronic information systems, that enables space to be be modelled so effectively that real world actions are facilitated. Trigonometry and cartography are perhaps the most obvious examples of this system, but this study will take a wider view having reference to examples like perspective theory and the diagrams of mathematics and logic. At its simplest, the focus is mathematically based drawings that influence space. This diagrammatic orthodoxy is a mathematic drawing system that has built slowly from small foundations. Despite the overall systems marked success, fundamental assumptions sealed in at its inception later became major discrepancies as the system evolved and increased in complexity and scope. A system that, I would argue, while once an essential part of any western education, has now largely been consigned to the electronic information structures that surround us, its mathematical workings concealed by user-friendly interfaces.

If this study of age-old spatial systems and its application to contemporary sculpture seems obscure, it is only because the system has attained such ubiquity that its dominance is easily overlooked. The artist/ critic Peter Halley in his essay "the Crisis of Geometry" describes a *"modern obsession with geometry"*, that he argues is: *"an obsession that any person living in the industrial world can confirm by simply stepping outside and looking around"(2)*. Like Halley, I am interested in taking a critical approach to geometric spatial systems. This investigation will pay special attention to the uncertainty that has marked the ascent of this system, especially the constant tension between the ideal model of space the system represents and the often inconvenient realities of the world the system purports to replicate. This is a tension that has perhaps been aggravated by the mystical and divine associations that attended its early development. The idealisation of the trigonomic system as insight into the methodology of some mathematically inclined god requires further and ongoing questioning. While the diagrammatic system may have lost its claims to both the scientific purity that modernity perceived in it, and the mystical insight that the ancients attributed it, the utility of the system remains. Although Euclid's *Elements* (written approx 300 BC) may be an increasingly arcane text, the spatial rules it elucidates are as crucial to contemporary information technologies as they were to navigators in the age of exploration.

This is a sculptural investigation, contemporary sculpture being the umbrella term for an increasingly diverse genre, within which these built drawings are located. Writing an introduction to the book "A Sculpture Reader", Karen Wilkin describes the current range of work that can be described as sculpture:

> *"…with the advent of what I suppose must be called postmodernism (…) such once-taken-for-granted conditions as coherence, objecthood, and material and material integrity appeared unessential. Why should a sculpture have to be hard? Or singular? Or tangible in any way? Or even visible? Artists have announced the idea of sculpture as performance, as the relic of an action, as process, as threat, as accumulation, as (perhaps unvisited) place, as light, as idea." (3)*

Despite resonating with many of the questions Wilkin asks of what sculpture can be, a key distinction will be made here between drawing; a two dimensional model that can formulate and influence space, and sculpture; where the work inhabits three dimensional space and is forced to deal with the natural forces that attend that real space. Ultimately the resolution of the work presented here depends upon three factors; material, scale and gravity, all readily recognisable as the traditional concerns and territory of sculpture.

Sculpture is the logical mode to undertake this investigation. Yet it will be coupled, and at times opposed to, an interwoven drawing practice. In this investigation, drawing and sculpture will occupy (highly mobile and permeable) positions as respectively; ideal, abstract, perfect system in two dimensions, and actual, tenuous, compromised and contingent reality in three. The systems explored here have their basis in the diagram, a mathematical system for the idealised mapping and navigation of space. The diagram is an entirely abstract system that especially in western culture since the early modern era has provided a ruthlessly efficient system for the delineation, quantification and accumulation of the physical space we all inhabit. The translation of this system into the compromised, imperfect real world will be the main strategy used to investigate these drawing technologies, a three dimensional investigation of two dimensional methods and media.

This thesis investigates how specific mathematical drawing systems can function to provoke and transform conventional understandings of sculptural artwork. The research question therefore is; how can a sculptural practice, utilising drawing media as material and geometric formalism as methodology, undertake an investigation of the two-dimensional drawing systems ability to inhabit real space? How can the inherent uncertainty of those systems be manipulated so that the audience may experience a bodily affect of the prospect of imminent collapse? A fundamental aspiration of the sculptural work is to produce a visceral bodily reaction in the viewer, based around a sense of uncertainty, fragility and precariousness. The work seeks to produce an intimation of imminent collapse. The desired outcome of this investigation is to develop a vast, intricate system apparently pushed beyond its own structural integrity or, belatedly suffering the effects of poorly chosen materials, foundations or methods. I aim to confront the viewer with static objects that are felt and understood immediately, viscerally, as being in a process that will systematically lead to its own decay. The research will demonstrate new knowledge in the discipline of sculpture, specifically the effect of gravity as an activating force. The two artworks produce a heightened kineticism in static forms highlighting the affect gravity can induce in the audience when harnessed and adroitly manipulated by a physical sculptural force.

The rendering of this effect/affect and its resolution are discussed with reference to three main factors; media, scale and gravity. These concerns are all interlinked and their relationships and distinctions blurred, yet each is examined in terms of the development of the two sculptures presented and the evolution of preceding works. Each factor will be addressed with reference to the two works presented; *span* and *survey*, often incorporating earlier works into the discussion and offering comparison with selected artists and artworks from the last hundred years. Both of these works are large installations, constructed solely from mechanical pencil leads; 0.5 mm graphite rods. These are joined into geometrically complex structure that utilise the formalism of two-dimensional drawing systems to colonise space in the three dimensional real world.

Crucially the media employed to undertake this investigation- graphite, 0.5mm mechanical pencil leads- are those of drawing itself. This material is recast to occupy and operate beyond the security of their two dimensional world in three dimensions. The fragility of this material will play a key role in the intended uncertainty of the structure, while also emphasising its subjection and susceptibility to gravity. The minute dimensions of this material significantly adds to the complexity of the overall structure as it is coerced into occupying space on a large, human scale. Perhaps most importantly in its very form, a mass-produced line, this material continually brings the work back to drawing, and the uncertain power of drawing systems to affect space.

Questions of scale are central to this investigation, and to achieve the aim of activating a specific bodily experience with the sculptural forms, a careful appreciation and orientation of scale and monumentality is required. The interrelations and dynamics between scale, material, gravity and complexity will largely determine both the form of the work and indeed what forms are possible for this type of work. The small scale of the material means that any large structure constructed from them will necessarily be composed of thousands of the 0.5mm lines. This proliferation of incredibly fine lines, from any angle appearing interwoven, interlinked and overlaid, creates a visual complexity. When approached by a viewer, the work is composed of

too much detail to be comprehended as a whole. Minimal in its use of mass produced material, it is baroque in its complexity. While the work is optically complex it is a complexity built by the repetition of simple basic units and modules, not a complexity formed through sophisticated techniques or advanced materials. There is complexity in the system, but not sophistication. The visual complexity of these works is a byproduct (although not unintended) of their scale. Scale will be the mechanism through which the work's fragility is emphasised, their complexity magnified and the work's subservience to gravity activated and made palpable.

Gravity and its inescapable consequences will emerge as the key operative feature in the work, all the other factors, including scale and materiality, are, to a greater or lesser effect, determined and/or activated by gravity. However the interaction with gravity is a product of both material and scale. A less palpably fragile material would not carry such a strong reading of vulnerability to gravity. Works need to be of minimal human scale in order to address gravity in a manner the body can appreciate. Gravity is the unseen force, the affect by which the works vulnerability and uncertainty are made palpable. It functions as an omnipresent, ubiquitous force of which we are seldom consciously aware, and one which when consciously encountered, is usually in the form of vertigo, a potentially nauseating fear. Gravity, when properly engaged by the sculptural form, provides the tension, the dynamic of collapse that activates and frames the experience of the work. Gravity provides the force against which the work becomes kinetic, but it can only do this when the three factors above: material, complexity and scale have been successfully incorporated and utilised. While all three dimensional artwork will necessarily be engaged or affected by gravity, the key difference and new knowledge presented is that in these works, gravity is engaged as the agent of an implied collapse, the uncertainty of the system is physically present in the work. Gravity is the mundane reality that continually threatens to overwhelm the fragile structure, making the uncertainty of the system real, palpable. This perceived impermanence provides a form of kineticism, a temporal aspect to the work.

The declared outcome of an artistic environment that elicits a palpable and transformative physical reaction to the work will be investigated with reference to contemporary theory that falls under the umbrella term "affect", a body of cultural theory that pays special attention to these bodily interactions with objects. Theories of affect focus on intuitive, visceral, often highly personalised, and socially differentiated reactions to media and objects. Sarah Ahmed outlines in her essay "Happy Objects" that; *"To be affected by something is to evaluate that thing. Evaluations are expressed in how bodies turn toward things. To give value to things is to shape what is near us." (4)* and this is a useful reference for the outcomes of this research. I am particularly interested in how "bodies turn toward" these objects, and consideration, critique and manipulation of these affects will provide much of the rubric for assessing the success of these "things". The affect of the formal qualities of geometry and the diagram will also be examined. Regardless of any understating of trigonometry or geometry, the diagram and the map "read" as a rational, objective, and logical system, free from prejudice or superstition. What I describe as an orthogonal orthodoxy of the diagram will be unpacked with special regard to this inherent, innate (if limited) legibility, the extent to which its purported rationalism is felt.

Various aspects of the works presented and selected will be compared and contrasted with a range of twentieth century and contemporary artists and their practice. Some of American artist Tom Friedman's work will be discussed with reference to the single material sculpture, artworks made from multiples of the same

object. The material and its import will be explicated with reference to many of the artists presented here, including the important Venezuelan artist Gego. Issues of the methodology and resultant formalism of modelling systems will be presented with comparison to works by Sol LeWitt and Anthony Gormley, with particular distinctions being made between modelling form and the system by which form is modelled. Optical complexity will be addressed by discussing some work of the German collective Group Zero, especially Gunter Uecker. Recent large installation work by Tomas Saraceno will be compared with an emphasis on fragility and organic form. Fragility and ethereality will be the focus for investigating large installation work by Sarah Sze. Gravity as an activating force for inducing bodily affect is discussed in many of these comparisons but is a special area of interest in the large steel work of Richard Serra. Finally some groundbreaking work by constructivist pioneer Tatlin will be unpacked with regard to his concept of a "culture of materials". Because of the interwoven aspects of this investigation into fragility, scale and gravity, there will be significant blurring between these neat categories and often different issues will also be addressed to some degree outside its assigned position.

Works presented

> *'It has been claimed that, no matter how deeply embedded within unarticulated experience a skill may be, the knowledge it represents can be made explicit and objective by being built into machines.' Arnold Pacey, 1999(5*)

This thesis investigates how specific mathematical drawing systems can function to provoke and transform conventional understandings of sculptural artwork. Sculpture has often been closely linked with drawing and the diagrammatic systems, the necessity to first draw and plan work, while common to many art forms, is keenly felt in sculpture where not only form and aesthetics must be planned but also the interaction with physical forces such as gravity. Furthermore it could be argued that the ability to plan and predict conferred by the diagrammatic system has played a key role in western civilisation, from its role in architecture to even more abstract uses in such fields as economics and climate modelling. The examination of these systems provides the stimulus for artworks that aim to "realise" "our perceptions of the world in the forms of space and time" while simultaneously teasing out some of the inconsistencies and inadequacies of these systems.

The two art works which together serve to resolve this question, are from a continuing series of sculptures, inspired by drawing and drawing technologies, and built entirely from 0.5mm graphite mechanical pencil leads. This material immediately cements the connection with drawing, and the brittle fragility of the material will be key to producing the required affect of the work. This material also references drawing in the sparseness of line, the varying distance when the audience engages physically with the sculptural work results in complex optical effects, at a distance the lines exist on the verge of perception. The material also raises important questions of scale, to occupy enough space to operate sculpturally, (rather than as a model, on a shelf for instance), the work must be large enough for people to have to move around it in order to view its entirety. This minimum size necessitates the work be made from many thousands of tiny components.

The new knowledge resulting from this research, is the way in which the sculptural works highlight the role that natural forces, omnipresent in the world, can play in manipulating affect to achieve highly specific outcomes. The works are drawings, a diagrammatic system for influencing space. When relocated from their traditional two dimensional realm, a benign, ideal, simplified (and in the geometric source material historically even divine) environment, the works struggle to enact the same strategies and tactics in the hazardous, contingent and compromised three dimensional, real world. In this real space it is gravity that poses the chief problem for this system. Gravity is also easily understood by the audience: the ubiquitous mundane force is a constant that subtly, but implacably influences and informs our entire lives. It will be argued that the interaction with gravity is key to the perception of the work's uncertainty. And through this process the viewer can understand viscerally the premonition of structural failure, the work's implied collapse,

This amplification is accomplished through both the manipulation of scale and the physical positioning of the work. A resolution of the *survey* works is accomplished largely through the installation of the work

directly on to the wall, cantilevered out into space. Situated so that gravity works perpendicularly against the work, this precarious intrusion of a two dimensional media into three dimensions emphasises the tension inherent in this relationship. In order to achieve this affect, the work needs to be of a certain scale, large enough to push at the viewer's sense of credulity. The further the work projects from the wall, intruding into our space, the more effective it is.

The positioning of this work in a space is also crucial to its optimum operation. At longer sight lines (the further away the viewer is) the flatter the works become. If *survey* can be positioned so that the audience can see it while approaching from a distance, the work is initially seen as "flat", it has optically reverted to its two-dimensional origins. As the viewer approaches, the work resolves into three dimensions drawing the viewer forward, closer to its brittle structure. Again this effect is heightened in scale. A larger work, seen from further away becomes even more optically complex. At any distance over ten metres it is nearly impossible to really see an individual 0.5mm mechanical pencil lead, the more so when they are surrounded, obscured and overlain by thousands of other leads. At sufficient distance the audience only really perceives an indeterminate mass. Obviously the form is there but it is difficult to ascertain. This is somewhat analogous to shading or cross hatching in traditional drawing, the slow, subtle building up of tone (and therefore illusionistic mass) through the proliferation of a multitude of individual marks, which combined, lose distinction from their cohort.

The second work presented, s*pan*, does not create quite the same optical effects as *survey*, but is a more focused application of the opposition of gravity to create tension. *span*, a simple octet girder (engineering parlance for a girder design favoured for being the strongest form made from the least materials), projects out from a wall crossing an intervening space to meet the adjacent wall. This work is a simple, minimal exploration of a diagrammatic drawing system, and its ability to function and survive in the 'real world', a world that the two dimensional system is accustomed to influence and inform, not actually occupy. Highly reminiscent of bridge building, itself one of the purest expressions of engineering ability, *span* crosses an open space, linking two walls, exposed to and opposed to the implacable but mundane pull of gravity across the entire space. Bridge building is the utilisation of diagram based systems to cross physical voids, to in effect, bring together two previously distinct areas, a highly evocative act and one with a strong metaphorical import, in international politics to "build bridges" is to take steps to ensure that rapprochement with others is facilitated.

As *span* crosses the space, the ordered geometric form also makes the void mapped, measured, a thing known and malleable, calculable and capable of being used for further calculation. The geometric ordering of the work creates a metric for the space, a rhythm for measurement. A yardstick is implanted within the minimal white walls of the gallery, bringing in to play a vanguard of measured rationality from where the entire space becomes open to delineation. This rendering of the space, while physically true of the optical effect of the work, is also true in a more technical trigonometric sense. The line that *spa*n is, bridging

two adjacent walls, is also the hypotenuse[1] in Pythagoras' famous theorem, when $a^2 + b^2 = c^2$, *span* is the c^2, the step that makes the entire form known and manipulable. Pythagoras will be referenced in this investigation as his famous little theorem represents one of the founding principles of the entire edifice of diagrammatic systems, drawing technologies with the power to shape and inform the real three dimensional world.

Even more so than *survey, span* is all about the opposition to gravity, from the moment the work leaves one wall to begin its crossing to the adjacent wall, the entire work is exposed. The drawing has braced itself off the wall and projected out into space; as soon as the work leaves the two dimensions of the wall it exists in a hostile space where the natural role for such a fragile media is falling, failure. This implied collapse affects the entire work, it is perpetually on the point of disaster, frozen a moment before self-evident failure overwhelms it. The viewer easily, physically, understands this affect. Gravity and falling are constantly understood and engaged by the human body, yet only rarely on a particularly conscious level. Gravity is an inevitable opponent once the shift has been made from two dimensions to three, as ubiquitous and omnipresent to sculpture as paper is to drawing. This ubiquity informs all sculpture, anything three dimensional (a simplistic definition of sculpture perhaps, but adequate for this purposes), an effect so constant, so all encompassing, that it is easily overlooked in everyday experience.

As the work is dealing with drawing systems it also references methodologies of drawing. Both *node* and *survey* feature an unbroken baseline that runs straight across the length of the work. As a trigonomic, mapping model this baseline would be sea level. As a drawing it is blackness, the darker tone that fades as the system spreads from its certain base into less sure territory. This baseline has been situated at eye level, the 1500mm high line at which the centre of a painting, photograph or drawing is hung in a gallery. By situating the work at this level, the baseline is made to appear much more solid, especially from a distance, as the viewer approaches, this solidity dissolves, the work becomes more fragile the closer the viewer nears. The situating of the work in the gallery space is therefore key to emphasising the visual complexity of the work.

But these works do not collapse, they remain, it is only perceived that they are untenable. This is the difference between the perception and percipience, percipience is a correct perception, a seeing the reality of things. As will be seen the foundations of the system may be confused and even self contradictory both in underlying theory and the making of the work, and yet it works, it continues. After the theorising and whatever the conclusions, the utility of the system remains, and however tentatively, so do these installations. The system they are based on may be compromised, the material they are made from may be

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[1] The hypotenuse: In the theorem of Pythagoras the hypotenuse is the longest side in a right angle triangle." In a right-angled triangle the square on the hypotenuse is equal to the sum of the squares on the other two sides." Pg 166, *The VNR Concise Encyclopaedia of Mathematics,* Ed W.Gellert, H Kustner, M Hellwich, H Kastner, Van Nostrand Reinhold Company, New York, 1975. Pythagoras' theorem is customarily denoted as $a^2 + b^2 = c^2$, the hypotenuse being c^2. Although the theorem is capable of deducing the length of any side of a triangle when the other two sides are known, the hypotenuse is usually cast as the unknown quantity, the answer to be found.

inadequate and flawed, and yet it is good enough, sufficient to continue, while continually evoking the collapse and downfall its design and substance seem to make inevitable.

survey: material

> *'Mathemeticians have always used pictures to illustrate their new-found truths of geometry, and as an aid to the reasoning process. Thousands of years of transmitting Euclid's Elements form the Greeks through the Middle Ages and the Rennaisance to modern times carried with it a tradition about mathematical diagrams and their purpose (...) seeing them as an intuitive guide to logic, and a shorthand with which to provide instant demonstrations or fatal counter-examples." John Barrow, 2008(6)*

The series of 0.5mm graphite mechanical pencil lead works can be traced back to 2007, at the time I was completing a masters degree and particularly interested in the linear perspective system. What attracted me to this area of study was the difference between how this perspective system and the human eye interpreted and depicted the world. The chief problem was the presence of straight lines; the linear perspective system finds and depicts straight lines everywhere while the spherical human eye manages to subtly curve any line. My interest revolved around the idea of systems that were perceived as correct or truthful despite being at odds with our own observations. My own life has been significantly effected by physical deficiencies in my own vision and every time I have been measured against the “correct” method of seeing I have been found wanting. Technology can correct some of the issues but in a medical sense I will never optically perceive the world “properly”, in accord with the conventional system.

This interest in a system that carried such a strong aura of rightness, even truth, spurred me to undertake a series of drawings investigating the linear perspective system. What I hoped to achieve in these drawings was to emphasise and activate, not the system's ability to create an illusionistic space within a two dimensional plane, but the system's ability to project forward and influence the positioning of the viewer in the three dimensional real world. While a fascinating and highly educational investigation, I felt these drawings failed in this aim, the desired affect was not achieved. Experiments with camera obscura and apparatus to enable paired drawings to be viewed in three dimensions also offered interesting potential for further work, and yet the goal driving this investigation was not reached. The breakthrough came when, frustrated with the ever increasing complexity of these drawings and efforts to maintain order within the two dimensional plane, I decided it might actually be possible (and perhaps even easier) to build some of these complex forms in three dimensions, take them into the real world.

Remembering an unsuccessful attempt to create something out of a large amount of 0.5mm graphite mechanical pencil leads I had been given while undertaking my fine arts degree, I experimented again with this material, eventually finding a method of bonding the individual leads together into larger structures. While the work maintained an aesthetic similarity with previous two-dimensional drawings, the shift into three dimensions, caused the work’s focus to shift. The fragility of the material really came to the fore when it came to constructing three-dimensional forms. The tiny, half millimetre lines of graphite, never longer than 75mm, are very delicate, each can only absorb and direct force upon it lengthwise, under almost any force, not disposed longitudinally through the line, they will break. As soon as I started constructing forms from this

highly unsuitable media, the material started educating me about exactly what methodologies would actually work.

These works quickly became about what was possible. Because of the inherent fragility of the material, any structure composed of it is always in danger from any slight disruption to the form and its environment. The forms that were possible in this material, especially in larger works, were shown to have a tetrahedral[2] format . This tetrahedral form could function in both a regular (all components of equal length) manner in a work such as *span* to achieve a girder-like geometric regularity or with irregular lengths to create a more organic nodal form such as the *survey* works. While present in both styles, the forms resulting from these investigations into the irregular tetrahedral system, bore a strong resemblance to the drawing system used in the paired technologies of cartography/navigation. In essence trigonometry applied to complex organic forms.

At the beginning of the use of diagrams to control space, and in all consequent uses of these technologies, resides an ancient theory, the theorem of Pythagoras (approx 6th century BC), that allows for the computation of the length of any side of a right angle triangle provided the lengths of the other two sides are known. Mathematician and historian Jacob Bronowski highlights the importance of this theory: *"To this day, the theorem of Pythagoras remains the most important single theorem in the whole of mathematics. While this might seem a bold and extraordinary thing to postulate, it is justifiable because what Pythagoras established is a fundamental characterisation of the space in which we move, and it is the first time it is translated into numbers."(7)* This is a theorem by which discrete unknown qualities (distance, length or angle) of certain spaces can be computed abstractly. This was seemingly a simple advance, but it was one that would have extensive and fascinating consequences. Pythagoras was the first to express this relationship mathematically, but it had been known in crude form for far longer. Ancient Egyptian and Babylonian surveyors had known of and made use of special triangles with sides 3, 4 and 5 units long, listing the small number of triangles for which all sides are whole, natural numbers. Pythagoras took this further and defined the mathematical principles by which these values can be found for any right angle triangle, and as any triangle can be divided into two right angled triangles, nearly any form was, at least in theory, calculable.

This is the most well known of a whole school of geometric, diagrammatic methods first uncovered by the ancient Greeks. Arithmetic and geometry were considered separate studies and geometry was carried out almost entirely in the form of the diagram. The Greek method so differentiated geometry that it was customary that all diagram proofs must be capable of being constructed with only a straight edge, (one not encumbered or made unnecessarily practical by mathematical gradations such as we would expect with a ruler, merely a straight edge) and a compass. This reliance on such humble tools emphasised the idealised purity in which geometry was held. Although capable of many practical applications, the abstract nature of the study was of paramount importance at the time. While the more practical study of arithmetic was devoted

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[2] The Tetrahedron is the most basic regular (all sides the same length) polyhedron. It is four sided, with each side being an equilateral triangle. The Tetrahedron is the simplest of the Platonic solids, a group comprising tetrahedron, cube, octahedron, icosahedron and dodecahedron, which according to Plato, are the essential building blocks of the entire universe.

to (simplistically) counting things, to the Greeks geometry's true purpose was to uncover the perfection of the hidden workings of the universe.

The refinement of Pythagoras' theorem would eventually lead to trigonometry, where the calculation of the lengths and angles of any sides and corners of triangles could be ascertained from less preliminary information. Although limited to right angle triangles, any triangle can be divided into two right angle triangles, and any two-dimensional polygon can be constructed from triangles. Therefore any two dimensional plane (or effectively any relatively small section of the surface of a sphere) can be ordered with Pythagoras' theorem. By the time trigonometry reached its modern state with the publication of *Introductio in analysin infinitorum* (1748) by Leonhard Euler, it was a fully formed instrument for the delineation of physical space, and its financial manifestation, real estate. Although technology would continually render its practice ever simpler, by the nineteenth century trigonometry offered a complete and totally coherent system for determining space and location within that space, to the extent of calculating interstellar distances by the calculation of parallax. Paul Virilio writes of the dominance and scope of a geometric spatial system that "dissects a universe": *"The communal perception of sensible space was a formation based since Antiquity on the mnemotechnics merits of Euclidean geometry, a geography of regular plane surfaces regulated by a system of dimensions that dissects a universe in which the measure of superficies dominated the geographic." (8)*. By making space subject to number Pythagoras had created a "communal perception" of the world, one that could be measured, compared and manipulated.

As I experimented more with this material, the irregular tetrahedral formalism eventually used by works like *survey*, came to the fore as a means of making ever-larger structures. The Pythagorean structural form described a surface in space, dissecting it into irregular tetrahedrons, and breaking those tetrahedrons down into triangles. This triangular format was also the best way of distributing weight and force throughout the structure, the sheer fragility of the material demanding only the most efficient of systems. The internal logic that limits (delineates) the potential forms that the trigonomic system is capable of and inclined towards producing are ruthlessly exposed once the attempt to colonise real three-dimensional space is embarked upon. Direct aesthetic decisions on the ultimate form are thus avoided; form becoming a negotiation between the possibilities of the system and the physical limits of the material. The system and the material become the premises of a syllogism the outcome of which is rational and inescapable, whatever the flaws of the premises. As rational and self-propagating as the structure may be, its presence in the physical world is always contingent and tenuous. The convoluted techno/organic form is only the description of a surface, lacking supporting infrastructure. The form is a space delineated, mapped and described, but the space itself is only tentatively occupied, the media pushed to its limits in its attempt to evolve from abstract to real. The limitations of the material have forced a certain formalism upon the work; the incursion into three dimensions can be made, but if it is done in such a flawed material it will have an identifiable trigonomic aesthetic.

In these three dimensional drawings the line, as join, fold or structural element, is reduced to its most bare fundamental nature. Arguing passionately in 1920 for a new form of Art in his Realistic Manifesto from 1920, sculptor Naum Gabo proclaims:

> "*We renounce* in a line, its descriptive value; in real life there are no descriptive lines, description is an accidental trace of man on things, it is not bound up with the essential life and

constant structure of the body. Descriptiveness is an element of graphic illustration and decoration.

We affirm the line only as a direction of the static forces and their rhythm in objects.

(…)

We renounce in sculpture, the mass as a sculptural element. (…)

Thus we bring back to sculpture the line as a direction and in it we affirm depth as the one form of space." (9)

The 'realism' Gabo calls for is one in which the line itself has become a sculptural medium, a medium through which fundamental questions of our perception of space can be explored.

Central to this research project will be this theme of drawing as an abstract technological system for influencing the physical world, the potential affect of drawing. The body of work discussed here began from a frustration with two-dimensional drawing and the limited power to affect I found in it. The material also carries strong connections and references to its provenance as a drawing media. Drawing can be seen as a barely physical process to bestow, summon or extort order from or upon the empirical world. It would be a mistake to think of drawing solely in terms of two dimensions, even if a blank sheet of paper would admit this account. As soon as any media are applied, the incursion into the third dimension, physical space, has begun. The thin layer of graphite and the narrow trench inscribed on the paper are just the first and most immediately 'real' indicators of the drawing's power to affect space. Drawing is seldom an end in itself, drawing is preparatory, an apparently necessary, yet in many ways, abstract incarnation to smooth the path for the real.

Many years ago I saw the drawings of New Zealander Jeffrey Harris, an artist perhaps better known for his painting. These drawings brandish an impressive level of technical skill, which is enhanced by the uniformity of line, each mark on the paper appears the same width, the same tone the same pressure on the page. In a Harris monograph, curator Justin Paton describes how: *"Harris used each pencil once and then picked up another, in case resharpening altered the perfection of the line" (10)* Once sullied by use, the pencil is no longer being capable of guaranteeing him the perfect uniform line. While this homogeneity is achieved in my work through the convenience of mass production the result is the same. The uniform precision of the tiny lines creates a visual complexity, when enough are present the eye cannot make sense of the whole. In combination with other factors like scale, the material is an integral part of achieving an optical complexity. The conformity of the mass of individual lines both in dimensions and its limited palette of greys, make the perception of depth particularly difficult.

Both *survey* and *span* are works that can be described as single material sculpture, artworks constructed from varying numbers of the same object or material. This media is often a common, mass-produced, consumer item. There have been a large number of artists working in this manner but of particular of interest here is Tom Friedman. Tom Friedman is an American sculptor who has worked in a huge variety of media. He is well known for his use of large numbers or iterations of a single material, evidenced in works like *Hot Balls* (1992), *Untitled* (1992)(the food storage bag work) and *Untitled* (1992)(toothpick work) all of which are composed only of varying iterations of single items. Often Friedman's work will feature a clever, conceptual element, frequently highly humorous, that colours our perceptions of these repeated items. In a

monograph on the artist's work Adrien Searle describes: *"Meticulousness, playfulness and the quality of his observations of the world around him"* as hallmarks of Friedman's work. He is says Searle, *"dealing with the modern everyday, and transforming it into something haunting"(11)* A good example is *hot balls* where the arrangement of balls shifts in our reading as we become aware that the artist has stolen all the balls. What is salient to this study however is the arranging of the material, and specifically what is done with the grouping of the repeated items.

As explained above, the utter fragility of the material I have used has necessitated a certain technique; the work can only occupy space when organised into particular systems. Although thematically there may be many similarities between single material sculptures like the *untitled* toothpick work and mine, this difference between arrangement and construction is a critical distinction. In a work like *hot balls* Friedman is simply arranging the balls in the gallery, the balls can sit anywhere on the gallery floor, he has complete control and choice over their placement. This is in contrast to a construction where the placement of objects is inherently limited by the material itself. In the first the artist is dictating how the material is deployed, in the second the artist is in dialogue with the material, negotiating and persuading it to achieve something it is barely capable of.

The ability to arrange the material into the form of choice is often key to the transformative effect that features in so much of Friedman's work. I consider the work of Friedman' s with the strongest resemblance to the work in this study is the series of pencil works from 1995, again simply called *Untitled*. In these works short segments of wooden pencils are joined into a complexly bundled continuous line, a crumpled loop. The durability and appropriateness of the building material has enabled Friedman to utilise the concept that the complicated mass is actually a single line that loops back on itself to achieve the transformative effect that is a common theme throughout much of his work. With Friedman the material is subject to his concept and will often be arranged in a clever manner. My material however is so flawed that its structural limitations, to a certain extent, dictate the final form.

The subjection of form to physical necessity rather than to concept or conceit is a key distinction between my work and Friedman's. Where Friedman is concerned with the treatment of objects, my interest is the treatment of systems. The treatment of objects means a freedom to arrange those objects in order to enable more nuanced readings. A systematic treatment is concerned with a whole system and much of the formalism of the work is informed solely by that system's relative strengths and weaknesses. The system plays an important role in determining what forms it can be induced to occupy. This physical aspect of the works formalism will be discussed in greater depth with regard to gravity.

Works like *node* and *survey* also share a tenuous rhizomatic aesthetic with artworks such as *Reticularea (Ambientacion)* (1969) by the Venezuelan Artist Gego (1912-1994). These webs of intricately linked lengths of wire represent the same bare orthogonal necessities of occupying space that I seek in my work. Describing *Reticularea (Ambientacion)* Catherine de Zegher writes: *"…what appears to have independent, permanent existence is actually the consequence of many interacting forces; reality only takes form to the extent that it arises from an interdependent matrix of parts." (12)*. It is this idea of a dynamic use

of the material, illustrating a reality that is the bare expression of physical forces interacting to inform the resultant shape, that is a major goal for my large graphite artworks.

Impressive as this work is, I see a major difference with my practice in the use of materials. The wire joined with loops utilised by Gego provides a fairly flexible although relatively heavy web of triangles. Suspended from the ceiling the works hang and form is entirely subject to gravity, almost more reminiscent of drapery than my mathematic aesthetic. My use of graphite mechanical pencil leads results in a brittle, featherweight structure, a self-supporting structure rather than the hanging fabric–like form of Gego's installation. Gego's work can only succumb to gravity, is limited to one type of formalism, it must hang. Consequently my material is capable of a wider range of more complex forms, and far more nuanced and dramatic interactions with gravity. This is mainly due to the different materials used. Gego's heavy flexible wire is both too heavy and flexible to support itself and resist gravity in the same manner as my brittle light graphite rods.

In such superficially similar works, it is the choice of material that is the critical difference in activating the work's affect. In wire the material carries none of the resonance to gravity that the fragility of graphite ensures. Without this brittle fragility Gego's work never really engages gravity after its initial capitulation. Where Gego's work acquiesces to gravity's incessant demands, my works are opposed to gravity, organised to resist and overcome this natural force, albeit temporarily. The complexity and improbability of *survey,* combined with the palpable fragility of the material, result in an immediate, visceral appreciation of the form and the precarious nature of its position in space.

span: material

> *'mathematics may be defined as the subject in which we never know what we are talking about, or whether what we are saying is true.' Bertrand Russell (13)*

span is constructed from the same material and shares the same concern with fragility, as *survey*. Where the irregular form of *survey* is opportunistic and contingent, *span* is a rigid mathematical work, rational and austere. Bridging the void of the gallery the work forms the hypotenuse of a right-angled triangle with the walls forming the two other sides. The fragility of the material reflects the uncertainty of the spatial mathematics that inform it, the works tenuous survival reflects the utility of these systems in spite of the doubt that attends them. The delicacy of the material makes the work barely present, it is as close to Plato's perfect intangible world of forms as an object can be. The Platonic concept of an eternal world of mathematical perfection, open only to the intellect, not the senses, was a powerful idea with a long history in western thought.

Bertrand Russell (1872- 1970), writing in his History of Western Philosophy, argues that the spiritualism that Pythagoras invested his mathematics with would exert a strong influence on thousands of years of culture:

> "Mathematics is, I believe, the chief source of the belief in eternal and exact truth, as well as in a super-sensible intelligible world. Geometry deals with exact circles, but no sensible object is ever exactly circular (…) it is natural to go further, and to argue that thought is nobler than sense, and the objects of thought more real than the objects of sense-perception (…) mathematical objects, such as numbers, if real at all, are eternal and not in time. Such eternal objects can be conceived as God's thoughts. Hence Plato's doctrine that God is a geometer (….) Rationalistic as opposed to apocalyptic religion has been, ever since Pythagoras, and notably ever since Plato, very completely dominated by mathematics and mathematical method. (14).

Russell is here unequivocal in stating the importance of Pythagoras, and the mathematical tradition he engendered, claiming that he is responsible for the very idea of an ideal, eternal world. An immaterial truth that only mathematics can describe, a truth that would not prove as eternal as it may once have seemed.

Russell, in his essay, *The Retreat From Pythagoras*, demonstrates the loss of certainty in mathematics that would accompany the post-modern era. Once established at the level of utility and ubiquity embodied by Isaac Newton's *Philosophiæ Naturalis Principia Mathematica*, published in 1687, mathematics became the pre-eminent modern tool for influencing and predicting the physical world. The utility, coherence and completeness of the mathematical world model would encourage its traditional mystification. A youthful Russell describes his early view thus that:

> "Mathematics, rightly viewed, possesses not only truth, but supreme beauty- a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection

such as only the greatest art can show. (…) Remote from human passions, remote even from the pitiful facts of nature, the generations have gradually created an ordered cosmos, where pure thought can dwell as in its natural home"(15)

Writing in 1907, a young Russell embodies an archetypal modern reverence of mathematics, experiencing it as aesthetically pleasing, if only austerely so. However by 1959, Russell, who had lived through two world wars and witnessed the ascent of both Einstein's theory of relativity and the counter-intuitive results of quantum theory[3], espouses a more post modern attitude, commenting directly on the above text:

"All this, though I still remember the pleasure of believing it, has come to seem to me largely nonsense, partly for technical reasons and partly from a change in my general outlook upon the world. Mathematics has ceased to seem to me non-human in its subject matter. I have come to believe, though very reluctantly, that it consists of tautologies. I fear that, to a mind of sufficient intellectual power, the whole of mathematics would appear trivial, as trivial as the statement that a four-footed animal is an animal. I think that the timelessness of mathematics has none of the sublimity that it once seemed to me to have, but consists merely in the fact that the pure mathematician is not talking about time. I cannot any longer find any mystical satisfaction in the contemplation of mathematical truth."(16)

Russell is voicing more than a sense of unease about the true nature of mathematics. In the landmark work *Principia Mathematica* (1910); co-authored with Alfred Whitehead, (1861-1947) he attempted to provide a purely logical framework within which all mathematical operations and functions could be accounted for without any internal contradictions. Despite the impressive scale and incredible complexity of this work,

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[3] The special and general theories of relativity proposed by Einstein exposed some problems in Euclidean geometry, problems that had been predicted by work in non-Euclidean geometry by theorists such as Carl Friedrich Gauss, Janos Bolyai, Nikolai Ivanovich Lobachevsky and Bernhard Riemann. Mathematician Tony Crilly describes this loss of certainty: "The geometry of Euclid which had been thought to be the one true geometry, (…) had been knocked off its pedestal. Euclidean geometry was now one of many systems, sandwiched between hyperbolic and elliptic geometry. (…) The advent of non-Euclidean geometry was an earth shaking event in mathematics and paved the way to the geometry of Einstein's general relativity." (pg 111, Tony Crilly, 50 mathematical ideas you really need to know, Quercus Publishing Plc, London, 2007). Crilly continues: "Euclidean space is flat (it has zero curvature) but Einstein's four-dimensional space-time geometry (…) is curved. It displaces the Newtonian force of gravity as the explanation for objects being attracted to each other. With Einstein's general theory of relativity it is the curvature of space time that explains this attraction" (pg 195, Tony Crilly, 50 mathematical ideas you really need to know, Quercus Publishing Plc, London, 2007). On a large scale relativity exposes basic flaws in the Euclidean/ Newtonian account of space that are almost indiscernible on a human scale, The Euclidean/ Newtonian account of space is coherent and useful at the scale of earthbound endeavour yet untenable in the larger reality of outer space. Crilly details the essential effect of scale on the utility of these theories: "Speed and distance have to be very large for the differences between these two theories to be apparent. (…) it will be a long time in the development of (…) travel before we would have to discard the Newtonian theory in favour of Einstein's. Space travel will force us to go with Einstein." (pg 195, Tony Crilly, 50 mathematical ideas you really need to know, Quercus Publishing Plc, London, 2007).

ultimately no coherent foundation could be found. The quest would be called to an early halt by the work of Kurt Gödel (1906-1978), an Austrian mathematician and philosopher whose key work *On Formally Undecidable Propositions of Principia Mathematica and Related Systems* (1931) apparently proves that mathematics and in fact any logical system is an entirely abstract system of signs. Abstract signs can operate with and upon each other to create structures of vast and powerful complexity, but these structures remain abstract and without tangible connection to the physical world.

If we accept the elder Russell's account of mathematics as an abstract system, a human tool rather than an uncovering of natures mysteries, the system's ability to affect space becomes more intriguing. The mathematical diagrammatic method may be abstract, without any objective truth, and yet it remains relatively effective at informing and occupying real space. *span* is a mathematical diagram in space. A diagram shorn of its traditional support and forced to operate in real, three-dimensional space, the graphite barely manages to bridge the space, it functions, or holds together, but it seems on the verge of collapse. The transition from the ideal, simplified, two-dimensional drawing to three-dimensional space, has enabled the fragility of the material to undermine the assumptions with which it has been deployed. A two-dimensional drawing of this work, a diagram for this girder, is certain, is complete and coherent and will remain that way indefinitely. The three-dimensional drawing *span*, bridging real space, is uncertain, and contingent.

The body of work addressed here, and *span* in particular, contains many similarities, and equally important differences with a style commonly known as geometric minimalism. Although the umbrella term "geometric minimalism" is perhaps more readily associated with a predominantly American school of painting, characterised by the work of Barnett Newman, Frank Stella et al, however the key practice in relation to this study is the sculptural and installation work by Sol LeWitt. LeWitt rose to prominence with sculptural forms based on mathematical concepts and methodology, especially with regard to systems. Two of LeWitt's works will be specifically addressed here and compared to work of mine. Both works; "*variations of incomplete open cubes*" (1974), and *Wall Drawing No.1, Drawing Series II 14 (A&B)*(1968), are concerned with the implications and permutations of systems, albeit in quite different manners.

"*variations of incomplete open cubes*", is part of a large body of work in which the artist drew and constructed his forms based on cubic structures. While many of LeWitt's works are sculptural, grid constructions in a minimal white, "*variations of incomplete open cubes*" is a drawing, a grid, matrix or rubric, showing nearly every possible permutation of the cube, divided by the number of linear components of which the cubes are constructed. Drawn in an orthographic projection that references the technical drawing of design and architecture, this is a rigorously systematic exploration of the cube that, through its multiple permutations offers a complete elucidation of all possibilities the cubic system offers in its most basic module.

The choice of the cube as the focus LeWitt's investigation is the first element of this work that I find problematic; the grid and its three dimensional version, the cube, have featured prominently in 20th century art and its corresponding theory and critique. The grid has come to symbolise the spatial preoccupations and methods of western civilisation, and as such has been a focus for critique and investigations of this aspect of

the culture and its artefacts. Writing of the link between the State's power apparatus and geometry for example, Deleuze and Guattari tell us;

> "…State geometry, or rather the bond between the state and geometry, manifests itself in the primacy of the theorem element, which substitutes fixed or ideal essences for supple morphological formations, properties for affects, predetermined segments for segmentations-in-progress. Geometry and arithmetic take on the power of the scalpel. Private property implies a space that has been overcoded and gridded by surveying. Not only does each line have its segments, but the segments of one line correspond to those of another; for example, the wage regime establishes a correspondence between monetary segments, production segments, and consumable-goods segments." (17)

This text provides a key insight into my main problem with these works of LeWitt's and the reason for the signature form of my own work. While the grid has come to represent the "state geometry" which Deleuze and Guattari write so well of above, and is even explicitly mentioned; "… a space that has been overcoded and gridded by surveying…" the key for me is "by surveying". While the grid may spring to mind immediately when thinking of maps, city blocks and land use, the actual shape of surveying *is the triangle,* as shown above in the history of trigonometry, the cubic grid is merely the user friendly interface laid over the triangular structure. The focus on the grid is therefore arguably a superficial understanding of where the actual power of these systems resides.

While the investigation of the cubic structure, especially with the rigorous exploration of permutations evident in a work like "*variations of incomplete open cubes*" is of obvious interest to me, I propose that the works in this study address this interest in the foundations and precepts of these systems in greater depth and complexity. "*variations of incomplete open cubes*" can easily be read as an investigation of the very roots of a geometric spatial system that has been of crucial importance in western culture and its artistic legacy. This is a very similar goal of my own work "*selected proofs*" (2011), a collection of models sourced from the history of linear perspective systems from an era when this body of knowledge was ill defined and unfixed. In the same manner that LeWitt explores every variation of the cubic system, this work, which is composed of a series of variations on a theme in an analogous manner to LeWitt's, is concerned more with the underlying structure that enables the cubic grid, the assumptions and precepts on which this cubic system is founded.

This concern with the foundations or the initial precepts of systems, is important because once these precepts have been accepted as orthodoxy, once they have become the established method, their influence and their inconsistencies may easily be overlooked, their implications lost in the apparent logic of their ordering. By examining every permutation, every combination of the construction of the cube, and to do so in such a rigorously mathematical, rational fashion, (first three components, then four, then five…) is to delve into that spatial system, detailing and labelling all of its possibilities and possible inconsistencies. And yet to view LeWitt's work as an investigation or critique of spatial systems is to recognise the tautological nature of the work. In "*variations of incomplete open cubes*" there is the list-making, the numerical progression, the square grid that the work is laid out in (or on), all these features argue that the interrogation is being conducted with all the same assumptions, all the same preconditions and precepts of the system examined.

LeWitt's "*variations of incomplete open cubes*" begins (assuming it is read in a top to bottom, left to right, a manner that the works structure itself suggests), with the set of incomplete open cubes that consist of only three lines joined, two angles. There are only three variations in this set, before dropping to the next grouping, those composed of four lines, three angles, and so on. Why then has LeWitt omitted those variations that consist of only two lines, just one angle? He has even omitted the single line, without angles, just a singular mark. Why, in such an otherwise exhaustive list, is the simplest unit excluded? The title of the work seems to offer no reason why these sets do not fit in with the declared aims or structure of the work, no reason for their elision, they are just not there.

Whatever the reason for LeWitt's omission, the void left by this elision points to a gap that my work, *selected proofs*, seeks to activate and respond to. While LeWitt is exploring (nearly) all variations on the drafting of the basic module of cubic system, the interest in my work is the system by which the cube is rendered, and the initial uncertainty of that system, before it is codified. The question of why LeWitt omits variations consisting of two lines is key to this study. Are for instance, two lines not three dimensional enough to fit his investigation? If so, this is a strange decision bearing in mind the flat, orthographic treatment given to all the subsequent variations. Perhaps the simplicity of the two line elements justifies their omission? Are they so essential they are capable of being read in too many different ways and are open to too much interpretation? Or are they too simple to convey meaning? Whatever the answer, it is the uncertainty of what is left out that is the goal of my works. In his exploration of the system, LeWitt has omitted the tentative, ill-defined beginnings of that system that I am most interested in.

Another grouping of LeWitt's work however, comes much closer to my area of interest. In his wall drawing works, such as *Wall Drawing No.1, Drawing Series II 14 (A&B)*(1968), LeWitt provides the gallery with a set of simple, geometrical rules and the drawing is actualised by gallery staff according to the prescribed principles. To me, these works are a far more interesting and rigorous investigation of the development and evolution of systems. From a simple, hierarchical set of rules, results a work that is large, complex and slightly different at each iteration. Although I have used the word complex, in this case, as in my work, it is a complexity formed from a massive repetition and accumulation of simple, similar elements. For LeWitt this is the proliferation of short ruled lines, of varying colour, but limited to a certain density, a number allotted for each area. In my work it is the repetition of triangular three dimensional forms to build up a work such as *survey*, or *node* that is key. Of crucial interest to me here is the slight differences between each iteration of the work. The rules provide the system, a top-down authoritarian hierarchy of a system, while the enacting of the work is reliant and subject to variations in media, participants, wall surface and material, lighting and environment and even, I suspect, irregularities in concordance with the established rules. While the rules are always the same, the results are always different, similar at a large scale, varied at the small.

This effect, the obsessive repetition of simple, micro, geometrical components to create a large complex macro with hints and elements of an organic system intermeshed with its ordered linearity, is precisely the result desired in a work like *node*. *node* shares with LeWitt's wall drawings an interest in the complexity and uncertainty that can result form the massive repetition of simple highly ordered components. These are works about systems, confidence in the logic and predictability of systems, the gap between planned ideal and the contingent reality.

The pencil material, with its drawing provenance, also links *span* to these wall drawings of LeWitt's. His array of equal length lines are disordered, random and strictly two dimensional, while in *span* these equal lines have been strictly composed into a pattern that permits it to occupy three dimensions. Both works utilise the gallery as support. In LeWitt's wall drawings a white wall is assumed, its dimensions dictate the works proportions. While the gallery provides the two-dimensional expanse across which LeWitt's system operates, with *span* the gallery provides the structural base from which the work projects. For LeWitt the gallery is a blank slate, an architectural picture plane; in my work the gallery is a plinth, the whole building becoming implicated in keeping the work aloft.

Writing of the modern reaction against the sculptural base, or plinth, artist and theorist Jack Burnham defines this base/plinth as: *"…the base, the greatest mass upon which a sculpture rests, it refers to the support as a whole; (…) planar support which separates the sculpture from the ground…" (18)* This is a definition that perfectly fits the role of the gallery space in a work like *span*. Here the gallery has become an unseen base or plinth for the work, separating the *"sculpture from the ground"*. Utilising the gallery in this way permits the fragility of the material to be emphasised, its delicacy accentuated by the distance it keeps from the ground. This aspect would be substantially lost if the work were to be suspended by thread, or other additional support used. The fragility of the media requires that it alone carry the weight. Enlisting the gallery as plinth preserves the clarity of the work, the visually minimal role of the gallery/plinth underlining the fragility of the material and the tenuousness of its predicament.

survey: scale

> *'In a true drawing, a creative one, the marks, the traces, the lines are not included or closeted in the background. on the contrary, the marks , the lines- the forms, if you will- create the background as an inexistent place. As a result we have a description without place.' Alan Badiou,2006, (19)*

The small scale of the individual components of the material used in both works (the longest length available is 75mm) means that any large structure constructed from them will necessarily be composed of thousands of the 0.5mm lines. This proliferation of incredibly fine lines, from any angle appearing interwoven, interlinked and overlaid, creates a visual complexity. When approached by a viewer the work is composed of too much detail to be comprehended, it is baroque in its complexity. While the work is optically complex, it is a complexity built by the repetition of simple basic units and modules, not a complexity formed through sophisticated techniques or advanced materials. The visual complexity of these works is a byproduct (although not unintended) of their scale.

This body of work has been a study of systems, what Jack Burnham defines as *"an interacting assembly of varying complexity" (20)*. Complexity is key to the impact of a work like *survey*. The overwhelming visual effect of the proliferation of tiny lines creates more order than the eye can comprehend. There are too many interactions in the system for the whole to be intelligible. The visual complexity of *survey* is the factor that makes it, in a sense, kinetic. A subtle kineticism to the work is crucial to it being read as temporary, capable of motion, the implied collapse. Discussing what he terms "interactive fields" Burnham states*:"(…) in terms of optical principles employed, two categories of field effect stand out: those that are static but provide an optical sensation of movement between units; and those that use machine principles to produce real motion." (21)*, it in this first sense that *survey* can become kinetic.

survey is derived from an earlier work; *node*, a vaguely organic void encased in a trigonomic web. While planning this work I was also experimenting with using tiny lengths of pencil lead packed into small volumes, through which I was able to explore a tonal solidity akin to shading in two-dimensional drawing. Pack enough lengths of graphite into a small enough volume and something close to a "black" can be obtained. By slowly altering this density by either using progressively longer lengths or simply using less of them, a range of tones could be manufactured. Upon considering the optical effect the prototype node was producing, it seemed obvious that this effect could be amplified through the incorporation of these different "tonal" values. These smaller pieces, much more dense and intricate, were built into the sparse meshwork of the main body, whereby a full contrast from the tiny, closely packed, intricate portions to the loose network composed of longer more widely distributed pieces. This shift in solidity and complexity enhanced the necessary disorientation that became increasingly important in the work. From a sufficient distance (and the work was situated so as to permit long sight lines within the gallery) the 0.5mm graphite leads became effectively invisible except where it was most densely packed, where it would appear as a nebulous dark

region of shadow suspended in the air. As the viewer approached, the work became increasingly more resolved, larger sections became perceptible until the whole work could be appreciated.

I have compared this optical effect to a moire pattern, and like the moire phenomena, viewing distance is a factor. Changes in the viewer's distance have a distinct effect on the size and patterning of the moire patterning. While not an actual moire, I feel that the perception of movement in *node*, can be attributed to an analogous effect achieved by the interplay of two differing patterns at different distances; Burnham's "field interaction". As such the effect became a function of the works placement in the gallery. Establishing long sight lines was negotiated with the curator early in the process, and initial decisions, discussed above, concerning the size and complexity of the work were vindicated as the optical effect became more apparent during the works construction

e*XPOSURE (LIFE-SIZE) MAQUETTE, 2005* a work by Anthony Gormley, shares a similar vector like structure as *node*, and apart from the obvious impact of the different material from which the work is formed, the chief difference between his work and mine illuminates the role of formalism in the two different bodies of work. Gormley's work is predominately concerned with modelling the human form, despite the fractal, node like construction of the work its outer limits, its boundaries, describe human forms. As such his work is very much a continuation of traditional statuary, his work is different from bronze casts of famous men in public squares only in the sparseness, and consequent ambiguity of identity, of line by which the form is modelled, his statues are more a sketch of the figure than the traditional fully rendered form.

Gormley here, is using the line in a purely descriptive role, and while, like my work, *node*, the line is utilised to fill space, it is in the interests of describing a form, a tool of formalism. In my work however, despite a superficial similarity with Gormley's formalism, I am aiming to use the line in a very different manner. As the Gabo manifesto has already announced; "*We renounce* in a line, its descriptive value; in real life there are no descriptive lines, description is an accidental trace of man on things, it is not bound up with the essential life and constant structure of the body. Descriptiveness is an element of graphic illustration and decoration". Gabo here has precisely delineated the difference between these works of Gormley and mine, I am aiming to make the line so much more than a merely descriptive, graphic tool, I am aiming for a meta-formalism, where the line is a dynamic, structural element. A line, the use of which implies and informs the entire history of delineating space through its colonisation of space. Where Gormley's work is a model of the human form, mine is a maquette for investigation of the human formalisation of three-dimensional space.

Central to the theory and application of these mathematical diagrammatic methods in relation to the real, three-dimensional world lies the concept of modelling, and in more specific art terms the difference between the construction of a model and that of a maquette. In sculptural terms there has always been a distinction between the two, which while a somewhat debated division, I have interpreted and for the usage of this text will be as follows. A model is merely a scale representation, such as an architects scale model to show clients, and is therefore constructed to convey and illustrate to others. The model is in essence an educational and illustrative tool, one designed to show others something already known by the creator. A maquette on the other hand may be thought of as subset of the model, (for they also achieve the models aims) a special class of models that is constructed so that the artist may discover something about the

proposed work or outcome, (both the model and maquette being preparatory acts) either material, mechanical or aesthetic. In this sense the maquette is a tool for experimentation, a method for uncovering the unknown, a proving ground for the possible. This distinction also informs a subtle point about early mathematics, while the advanced mathematics we are used to is characterised as abstract, something that happens in diagrams, on whiteboards, in computers, early mathematics could be surprisingly physical. Much of the early Pythagorean work on squares and natural numbers, for example was founded on arranging small pebbles into geometric shapes where their special properties could be visually apprehended, and experimentation and investigation became little different from play. As historian of mathematics David Berlinski writes;

> "They (Pythagoreans) lived in caves- I mean such is the legend- and squatting there, a pile of smooth pebbles in their laps, they saw that there are square numbers as well as triangular numbers, and amicable relationships between numbers,…and in all this, as the tallow dripped from their candles, they treated the natural numbers as if they were themselves men at play, serious but never solemn, their endless curiosity amounting at times to a form of intellectual rapture…" (22)

The diagram then (to the pythagoreans), was a maquette, an active exploration. It was a device to increase knowledge as well as model for illustrating this knowledge to others. This model/maquette distinction will be a key to the choice of diagrammatic technologies examined and applied to the construction of sculpture here.

Sculpture has a long and rich history of modelling the human form, and arguments can be made that there is little territory unexplored in this regard. Of far greater interest to me, and the subject of my work *node* is the investigation of human technologies for delineating and manipulating space. The sense in which my work is a maquette and Gormley's a model is that mine is investigating a subject still uncertain. Gormley has utilised new techniques for rendering forms already reasonably well understood, I am seeking to unpack those techniques. The uncertainty of form that results from both the construction, which unlike Gormley is not directed toward a specific form, and the perceptual indistinctiveness caused by the proliferation of cross hatched, interlinked lines, directs attention towards the manner, the how, of the form, rather than the what.

The materiality of these works is also a key difference in regard to Gormley's work. The distinction made earlier between the model and the maquette, the rendering and the active investigation is also informed by the choice of material of these works. Gormley's work are constructed from various metals, perhaps the material most obviously perceived as lasting and permanent, hence its ubiquity in the type of public square, famous men statue that I argue, Gormley's work falls within the tradition of. Despite the sparseness and apparent indeterminacy of these structures, the choice of material renders them physically resilient, the countless interlinking nodes conferring great structural strength to the resulting sculptures.

The resilience of Gormley's sparse models of human form is in contrast to the contingent fragility of my works. The inherent tenuousness of the 0.5mm graphite pencil leads ensures that the work is always in question, unlikely to continue, temporary. This uncertain incompleteness of a work such as *node* is another aspect that could be seen to make it a more dynamic active sculpture than that of Gormley's, a distinction I have characterised here as that between model and maquette.

The human body centred formalism of Gormley's work provides an endpoint, a resolution that, in my opinion, limits the scope of the sculpture when compared to a work like *node*. Because the work is concerned with modelling the human form, it is always reducible to something recognisable, its limits are known, and despite any interesting things that may occur structurally within the work, the human form supplies a limitation, a boundary, which the work cannot exceed. This boundary functions both physically, in that if the work does not conform to a certain shape it is no longer identifiable as a human form; and conceptually, no matter what else the work may achieve, its identification as a human form, once made, is nearly impossible to ignore.

The concern of *node* is not the formalism of the human body, but the formalism of human technologies for delineating space. As such it is concerned with techniques for occupying space rather than how a specific form exists in that space. This makes for a much more open ended reading of the form. In a way, the exact form of this work is unimportant, arbitrary, because the work has been deliberately constructed to exaggerate this effect through the proliferation and confusion of lines to the extent that the perception of the exact physical form of the work is difficult, complicated. The confused perception of the space the work occupies, as opposed to the recognisable, familiar form with which Gormley is concerned, makes for a far more active work, an investigative experiment, a maquette rather than a mere model of something already understood.

node and the other sculptural works developed over the course of this project are works formed, and informed, by a need to colonise space. In this sense, it has direct connection to the idea of meshworks and hierarchies as discussed by Manuel De Landa in *A Thousand Years of Non- Linear History.* In this text De Landa distinguishes between the hierarchically organised, centrally planned, top-down aspects of city planning and generation, and the more anarchic, function driven, bottom up meshwork. While the centrally planned hierarchy is well understood as in street planning, zoning restrictions, infrastructure, the meshwork concept focuses on the ad hoc, citizen initiated aspects of city growth, the markets, alleyways, squatting, the re-purposement of the city as its inhabitants find new ways of making their environment suit their needs. De Landa is careful to stress the interplay between these two aspects of city growth; for example a successful market situated in a carpark may be incorporated into city planning, and recognises that the two aspects are simply complementary processes:

> "However, it is crucial to avoid the facile conclusion that meshworks are *intrinsically better* than hierarchies (in some transcendental sense). It is true that some of the characteristics of meshworks (particularly their resilience and adaptability) make them desirable, but that is equally true of certain characteristics of hierarchies (for example, their goal-directed-ness). Therefore it is key to avoid the temptation of cooking up a narrative of human history in which meshworks appear as heroes and hierarchies as villains." (23)

node is a work in which these two aspects, hierarchy and meshwork, are present in an uneasy equilibrium. Hierarchy is evident in the trigonometrical construction, an ordered logical methodology, the meshwork however is the manner in which this logical system has no centralised plan, it merely has to fulfil its function, that is, fill space. The fragility of the material therefore becomes the determining factor in the form, the hierarchic idealism of the trigonometric system constantly being coerced into a more ad-hoc meshwork by the limitations of the media it has to operate through.

As exhibited in the group exhibition of contemporary New Zealand art *Prospect,* at Wellington's City Gallery, in November 2011, *node* was simply placed on the floor of the gallery with no barrier, enabling the audience to approach extremely close. Such positioning offered the work no protection from audience interaction whatsoever. As it was constructed from such a fragile material, it was potentially subject to complete destruction at the hands of the audience. In fact the entire conglomeration could have been reduced to fragments in a matter of seconds. Many viewers reported a feeling of nausea or vertigo when encountering the work at such close proximity; others experienced a deceptive sense of motion from what was a completely stationary object. While perhaps the sheer amount of lines intersecting may have produced some form of moire effect to account for the sensations of motion, it is clear that being in such proximity to such a large, palpably fragile object heightened the viewer's perception of their own body and its movements. When given, unasked, the responsibility of not blundering into this object already visibly on the verge of collapse, the viewer experiences an exaggerated consciousness of their own potential clumsiness, becoming personally implicated in the continued existence of this precarious sculpture.

In terms of optical complexity, the stark dark grey of the graphite against the minimal white of the gallery references Op artists such as Bridget Riley. Much of Riley's work creates a kinetic impression through overwhelming the eye with complexity. It is however with optical sculpture and the deployment of complexity to generate "field effects/affects" that the strongest resonance with my work is found. Gunther Uecker is a German sculptor, who together with Otto Piene and Heinz Mack constituted the core of Group Zero. Group Zero were a German collective that, beginning in 1958, approached the kinetic from many different angles especially the play and motion of light. An exhibition of his later machines made from bandaged and lashed together sticks had a huge impact upon me when I saw it in the late 1990s. Of particular interest to me are his optical sculptures such as *moving light* (1960), a large circle painted white, and covered with randomly situated, densely packed, white painted nails.

Uecker's *moving light* has been painted entirely white, making shadows the most active feature of the work. The interposed nails constantly fracture and reform the shadows as the viewer's eye moves or is moved around the sculpture. The profusion of what appear to be constantly shifting lines creates a sense of dynamism within the object. This is a similar effect/affect to the one that occurs in a large work of mine like *survey* or *node*. The depth to the sculpture gives space for the tiny graphite lines to be at varying distances from the viewer, when any slight movement in the eye will shift the patterns and configurations of the mass. In this work of Uecker's and *survey* visual complexity are key to the work, this complexity is partly a function of scale, if you assemble a large enough number of anything in one place, certain types of perceived complexity are almost inevitable. It is important to recognise that the optical complexity addressed here, Burnham's "field interactions", is not solely a function of number and scale. The methodology of the work's structure and construction can hugely influence the works potential to activate these "field interactions".

Another contemporary artist whose work often shares a complex delineated aesthetic is Argentinean Tomas Saraceno. Saraceno has produced a range of projects, usually with a focus on scientific principles or theory and often involving large installations. Work such as *14 billions* (2010), although realised on an entirely different scale, is immediately recognisable as sharing a similar aesthetic and interest with works

such as *survey* or *node*, having an insubstantial, immensely complex, drawn form, and sharing the scientific-mathematic tradition as a source of inspiration. The optical complexity of this work is directly comparable with mine, yet there are two key points of distinction, the first materiality, the second dealing with the issue of organic form, delineate both bodies of work. These two distinctions are also interlinked and interwoven, both being complicit and dependent with and upon each other.

The first issue is simply in the materiality of the work. My body of work examined here is focussed on the one material, 0.5mm graphite pencil leads, while Saraceno has employed a wide variety of materials in his work. The two works of Saraceno I will discuss here are *14 billions* and *galaxies forming along filaments, like droplets along the strands of a spider's web* (2009), as these are two that share an aesthetic most strongly with my work. Both of these works are constructed (solely in the case of *14 billions*) using elasticised thread, a material that could be seen to occupy the same territory as my pencil leads. Like my work, the thin dark line of thread immediately references drawing, the form is delineated by line, mainly void, the space is rendered into discrete chunks by the installation and the repetitive obsessive scale of the works create an analogous affect within the viewer. Despite these commonalities however the material difference is subtle and crucial. Quite apart from the affect of fragility, which although relevant here, has already been discussed above and does not need repeating, the material difference here is the contrast between the elastic and the brittle.

This apparently simple distinction actually has a large influence on the two types of work. With the brittle graphite, the line is rigid, each line “holds” itself, and each line connects at points. The work gains its strength through the girdering of each component, exploiting the self-sustaining trigonomic form. By contrast, the elasticised thread used by Saraceno, becomes a straight line through tension, the material has no rigidity of its own, it must be stretched between two points, its linearity formed by an internal tension between two or more anchored points. While this tension may be between distinct but interwoven threads, eventually the work must be anchored to something (the gallery walls, floor and ceilings in the instance of 14 billions) external to itself. While a work of mine like *node* is a discrete self supporting structure, a work like *14 billions* is a web strung between a braced infrastructure, one creates a collection of small incremental structures, the other pulls in its strength from an outside source. This is significant because one structure gains all its strength from an exterior source, while the other has to generate resilience from within. When a work is hung from gallery ceilings or strung between walls, the gallery becomes the structure; my work is integrally structural, it creates its own strength.

This difference in materiality and structural methodology is I believe indicative of a second, deeper difference between these works, that of subject matter. In the preceding text I have detailed my interest in geometric drawings systems to investigate and model the world, my work can be read as maquettes for spatial systems, investigations of our systems for modelling and manipulating the physical world. By contrast, when examining the oeuvre of Saraceno’s work, it becomes apparent that his interest is more in the physical forces themselves. Saraceno has created many different works that feature elemental, physical science producing highly effective but often subtle kinetic effects. Seen this way, Saraceno’s concern is with physical forces, the natural world, perhaps in a manner consistent with much of Olafur Elliasson’s work, while my focus is with the human technologies that aim to model and inform those forces.

Saraceno's *14 billions* is a huge work encompassing the entire gallery. The architecture also functions as the anchor for the work, the structure within which the physical tension activates the work. It is the use of natural physical force that makes the dependence on the gallery as structural support necessary. Physical forces cannot be separated from the natural world, you cannot make a work not affected somehow by gravity for instance, any outdoor work will be subject to weather, and the works physical connection to the gallery is illustrative of this. If Saraceno is making models of the physical world using natural forces, the works remain part of this natural world, embedded in it.

In a work of mine like *node*, however, while of course still subject to all the same environmental forces as Saraceno's, the intent is to model the human technologies to map spaces, in particular two dimensional systems for modelling the environment. This source material, which I have referred to previously as a technology, is necessarily distinct from the natural world. It is the discomfort of these two-dimensional systems transformation into three-dimensional forms, where, in contrast to their origins, natural forces like gravity have to be accommodated in actuality, rather than in the abstract realm in which they originated. *node* sits unsupported on the gallery floor, subject to and activated by gravity, but the work exists as a discrete object, unconnected to the outside world, needing no supporting infrastructure like that for *14 billions*.

This difference, between Saraceno's modelling of natural forces and my modelling of a modelling system is reflected in the materiality discussed above. Saraceno's installation uses tension dispersed throughout the structure to pull itself together, creating taut lines throughout a whole, from a floppy material. In each line the force is pulling in, the only way an elastic, non-rigid, thread can function structurally. I assume that in producing this work, *14 billions*, the whole gallery is threaded up like a loom and then pulled tight, the work being created at a stroke after much meticulous preparation. My use of rigid brittle graphite however utilises an entirely different manner of construction and physicality, and this difference stresses again the distinction between the natural of Saraceno and the technological of my own work.

In *survey* and *node*, thousands of irregular tetrahedral shapes each function as modular structural components building incrementally upon each other, this is both a structural issue and also a function of how the work is constructed, one triangle at a time. *14 billions* is one large structure, break a few threads and the whole unravels, *node* is a collection of familial but discrete structures, several can break or collapse without the whole being in peril. The incremental growth and construction of *node*, like the logical unfolding of Euclid's geometric system, mirrors the gradual accumulation of human technology. Saraceno's work is a unified whole, no single part comprehensible or indeed functional when separated from the whole, more reminiscent of the natural world that is a theme of much of Saraceno's work.

span: Scale

> *'... You know that they use visible squares and figures, and make their arguments about them, though they are not thinking about them, but of those things of which the visible are images (...) They make them into hypotheses as though they knew them, and will give no further account of them (...) Starting from these, they go on till they arrive by agreement at the original object of their inquiry.' Plato approx 380 BC, (24)*

While the issue of scale is equally as crucial to *span* as *survey*, it functions in a slightly different manner, *span* is much less about the mass, the amount of complexity, than about the simple crossing of space. *span's* scale is determined by the architecture, the environment it finds itself in. *span* is a built line and as a line it is defined by Euclid as the shortest distance between two points. While the work's dimensions are mainly directed towards length, the work is intended to function in a minimally monumental fashion. In Gabo's manifesto point three proclaims: *"We renounce volume as a pictorial and plastic form of space; one cannot measure space in volumes as one cannot measure in yards: look at our space…what is it if not one continuous depth?. We affirm depth as the only pictorial and plastic form of space." (25)* Just as Gabo refuses to measure space in volumes, In *span* and preceding works I am attempting to approach monumentality from a different set of initial assumptions.

Monumentality has been a feature of sculpture since time immemorial, and the term has always been associated with the idea of a monument to something, to commemorate or remind. Judith Collins, writing in *Sculpture Today*, describes the shift in the usage of the term: *"As art has ceased to be controlled by church, state or nobility, and lost its historic public role, monuments to power, conquest and sacrifice are no longer commissioned from artists. However in the second half of the twentieth century, a new source of revenue appeared, specifically for the production of large scale public sculptures, so that the monumental came to replace the monument." (26)* The monumental is not the monument, it has become a function of scale not the measure of some institution or patron's power. This scale has always been judged relative to the human body, the human psyche being strongly affected by the relative size of different objects. In seeking to create a sense of the barely monumental, I am positing that a work approaches monumentality if it requires the body to move to apprehend its form fully, a work that cannot be comprehended from a single perspective.

span then is an attempt to approach this monumentality from a different angle. The work itself is relatively small, the space it commands and the affect it can produce in the viewer are substantial. A part of *span's* claims to this monumentality come from its close interaction with the architecture of the gallery. The work implicates the gallery in its resistance to gravity structurally, physically, the gallery is the support for the work. This monumentality is also a feature of the works interaction with gravity, which will be discussed in a later chapter

Another recent work, titled *selected proofs,* a collection of 34 small three-dimensional models of perspective demonstrations or proofs, is an example of the differing power of scale to affect the viewer. Like *node* each piece is constructed from 0.5 mm mechanical pencil leads although because of the large difference in scale, the effect is less one of fragility than intricacy. As three-dimensional projections of two-dimensional diagrams intended to represent space, these works have carried the intent of the diagrams to an absurd conclusion. No longer modelling space but occupying it, albeit in a small, timid fashion, these works may be considered, individually, as more “true”, more proven, than their two dimensional forebears. If we accept that to exist in the real world is to “prove” the two-dimensional theory, then certainly these small works have more authority than their precedents. Yet the projection into three dimensions is redundant, a tautology, the “proof” is no more convincing than the original. Indeed they merely emphasise the difference between conflicting and competing perspective theories, all claiming to resolve the same inquiry with divergent answers.

This is a work then about the beginnings of a system, the axioms of a syllogism, the initial precepts on which all further deduction is based. It is important to note that the assumptions that become enshrined once deduction has started, are seldom questioned. All of the works in *selected proofs* are directly modelled on different perspective proofs from various theorists and were published between approx 1400 and 1670, a period bracketed by the work of Brunelleschi at the start and Desargues at the end.

In one of the crowning achievements of the Italian Renaissance, in 1413 Filippo Brunelleschi demonstrated for the first time the proof of his linear perspective system from the steps of the cathedral whose dome he would later complete in a daring technological feat that would further ensure his lasting fame. Brunelleschi’s system was unique in being mathematically demonstrable, it could be applied to any situation and within its representational matrix relative sizes and positions of depicted objects could be calculated, it was an internally coherent structure whereby objects were not merely depicted but their relationships to other objects and perhaps, the observer, were codified, systematised and made legible. What made Brunelleschi’s system unique was its mathematical proof, and that that proof was coherent across the entire picture plane, so that objects and figures would sit in their correct and non-contradictory places. Brunelleschi achieved this through the use of vanishing points, points that literally vanish until they are little more than a geometric fiction, plotted across a horizon that is itself a vanishing axis. The eye being merely another vanishing point, privileged but bound by all the same rules. The intersection of lines projected from these vanishing points to the pictures edge provides a reference grid in which the size and position of any object or figure can be calculated (eventually) mathematically. It was accepted (despite some demonstrable inaccuracies) as an entirely objective system of representation, the first to achieve true objectivity as a result of its appeal to the authority of mathematics.

One of the most interesting aspects of Brunelleschi’s system is the bizarre procedure he utilised for its demonstration. Brunelleschi painted a small panel of the Baptistry of St. John, viewed from the steps of the Basilica di Santa Maria del Fiore in Florence's Piazza del Duomo, according to his new system, then drilled a small hole in it. He then would get the viewers, standing in the same position from which the panel had been painted, to look through the back of the picture towards the real scene but actually looking directly into a mirror reflecting back the painting. Why would Brunelleschi insist on such a complicated procedure? Could

the audience not have looked directly at the painting? Would that not actually have enabled them to more easily judge its accuracy? While a definite reason for this procedure would have been to enable the audience to directly compare the illusionistic depiction of the panel with the real scene, I would argue that another reason for this reflected representation was the necessity for Brunelleschi to define the viewing point. Brunelleschi was well aware that the accuracy and coherence of his new system within the picture plane also demanded a mutual accuracy in the point it was viewed from. Historian of mathematics Morris Kline stresses exactly this point while discussing Brunelleschi's system; *"The position of the artist's eye is inseparable from the design of the painting. To obtain the correct effect the (...) the spectator's eye should be at the level of the principal vanishing point and directly in front of it" (27).* I seems reasonable that when demonstrating his new system for the first time, Brunelleschi was careful to limit the viewpoint to the small aperture he drilled through his painting. From this one viewpoint the picture becomes truly objective in that is an allegedly identical experience for every individual observer.

For his second demonstration of his perspective system, a painting of Florence's Palazzo de' Signori, Brunelleschi dispensed with this complicated mirror apparatus and simply cut away the sky, leaving a skyline of buildings, that could be directly compared. For an initial audience unused to this precise technique of viewing, the mechanical constraints rendered by the hole and mirror were necessary. From the very first public viewing the linear perspective system has created a unique, individual yet totally interchangeable observer, yet it was only in this inaugural incarnation that this viewpoint was made physically manifest. That Brunelleschi did not use the technique in his second demonstration shows that he recognised the power of his system to organise space outside the picture plane. Clearly Brunelleschi was interested not only in creating the perfect system for creating illusionistic depictions of real space, he was also fascinated by the power of those systems to impose upon the viewer standardised conventions of viewing. All of the works in the *selected proofs* series share this “viewpoint”, a defined viewing position, and its orientation determines their placement in the gallery.

Although Brunelleschi’s system, recorded by Alberti, was adequate for nearly all practical painting applications, the field of perspective theories would remain very active until the work of Gerard Desargues in the late 1600’s. While differing theorists had been proposing alternative theories for hundreds of years, most had only been variations on Brunelleschi’s theme, and largely concerned with establishing the correct proportion of lengths and sizes within the picture plane. Brunelleschi’s theories and the theories of others up to Desargues, were all concerned with the measurement of distance within the picture plane. Desargues on the other hand, in an advance that would see him credited with the discovery of projective geometry, devised a system where the relative size of depicted objects was determined by the angle between them, these angles being rendered by a system incorporating advances recently made in trigonomic systems. This projective geometry, with its reference to the mathematic authority of the trigonomic system, was widely accepted as providing a final answer to the problem of depicting illusionistic space. However, Desargues' theory, while mathematically "ideal" was not really suitable for artistic practice, being a highly complex and technical method of obtaining results virtually indistinguishable from a competent use of Brunelleschi's far simpler system. However, its significance to this work is that it marks a neat point in history, book ending (with Brunelleschi) the period of most interest to this research.

For the chronological period covered by these works, the perspective system, as a method for creating illusionistic space, and the attendant consequences for the position of the viewer, was a system whose initial precepts, its foundations, were still malleable. Over this period the very axioms that all further implications of the system (a short list would include; figurative painting, photography, cinema, television, virtual reality, the very concept of the observer) would be built, were uncertain. Practitioners had an accurate idea of the criteria for success but the exact details of the rules and methods to accomplish those goals were incomplete. Different theorists advanced competing methodologies that varied from each other, some quite widely, others very similar, with just variances of complexity or practical application. Historian Martin Kemp discussing this period, states that the invention of linear perspective: *"…raises historical, artistic and scientific issues of great fascination and complexity, (…) and that its subsequent history (…) has been attended by controversies which centre upon the very nature of visual representation itself" (28)*, It is this controversy in a system of rules, its uncertainty, that is the main interest in this work. A work which is a series of contrasting "proofs" of essentially the same thing, how to depict the three dimensional world on a two dimensional plane.

All of these works in *selected proofs* are taken from demonstrations or proofs, from varying perspective theories. The usual format for a perspective theory were small books, composed of text and diagrams. Following the tradition of Euclid, these theories would start from simple axioms and build to complicated proofs through a rigorous system of logical incremental growth. Much of the diagram component would be made up of small workings illustrating salient points in the text. Most would also feature a demonstration or proof, usually in the form of a conclusion, to indicate the veracity of the earlier methods shown. It is from these "proofs" that the individual components of this work are chosen. Often these demonstrations are drawn in a contrasting manner to the simple geometric workings, in a three-dimensional style themselves. This was the initial provocation to explore creating these works. As the proofs are represented as three dimensional, their transformation into sculpture seemed an interesting potential. How, I speculated, would the various proofs read once rendered into the real?

As the diagrams become translated into three-dimensional objects, the conflict between the ideal world of the diagram, of the plan, and the imperfect, three dimensional, real world became a material issue. Most viewers' initial impression of the work is one of a precise intricacy, the small scale and tiny components amplifying this effect. However on closer inspection this impression is easily diluted. While lines in a diagram effortlessly intersect, meeting at points that are little more than mathematical fictions, in the imperfect, real world, this is less possible. Even though only 0.5mm thick, the graphite leads cannot intersect, or meet, perfectly at dimensionless points. The thickness, the materiality of the media, obstructs and deforms the system that, in two dimensions, performed flawlessly as a plan. Consequently, on close inspection flaws can easily be found in what at first glance seemed incredibly intricate, precise structures. Angles are askew, squares lop-sided, graphite forms pressed into inelegant lumps where too many are trying to occupy the same space. The shift into three dimensions has sullied the impossible perfection of the diagram source.

Scale is also carefully employed to achieve a specific affect, both in terms of the number of individual perspective models and the size of each. In its final state this work was composed of 34 discrete units, each a different demonstration of a particular theory. This was the largest number of distinct versions that could be found during my research. While no two are the same, the viewer is able to recognise themes, trends and

familial resemblances among the different works. With no prior knowledge of the subject matter there is still a sense of commonality obtained as the various units display similar features and tendencies. The scale of each individual model is determined by the longest unbroken line required, which has to be limited to 75mm as this is the longest length of pencil lead available. All of the works are therefore necessarily very small, and this limitation provides a coherent sense of a group as all the individual units are of a very similar size. A further consequence of this scaling is that the discrete objects appear very close to their apparent size in their printed form, further reinforcing their reading as drawings.

The structural nature of the work is one of the strongest responses amongst the audience, who frequently read the works as small architectural or scientific models. While not exactly a secret, the source material of the works has not been made conspicuously evident when this work has been exhibited, although it has been mentioned in accompanying catalogues and floor talks. In view of the works focus on uncertainty, the readings as architectural or scientific diagrams, is significant. Without knowledge of the true origins, the works are still interpreted (especially in the architectural sense) as models for space, structural investigations. In the sense of this research, where the power of the diagrammatic system to affect and control real space is the key theme, these readings must be seen as a success, there is an inherent legibility to the diagram form that immediately invokes spatial systems in the viewer, a tiny model is sufficient to suggest a huge form.

It is this alternative approach to scale and monumentality that *span* explores. Gabo points the way toward this thinking in his Realistic manifesto. Arguing for the renunciation of the *"age old prejudice that you cannot free the volume from mass",* Gabo claims that he can: *"…take four planes and we construct with them the same volume as four tons of mass. Thus we bring back to sculpture the line as a direction and in it we affirm depth as the one form of space." (29)*. Although Gabo is arguing against a sculpture that consists largely of cast bronze and carved stone, the way in which Gabo's four planes occupy the same volume as four tons of mass is the same as the way in which *span* occupies a much larger space in the gallery. Gabo argues that it is not necessary to clumsily fill a space with marble, bronze or plaster to occupy that space, a space can be surrounded, described by active lines. *span* pushes this argument almost to its limits. The work occupies and activates a space much larger than the work itself in the most minimal fashion, the space is plotted, made metrical by the work, even while the work itself is barely present.

Another issue raised by the alternative approach to monumentality of Gabo and others is that of permanence. While the inert filling of space which appalled Gabo in 1920 has even less relevance to contemporary practise, there is no denying that cast bronze or carved stone are (at least on a human scale) remarkably durable and permanent materials. It seems that sculpture not built on occupying mass will inevitably have to address its own longevity, in some manner and degree it will be ephemeral. While Gabo does not explicitly discuss this ephemerality in this text, from his comments on the both the past and future: *"the past we are leaving behind as carrion. The future we leave to the fortune tellers. We take the present day." (30)*. It seems likely that this loss of permanence would have seemed of little consequence to him.

Rather than being merely a loss of permanence the move away from bronze and marble enabled sculpture to embrace a wide new range of materials and affects, enabling ephemerality itself to become the

theme of a work. In *span*, as in *survey*, the relative permanence of the work, the possibility of its survival, is a key aspect of its affect. This is closely linked to the fragility of the material, but this fragility, discussed above, is more relevant to the individual components of the work, what we are discussing here is how fit to survive, the entire structure is, its likelihood of failure.

Both the works are systems pushed to the very limits of their own structural integrity. Performing at the extremes of the possible, the potential of failure becomes very real for the work. The sculpture contains an implied collapse, which adds to the implicit drama of what are very minimal geometric works. *span* is only temporary, for now it is fulfilling a function to which it is not terribly well suited, but even as it continues to do this, it never escapes from the implied collapse, the viewer half expects to see it crumble and collapse before their eyes.

Exhibited in 2010, at the Hirschfield Gallery in Wellington, *Untitled* was an installation that addressed this permanence in a less effective manner. While in many ways a successful work, in this aspect the work is interesting to compare with *span*. Inspired by the dubious techno-utopias of Buckminster Fuller[4], this work was an incomplete three-metre diameter dome. The thousands of tiny graphite lines, each perfectly straight, worked incrementally to produce the very gradual curve of the works sphericality. The interest for this work was geometry and trigonometry's relationship to the sphere. The sphere is always the perfect, absolute, form; also the simplest. Mathematician William Dunham claims: *"The sphere is simplicity itself. No three-dimensional body can be more easily defined, and none exhibits more perfect symmetry. It is indisputably pure."(31)*. Common in nature it is a form that human technologies struggle to produce. This struggle to account for the sphere, while simultaneously acknowledging its perfection is one of the key interests in constructing such a large-scale work in this manner. The work is a drawn circle, and the instrument used for drawing circles perhaps best illuminates the special status applied to circles and spheres.

The compass is the only common drawing instrument designed for drawing just one shape, the circle (although of varying sizes). While useful for other roles (in navigation for course plotting) it is always and only used to make circles (two dimensional spheres) even if only arcs of circles are actually drawn. No other drawing instrument is so specialised and also so indispensable, what a compass does cannot be replicated by any other mechanical drawing instrument, combination of instruments or advanced technique. Coupled

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[4] Buckminster Fuller (1895-1983) was an engineer who produced many novel engineering designs, none of which ever attained large scale production. His signature geodesic domes, while stunning architectural achievements were found to be prone to leaks and to feature a large proportion of unusable space. The only mass production of these domes was for U.S Air Force radar domes in inhospitable arctic environments. Most notable for his geodesic structures, many of Fuller's designs proved hopelessly unrealistic. Perhaps most notable of these was Fuller's attempt to revolutionise the automobile industry through the application of nautical techniques to car design. The resultant Dymaxion car, admittedly very streamlined, featured eleven seats and a periscope. In retrospect many of Fuller's design seem absurdly ambitious, bordering on megalomaniacal, impossible structures such as a three mile diameter transparent dome over Manhattan and giant floating cities hint at the inherent danger of utopian ideas when they become detached from the necessities of physical reality.

with this specialisation is the instrument's essential material and utilitarian simplicity, a useful compass can be constructed from a string, pin and pencil, and even the most complex versions are extremely simple implements, especially when the complexity of a hypothetical mechanical instrument for drawing hexagons, for instance, is imagined.

As the graphite leads only do straight lines, the essential simplicity of the compass is denied to this structure, and as a collection of angles all it can ever do is approximate the sphere. It is a dubious replica, an overly complex model, that exceeds what it is modelling only in its clumsy inefficiency. While researching this project I was influenced by the image below, which captures the Montreal Biosphere, a Fuller dome, constructed for the 1967 world expo, on fire (a fire that spurred the under utilised buildings eventual renovation). This powerful photo of utopian architecture suffering disaster and chaos, led me to aim for a degraded, relic like aspect to this work.

This was achieved by making the dome incomplete, while forming a complete circle at the equator on the floor. As the work rises it becomes less complete, cracks and fissures open until the work raggedly peters out. By incorporating this worn down incompleteness to the work, I was hoping to accentuate the works impermanence, to focus on the implied downfall of the system depicted. Contrary to this aim, the incompleteness of the structure is equally open to the reading of the work still being in construction, rather than in a process of crumbling demise. However I thought the fragility of the material, and the palpable insubstantiality of the structure, would tend to colour the viewer's reaction towards the work being read as in decay, rather than still in construction.

Although the obvious fragility of the material emphasised the apparent decay, when the work was complete it was obvious that this effect/affect was being achieved more successfully by the work in a different area. At the highest peaks of the work, the curvature of the work resulted in a significant overhang, where the work juts out over empty space. These parts of the work carried strong readings of being in jeopardy, their continued survival unlikely. The lower parts of the work are more vertical and the geometric structure seems more solid, grounded, but once the work curves over, the strain and tension in the structure became palpable. This implied collapse was a result of scale, there is a minimum size that the work needs to be in order to accomplish this affect/effect, and this minimum scale is aligned to the axis of gravity.

Although *untitled* was, at three meters diameter, a large work, and certainly operated on the human scale in that the viewer could walk around it, the scale was more effective in one axis than the others. The circumference, the works largest aspect, really added only bulk, the complexity of the work being accomplished through its sheer scale, the massive number of iterations of the same basic pattern needed to occupy such a space. While such complexity is an important part of the work, this aspect of scale, the width, did not perform as effectively as the vertical aspect of the installation. When aligned with the vertical axis, or placed in dialogue with gravity, the scale of the work functioned more effectively to produce the affect/effect of an implied collapse, an implicit, uncertain impermanence.

span has pushed this finding to an extreme. The work, three meters long, ten centimetres high and eight wide is large in only one dimension, its length. Scale has been focussed in this work on only the axis in

which the work will be opposed to gravity. The works size has been deployed only in the direction that will enable it to address the implied collapse. The longer the work, the more uncertain, the more tenuous it becomes and hence more successful. This is a different approach to scale and monumentality, the result of an investigation into different approaches to monumentality, where size is not deployed to create a monument to something or someone, but in order to make the work more viscerally interactive for the viewer. Scale, in both *survey* and *span* has been used to make the works palpably engaged with natural forces, the same world the human body inhabits. This material, in similar formal constructions, performs significantly differently on different scales. Tiny works like the *selected proofs* series are intricate models, inhabiting the model space they are somewhat removed from reality. This is reflected by their capacity to remain appreciably unaffected by natural forces such as gravity. Similar works on a larger human scale are explicitly engaged with these forces.

The main reason for pursuing larger work and the continual growth of succeeding iterations of *survey* has been the observation, that the larger the scale of the work, the more palpable its relationship to gravity. Gravity places every line in the structure under tension, every line is activated, made dynamic. On a larger scale this affect/effect creates a visceral reaction in the viewer, as our constant bodily subjection to gravity has resulted in a keen intuitive awareness of its properties. This intuition locates the work in time, its temporary nature and absolute disregard for durability emphasised by an impression of the works ultimate demise. This idea of an implied collapse, of the work finally succumbing to the gravity that has patiently pulled at it, is another aspect of the work where this static object approaches kineticism. This tacit kineticism, an implied motion, is integral to the work affecting the audience.

survey: gravity

> "*Gravity unites the sculpture and the spectator in a common dependence on and resistance to the pull of the earth. Materials and structure, volume and space, the unity of proportions of sculpture, do not speak for themselves but articulate a complex and profound sense of our own being in the world*" *William Tucker, 1974,(32)*

The idea for the works which would become the *survey* series originated from a body of map-making experiments I carried out as research into large scale spatial diagrams. These consisted of exercises involving the mapping of local areas in a personalised but compromised matrix of paces and bearings. Despite the performative and two-dimensional aspects of these walking, mapping works, they functioned as research that informed three-dimensional works in graphite and folded paper. Exactly the same shapes and formalism appeared in the straight lines of trigonometric, large scale mapping as in the brittle lines of the graphite structure, and while it is obvious that the faceted triangular form will model the space it describes, the space described will also affect the system describing it. The irregular trigonomic structure of a work like *survey* or *node*, was not only a system for describing and codifying space, it also bore a likeness to the landscapes it mapped.

Although none of this mapping work has been exhibited, it was key to the development of the work *survey*, shown as part of the exhibition “tenuous” at Pataka Museum in Porirua. This work is chiefly about the mapping of space and can be thought of as a maquette derived from my navigational readings and investigations of mapping technologies. Looking like a trigonomic survey of a coastline, an array of graphite pencil leads is cantilevered out from the gallery wall, encroaching into the space of the viewer. In keeping with the name tenuous given to the show, I have endeavoured to push the material here to its limits, a system for ordering space extended far enough that it is in danger of collapsing under its own weight. The omnipresence of gravity, which ultimately tries to render all mass back into the purity of the sphere, pulls at the fragile structure that aims to impose a human order on the space it invades. The very precariousness of this work conveys a sense of a systematic rendering, that while appearing intricate and precise it is nearing the limits of its efficacy, if it continues in its present fashion its demise is obvious, but for now it is stable, even, as a model, functional, useful.

In this work the effect of cantilevering the object out from the wall has addressed in new ways the concept of a fragile system ultimately doomed to break down and subsequently fail. By implicating gravity as the antagonist in this system, its precarious nature, and the folly of continuing in the same manner is emphasised. All real space is encumbered with gravity, just as it is absent in all two-dimensional abstractions of space; drawing is weightless, abstract, while anything real, concrete, carries and endures weight. Gravity is the *sine qua non* of reality, it cannot be negotiated with or cheated, it can only be obeyed, and it is this very quality of mundane necessity that makes gravity, and hence exhibiting the work projecting out from the wall, such a good method of exacerbating the works fragility.

Scale as in *node*, is crucial to conveying this sculptural manifestation of a flawed system. The work needs to be of a large enough size for gravity's grip on it to be palpable. Where small works like *selected proofs,* are too modest to really visually suffer gravity's effect, larger works that approach a monumental scale achieve this easily. This large wall work achieves its size through its length, it occupies enough space that the viewer needs to walk around it to appreciate, this necessity of movement to acknowledge is the sense in which this work addresses its need to deal with the monumental.

I was given the opportunity to exhibit an early version of *survey* at an exhibition entitled "big data" at the National Library in Wellington. This exhibition focused on the social depiction of space, what would once have been called geography. While this theme suited the underlying concerns of this work very well, and this larger more complex version entitled *survey II*, was well received, I feel it was less successful than the original *survey* exhibited at Pataka. The space offered at the National Library was a large entirely glassed-in room, inaccessible, in the middle of a large reading room/ exhibition space. While satisfied with the work itself, my concerns reside in the mounting of it within the space. Due to the closed off nature to the site I felt that a floor mounted work would not operate successfully as there was no opportunity for the audience to approach the work as with for example *node*. In fact I thought of the site more as a huge fish tank, a space you have privileged visual access to but which is physically sealed off. Taking this "fish tank" idea further the glassing in of this space, its inaccessibility to all senses except the visual, made it a more "virtual" space, more like a screen than a room. As the space was glassed in with no walls on which to affix the work the same approach that I felt worked so successfully in the first *survey* at Pataka was not available. I was also aware that although limiting in some senses the terrarium-like space also offered opportunities. For once the physical fragility of the work and its continued existence were not to be problems in the exhibition of the work. At the same time, this same fragility, while a practical, technical issue in exhibiting previous work, had also been a key strength in those works and a fundamental part of the viewer's reaction.

In retrospect it seems to me that the best answer to positioning a work in this unexpectedly difficult site would have been to build a large enough structure that it could bridge the space. Supported from opposite glass walls, the whole space could be occupied, by incorporating the architecture as a support structure, no external additions would be required and the work would subsequently retain the simplicity of its essential dialogue with gravity. However there was not the available time frame in which to construct a work to this scale. In reality I was left with two options, place a structure underneath to hold the work up, or to suspend the work from the ceiling. Initially I was determined to construct narrow triangular legs with which to hold the work up at its designed viewing height. However on experimenting with models and scale versions I became very concerned that the work could be read as furniture design, which would only function to confuse the work. Therefore, in consultation with the curator, I began to investigate suspending the work, a technique I had utilised for the safe handling and shipment of large works and a method by which gravity is no longer the opposing force but is to some extent enlisted in the structure and actually becomes complicit in strengthening the work. When suspended from multiple points the method operates rather like an inverted arch, contributing to the overall structural integrity of the sculpture. While the cantilevered precariousness that had been crucial to the first *survey* would be lost by this method of installation, there were mitigating factors that argued for its utilisation.

The exhibition “big data” was concerned mainly with the National Library’s collection of New Zealand geographical information: pre European Maori tracks and maps; contact era maps, surveys and landscape painting, cartographic and surveying equipment: social data such as census information and a considerable amount of contemporary and near future map making technologies and their outputs. In this setting I felt that a slightly different reading could be coaxed from the work, one in which it functioned more as a barely physically present, pseudo-high tech cartographic visualisation. The work shares an aesthetic with vector diagrams used to construct virtual computer models, an aesthetic shared by much of the other material in the exhibition. The glassed-in, fish-tank like space added to this virtual reading of the work in that it was much more a closed off, hermetically sealed space than any I had previously worked in. While the proximity of the audience had often been a source of problems in exhibiting large graphite works- and this site at first seemed to resolve all those issues- it came to reinforce to me how crucial that audience proximity actually was and how different the work was when “safely” sealed off behind glass. Without that closeness to the audience it was not able to activate a sense of imminent destruction and became instead far more about recreation in scale, rather than the visceral apprehension of fragility aimed for in previous work.

Given the constraints of the site, I decided that this approach was to be embraced rather than opposed and hence opted for hanging the work. The work then became a rendered pseudo-virtual model, hanging in the non-space of the glassed in room. Lit from above the work presented an array of differing angles, each catching the light at slightly varying angles and creating an assortment of luminosities. The glittering complexity evokes the effect of holograms (a reading that I have heard from audiences for several large graphite works and one I find of interest in accounting for the perceived immateriality of the object) and computer rendered landscapes and becomes, in keeping with the rest of the exhibition more about the modelling of space, reproducing in a reduced scale, as opposed to the key aim of the rest of the work featured in this exegesis, in which the key aim is to push a system to its tangible limits. As such in the terms of this investigation the work could not be considered a success, The result of hanging the work was to shift the relationship with gravity of the work, to suspend the work is to place it in an accord with gravity, the work hangs, finds its own point of stability. While suspension may still engage with gravity, it is in a subservient manner, hanging a work is to place it in abeyance to gravity, where a projecting work of mine, such as *survey* or *span*, gains its affective power through being opposed to gravity, and the sense of peril inherent in this graphic violation of a ubiquitous, insensate natural force.

It is also important that when hanging a work like this, suspending it from a ceiling, the audience is always conscious of how the work is installed. It is illustrative of the intuitive, tacit understanding of gravity that all people possess, that, no matter how transparent the fishing line, the audience is immediately aware of how the work is hung. People are so attuned to the operations of gravity that an attempt to hide a gravitational apparatus, no matter how carefully concealed, will always fail. Suspension does not overcome gravity’s effect, it merely emphasises the hand of the maker, caught in the clumsy attempt to mislead.

This failure to engage gravity in the desired manner is also reflected in the dynamics of actually suspending the work; the structural fragility so central to the work, is also compromised. When hung from various points, a work like *survey II* actually becomes a much stronger structure. The differing hanging points create an inverse arch effect, the work compressing together, gaining rigidity, like an inverted simple

keystone arch bridge. The stability and reinforcing provided by the suspension, while interesting engineering affects, run counter to the established aims of this body of work and results in a much less interesting, less affective work, than where *survey* simply projects from the wall, explicitly engaged in a dialogue with gravity, a dialogue that the audience bodily understands imperils the entire system. The only conclusion possible is that, in respect to my stated aims, suspending the work was a failed experiment, an experiment whose failure and the methodology of its failure, pointed the way to the resolution of this work, highlighting exactly the success of the projection installation of the work, *survey*.

Sarah Sze has become prominent for sculptural installations that share, to some extent, an ethereal, complex aesthetic with works of mine. Large installations featuring arrayed multiples of different mass-produced consumer items, Sze's forms suggest model cities, arcologies. These works are varied yet repetitive, small areas of varying order breaking out within the larger mass. Sze's fragile architectonic constructions, for example *Second Means of Egress*,(1998), are often attached to, or braced by the pre existing walls, floors and ceilings of the site and feature a tenuous girder-form structure in areas that is strongly reminiscent of work such as *survey*. Although Sze's work can feature many disparate elements, her works tend to be constructed from a multitude of small parts all conjoined to form large complicated structures recognisable as architectural or city like forms. Whereas a work such as *survey* does share some very similar elements with some of Sze's work, there are also many differences between both the approach taken and the reaction to these works.

Perhaps the most immediate difference between these two bodies of work is in the choice of material. Where Sze makes use of large quantities of different materials, often formed into discrete modules joined into a larger heterogeneous mass, works of mine, such as *survey*, are built entirely from the one material, the 0.5mm graphite forming one homogenous conglomeration. This concentration on the one material, and that being a material used almost exclusively for drawing results in a more focused range of readings for my work. Where Sze's work are dreamlike evocations of complex, heterogeneous, city like shapes, mine are homogeneous brittle incursions into and explorations of space.

The greater though perhaps less obvious difference between the two types of work is however in the two treatments of fragility. In Sze's work there is a light, tenuous quality to the installations that definitely references and infers fragility in many instances. Often this is a delicacy in the way that the different materials are composed, stacked or balanced, while the individual components themselves are actually quite resilient. The fragility present therefore is predicated on the uses the materials are put to. It is a designed fragility, an aesthetic tentativeness, an affect I have labelled ethereal.

The fragility apparent in my sculptures though is of a different kind, where Sze's fragility is one arising from the manner in which the components are arranged, mine is perhaps of an opposite nature. I begin with a superbly fragile material and then attempt to construct as durable a structure as possible from it. This results in a more dynamic, activated structure, every line plays a pivotal role in the continued existence of the larger whole, there is no excess, no flourish; everything is essential, everything is necessary. In *survey* or *node* the fragility is inherent, and integral to every component of the work. It is not a consequence of the technique or methodology of the works construction or display, it is the work itself.

As fragile and complex as Sze's works appear, this is a result of the sparseness of the construction, there is a lightness, or insubstantiality to the installations, this apparent effect is in contrast to the more bodily affective result of a work such as *survey*, where the construction is in negotiation with gravity. This incorporation of gravity as the work's antagonist, where the work is cantilevered out from the wall, rather than being built up from the floor, or scaling the wall in the way Sze's work often does, creates a much stronger impact upon the audience. Gravity is such a constant, always understood physically by the body, constantly acting upon all objects we encounter, that the viewer instantly comprehends its effect. As Michel Serres writes in his text "The Birth of Physics": *"Weight and complexity are the engines of separation. Fall assures difference, as creation. Once again, the fall gives order, as well as drift, decline, disorder. Always the double operator: the fall, here, is productive."(33)* The already fragile work is projecting out from the wall, the empty space below it a recognisable and physically understood threat to it, emphasising its affect on the viewer.

This affective role taken by gravity in my works provides an implied chronology that is missing, or perhaps, less present in Sze's works. The implied collapse of the work, the way in which its future seems imperilled, provides an overarching narrative to the work. If the sculptures seems so obviously tenuous that is because the viewer is already anticipating the future, assessing its current state and making assumptions about its fate. This "temporal resonance of affect" as Lone Bertelsen and Andrew Murphie characterise it, is the achievement of a temporal dynamic in a static object: *"Refrains join with future forces by stitching themselves into them. They are able to do this because affects, as transitions or passages, are able to link up across senses, across events, across "temporal contours*",(34) The refrain here is fragility, innumerable fragile components interlaced, the refrain repeated with every piece, and with every iteration the refrain conjures the apparently inevitable result; collapse.

The work of Richard Serra, in particular his large tilted steel works, such as *torqued ellipse* (1997) is much closer to the relationship with gravity that I am seeking to explore in my own work. Serra has created many of these huge works, where plates of steel, gently curved and subtly deviating from the vertical are set on the ground, where they overhang and curve away from and to the viewer is relevant to this discussion of scale. At first glance these works may seem very different to mine, one massive singular piece as opposed to thousands of homogeneous components; the steel of Serra is a material that is the very essence of robust industrialism, while my graphite is the fragile material of insubstantial drawings. And yet, in spite of these obvious differences, there is an aspect of Serra's works that illuminates perfectly the resolution of my work, this aspect is in Serra's use of gravity to activate the work, the enlisting of gravity for its affective potential, what I have termed the implied collapse.

Serra's works are very large, and the obvious weight and strength of the material make it tilt slightly, the works seem always on the point of toppling, frozen at the moment of succumbing to gravity's omnipresent pull. While completely immobile this implied collapse generates a certain form of kineticism to the work, no motion occurs, but motion (and any motion in a work like this would be dramatic indeed) seems constantly on the verge of happening, a potential kineticism that is as potently affective as any genuine motion in other more traditionally kinetic sculpture.

Serra skilfully manipulates the potential for a catastrophic collapse, a sensed disaster that never actually happens. Conscious of the affective power of an objects dialogue with gravity, the works are placed in the gallery so as to heighten the viewers intuitive appreciation. Discussing *Plunge* (1983), art historian Armin Zweite writes *"…the tilt- in the case of Plunge, something over three degrees, for example- is so minimally calculated that it is sensed before it is seen. Gravitation working on the blocks, the pressure bearing down on the floor, the tendency of the verticals to turn to horizontals are thus as much sensed by the viewer as the great inertia of the steel discs." (35)*. It is this visceral apprehension of gravity's affect/effect coupled with the dramatic affect of implied collapse that makes these large, but minimal works so successful, and this is also the declared aim for my works discussed here.

Scale is an important factor in this element of Serra's work, in order to achieve this effect, it is necessary for the work to function in accord with human conceptions of scale. The sculpture must be larger than its audience, it must tower over them, encompass them in its shadow. It is not overstating the case to say that if the work were scaled down, even if identical in all other aspects, it would cease to achieve this gravitational affect. The works must be monumental, monumentality being construed as a quality gained by any sculpture that occupies any volume larger than the human body, any object it is necessary to move around to view in its entirety. In terms of the relationship with gravity, the larger Serra's sculpture the more effective (and consequently affective) this potential becomes.

This issue of scale is also a factor in my work, in the case of work that is very small such as *selected proofs*, the tiny nature of the works negates the apparent affect of gravity upon them, although still palpably fragile, the works are too small for the affect of gravity to be easily appreciable to the viewer. In larger work such as *node* or *survey* however, the scale of the work is such that its own apparent weight can become active. When constructing these works, this size, or scale, was one of the key goals for the work, I desired to make the works big enough to achieve this affect. Obviously when discussing scale it must be admitted that Serra operates in a scale that my sculptures have not yet approached, yet when designing these works I was aiming for the smallest size (being limited by time for construction, transportation and the scale of the destination for these works) available at which a palpable susceptibility to gravity could be engendered and there is good reason to suspect that this minimum size is larger for a strong, industrial material like steel, than for a fragile drawing media like graphite pencil leads. While I believe these works have achieved this affect, I am very aware that scale, and its potential to magnify the gravitationally induced affect, is an area in which this body of work still has room for growth.

Placement of the work in space is also a crucial factor in both Serra's work and *survey*. In early large steel works, such as *Strike: To Roberta and Rudy* (1969-1971), the huge steel plates are so cleverly incorporated into the existing architecture that despite their massive, and obvious, weight, the works are held vertical without any fastening. *Strike: To Roberta and Rudy* (1969-1971) consists of one steel plate, 2.5 meters by 8 meters by 25 mm, and weighing nearly four tons, this massive plane is located with a vertical edge inserted into the corner of the gallery space, the support in the corner, coupled with the inertia of the work, hold it steady in the vertical. The realisation that these works are not fixed immediately creates a terror of the works fall within the audience, who are so conditioned to the effects and propensities of gravity, that they are bodily affected by the work, in all likelihood they instinctively retreat, turn away from it.

The locating of the work in the gallery is also key to the viewer's interaction with it. At the two first iterations of *survey*, at Pataka and the National Library, I was not able to establish the long sight lines for the work that previous experience, exhibiting at the Adam Art Gallery and City Gallery had shown me to be extremely valuable in heightening the work's affect. Exhibiting as part of a group show at the Adam Art Gallery, I had shown the first large graphite work, *as yet untitled*, in 2009. I had asked the gallery staff not to repaint the gallery space back to white from the grey it had been painted for the previous show, this dark background made the work even less visible from a distance, an effect heightened by the dark, recycled rubber floors of the Adam. Coupled with the reasonably long sight line provided by the space, the work could barely be perceived at a distance, only gaining substantiality as the viewer approached. This immateriality of the work at a distance was a very powerful feature and yet in the first two iterations of *survey* this aspect was not able to be fully resolved.

At Pataka, the architecture of the space did not permit a sight line long enough, and this first version of the work was perhaps not of a large enough scale to capitalise on such a spatial orientation. At the National Library the glassed in exhibition space, and the inevitable reflections, both internal and of the buildings lights, meant that although there should have been extremely long sight lines, particularly from the entrance, the work was essentially invisible behind the glass at the longer distances. When it came time to discuss the possibility of installing a large work for Te Puna O Waiwhetu, Christchurch Public Art Gallery exhibition *shifting lines*, I was adamant that the work required a long sight line and approach for the viewer. It was this version of *survey* in which I felt that this particular work became resolved, combining the larger scale with long sight lines. The result of the long sight line with a clear approach was that initially, at first sight, the work appears two dimensional, slowly resolving into three with proximity. The viewer is first drawn forward and then a shift in perception occurs as the brain struggles to process visual irregularities in what is assumed to be a traditional wall drawing. On recognising its three dimensionality the viewer will pause, forced to reassess their perceptions.

When installing *survey* for presentation in support of this exegesis, positioning the work in the engine room space was a key concern. Only in the exhibition *shifting lines* had I felt the work to be resolved and therefore planned the installation around lessons learnt from that. I wanted a long sight line and approach, with survey installed on the back wall, visible, (perhaps perceptible is more accurate) from even outside the gallery through the glass door. The affect aimed for by this forced approach from a distance to the work is similar, although without the extreme affect of the perceived threat to personal safety, as that induced by Serra's carefully placed steel plates. Describing the affect of Serra's work, Armin Zweite focuses on the body as the site and means of perception: *"Subject and object are correlated, the phenomenology of the body is essential as a transcendental viewpoint for the phenomenology of perception." (36)* Serra's work is so successful because it achieves this activation of the phenomenology of the body through its dialogue with gravity, the transcendental viewpoint being the bodily affect of the work. This affect is also a declared goal for my work, and while I feel it has been pursued with some success, I cannot argue that the work is operating on quite the same level as a work of Serra's such as *Strike: To Roberta and Rudy* (1969-1971).

Having experienced some of Serra's work, it is clear to me that the bodily affect of his sculpture is different to that induced by my work, such as *survey*, this is due to a key difference in the two types of work. Serra's work provokes a response whereby the uncertainty of the work is perceived as being a threat to the viewer's survival. Ushered into relatively small spaces, the palpably heavy steel plates seem to loom above the viewer, having learnt that they are just placed there, not fixed, the viewer cannot help but feel scared, concerned for their own survival. With my work the threat is to the work itself, it is the works continued survival at stake. Where Serra's work incorporates implied collapse to engender a sense of threat to the observer, the subject; my work utilises implied collapse to create a perceived threat to the work itself, the object. This significant difference accounts for the varying power of the affect triggered by each work, a threat to self is naturally felt more powerfully than a threat to some external inanimate object. My intent has always been to induce a sense of the uncertainty of systems, their fragility, I am not interested in dealing with perceptions of human mortality, or simply scaring people. While both Serra and I are, in the deployment of gravity and a visceral response to it, employing similar methods, the affects/effects of these methods are aimed at totally different targets.

The goal is to account for an affective property of sculpture that approaches kineticism by being activated through its interaction with gravity. This gravitational affective property, evidenced by Serra's huge steel plate works, has been the key advance made in resolving the body of work I have addressed here. From being merely a function of the scale of early works like *node*, this affect has been amplified through the unsupported projection from the wall of a work like *survey*, putting the scale of the work into a more direct confrontation with gravity. While differing in almost every respect imaginable to Serra's work, the pursuit and I hope accomplishment of this goal has resulted in an enriching and resolution to this body of work, wringing maximum results from such an austere, minimal media.

span: gravity

> *"...affect is the hinge where mutable matter and wonder (ofttimes densely intermingled with world weary dread too) perpetually tumble into each other." Gregory Seigworth, and Melissa Gregg, 2010,(37)*

Following what I perceived as the resolution of *survey*, when it was exhibited in the shifting lines exhibition in Christchurch, I decided that the relationship with gravity was the aspect of the work that was operating most powerfully. I therefore pursued an investigation aimed at focusing on just this aspect, bringing it to the fore of a new work, work that evolved into *span*. *span* is just that, a space spanned, a minimal line demarcating, and codifying the space it bridges. Span does not carry the overtones of landscape modelling of *survey*, or the reference to perspective of selected proofs, it is a simple defiance of gravity, a fragile system linking two walls, creating pattern and order as it delineates space. This work is the most recent and most basic expression of the new knowledge gained during the research, both theoretical and practical, carried out for this exegesis, and the practical research and experimentation which led to this work was a direct exploration of the media and its attendant system's ability to occupy and delineate space.

span began with simple experiments into projecting wall works, including *survey*, works that jut out into space, supporting themselves as they protruded. Some of these works, mirroring the engineering aesthetics that deal with exactly the same issues in the real world, quickly came to reference girders, the triangular lattices that are such a common sight at construction sites. Wherever physical engineering requires rigid strength a girder is used, the triangular bracing ensuring the forms resilience. As these load bearing structures are frequently hidden by functionally aesthetic claddings, the girder is perhaps most recognisable in more utilitarian applications such as bridges and cranes. Even when concealed behind the cladding of a building, the same principles utilised in the girder are present in all buildings, high-rise buildings can be thought of a massive vertical girders. With very few exceptions, when humans need to defy gravity's inexorable drag, a girder of some form will be involved.

Despite the natural tendency for the girder to present itself as the best way of bridging space, there is also an economy to its design that made it an obvious choice. Girders are designed and constructed primarily to extract the most strength and rigidity from the least amount of material. This essential simplicity was reflected in the girder designs I experimented with. The minimal nature of both my media and concept were entirely in accord with the engineering principles modelled by the full-scale version. The media of 0.5 mm graphite leads ensured that there was a key difference to the structures of large scale architecture and engineering; a girder is always designed around longerons, length wise unbroken lines of steel that form the basis for the girder. In graphite these unbroken lengths are simply not possible, the girder must be constructed from very short lengths, interlinked and interlaced, the dynamics and tension that the structure endures are transmitted through a more complex and tentative structure. This incremental structure also

results in a more “sketched” or freehand texture to the work, where the unbroken longeron design of the real girder results in ruler straight structures (anything less would be extremely undesirable) my tentative little girder is obviously handmade.

This sketched quality to this work emphasises its handmade quality, which in turn highlights the works fragility. The lack of the precision so characteristic of large-scale architecture, the unsuitability of the material, the extreme uncertainty of what the work achieves, all combine to make the work’s crossing of space an active investigation. It is this active investigation in the work that prevents it from being merely a model of a girder. If the work were a small scale girder of the same design, made from metal, installed in exactly the same location, it would be merely a model, a small reproduction of something well understood in the real world, it would be a bland and shallow artwork.

But *span* is not a model and this is because its outcome is uncertain. The work’s tenuous future, due to fragility, scale, and opposition to gravity make it a continuing experiment into its own ability to inhabit three-dimensional space. The constant threat of the work succumbing to the incessant drag of gravity at any point over its entire length, makes the work active, a maquette to experiment with the possibilities of the system. The uncertainty over the work's survival, the possibility or even inevitability, of the implied collapse animates the entire work, creating a far stronger engagement with the audience than is possible for a mere model. A model is just a three-dimensional illustration the audience is invited to view, *span* is a three-dimensional experiment for the audience to witness, the result of which is darkly imagined but ultimately unknown.

While fragility and scale both play key roles in how *span* operates, it is gravity that provides the activating agent. Considering sculpture as three-dimensional art, it is obvious that all sculpture must deal with gravity. Just as my shifting the location of drawing systems from two dimensions to three has brought gravity to the fore as a sculptural element, so any three dimensional object must deal with gravity. Perhaps the most obvious example of gravity’s crucial, but often overlooked role in sculpture can be found in the plinth, a sculptural tradition whose entire purpose was to raise the work off the ground, a clumsy, obvious method of combating gravity. One of the turning points in the search for alternatives to the plinth was some work of Vladimir Tatlin, like Naum Gabo, one of the most prominent of the Russia Constructivists.

Tatlin is perhaps most famous for his unbuilt and apparently unbuildable, *Monument to the Third International.* This absurdly utopian design for a headquarters for the world revolution was to be twice the height of the empire state building and featured three vast buildings inside its spiral lattice that revolved at differing speeds. The building was designed during the tragically brief ‘heroic period’ when the constructivist’s urge to use modern technologies as creative tools to construct a new society were in accord with the aims of the revolution. This environment in which the work was conceived should be borne in mind when criticising the work. With hindsight it is all too easy to imagine the building as a stage for Stalin, yet the sheer naive impossibility of the structure itself did not bode well for the new world the activists imagined they were creating.

Years before the revolution Tatlin had made a series of *reliefs*, constructions in various materials that projected out from at first from the frame, then just the wall itself. The 1915 *corner relief* and *complex corner*

relief, were works that had abandoned the frame of the initial *painting reliefs* from 1913, and had dispensed with the plinth, describing these works historian Camilla Gray writes: *"…during the winter of 1913-1914 that Tatlin made his first "Painting Relief". This was the first step in his three-dimensional development of the conception of form from that of an enclosed, sculptured mass, to that of an open dynamic construction sculpturing real space. For the first time in Tatlin's constructions we find real space introduced as a pictorial factor; for the first time interrelationships of a number of different materials were examined and coordinated."(38)*. With these works,Tatlin has taken art into the real world, a proletariat world where art is subject to all the same factors and influences as its audience. Gray continues: *"…it was the separation of the reality of art from the reality of life that Tatlin sought to destroy,"* and it was this focus on the reality of space that has informed my work like *span.* Gravity is perhaps the most mundane, most easily understood, most real (bodily to the viewer) of the natural forces. And it is this force that provides the means by which *span* gains much of its power, the reality of the works crossing of space is easily understood by the viewer, they have experienced the drag of that same force all their life.

span continues to bridge the hostile space, despite its obvious fragility, precisely because the material has been deployed in such an efficient manner. The conventions and forms of the spatial drawing systems it is based on are, at least at this scale, capable of supporting itself. This deep understanding of a material's possibilities, and the possibilities of systems to arrange elements so they can work in concert and provide mutual support provides a "culture of materials". "Culture of materials" may be thought of as the potential of systems of to affect the behaviour of large groupings of materials or elements. Gray uses the term when discussing how the *corner relief* works developed; *"These corner constructions were Tatlin's most radical works. In them he has created a new spatial form: a continually intersecting rhythm of planes whose movements jut into, cleave, embrace, block and skewer space. From such abstract constructions Tatlin began to concentrate on studies of individual materials examined in a series of basic geometric forms. This 'culture of materials' as he called it, was the basis for his later system of design…" (39)* This advanced understanding of materials and the potential for innovative application of them is perhaps better illustrated in the work of the engineer Vladimir Shukhov (1853-1939) than in Tatlin's models for unconstructable buildings and gliders that would never fly.

Shukhov was a contemporary of Tatlin, sometimes referred to as the "Russian Edison".He devoted much of his career to highly successful but eminently unglamorous civil works projects. Shukhov's architectural engineering projects were however extremely striking, based on a system Shukhov called hyperboloid. In some of his most famous works he oversaw the construction of huge radio towers. Structures whose sole purpose was to raise transmitters high into the air (a task Tatlin's monument was also designed to accomplish), the towers were shaped by the economy deployed in using the minimal precious materials to build them. This distinctive aesthetic and the rationale underlying it were directly responsible for my work *hyperboloid*, in which I explored the potential of Shukhov's system to enable construction of large forms in fragile graphite. The most well known example of Shukhov's design was the Moscow radio tower, which stretched 160 meters into the air until dismantled in the early twenty-first century. The extremely minimal construction technique fully exploits the properties of the media, it is elegant, graceful, an architecture of organic curves. Shukhov has achieved what Tatlin was struggling to accomplish in his unsuccessful *Letatlin* glider project when he is quoted as saying; *"My machine is built on the principle of life organic forms.*

Through the observation of these forms I came to the conclusion that the most aesthetic forms are the most economical. Work on the formation of material is art."(40).

This economy of material is also an element in my work, and after viewing Shukhov's drawings I determined to produce my own tower, *hyperboloid.* Any tower is a phallic resistance to gravity, the entire structure is a response to and a limited overcoming of gravity, and the higher the tower the more successful it is seen as being. There is still keen competition among cities and states for the alleged honour of laying claim to the worlds tallest building. Even the incredible 830 meter high Burj Khalifa is due to be surpassed in 2019 by the kilometre high Kingdom Tower in Saudi Arabia. *hyperboloid* is a work in which scale and the affect of gravity are entirely conflated, gravity drags at the work only in the vertical axis, the axis towards which the work is oriented. The very purpose of the design of the system utilised to construct the form is to reach a permanent accord with gravity. Against the continual pull downwards the elements of the work are deployed, negotiating a compromise whereby stasis is reached.

hyperboloid is therefore a stable work, at least as much as a structure executed in such a fragile media can be. Reaching a height of 1500mm, the work gains the standard viewing height for hanging paintings, it is raised up into the viewing space. This work has been exhibited in a group show *Dionoia*, at the Suter Art Gallery in Nelson, and while positively received I felt that the work was appreciated more for the elegance of the system than the effect I sought to activate. Tatlin's aesthetics of economy were dominating over the bodily affect of implied collapse which I was then coming to recognise as a potentially powerful aspect of this style of work. The superb engineering of Shukhov, applied even to my ridiculously unsuitable media, was too successful. In *hyperboloid* the negotiation with gravity has largely concluded, a working compromise has been resolved. While the material's essential fragility remains, the efficiency of Shukhov's structure ensures that the material is not unduly troubled by the stresses it encounters. It became clear to me that the works negotiation with gravity should be unresolved, a dialogue (or debate), the conclusion of which is finely balanced, and that this tension and uncertainty could become a main focus for future work such as *span*.

With *span* the work is oriented against gravity, cantilevered out into space, and this positioning of the work ensures that the interaction with gravity remains active, dynamic. This locating of the work is similar to Tatlin's decision to utilise corners in the development of the *reliefs* into the *corner reliefs.* Beginning with *painting reliefs,* these works lost the frame then began to inhabit corners. Corners provide economical structural support, just like with Serra's *Strike*, corners are areas where the organic can accrete. The corner is also key to the Pythagorean triangles that initially inspired this series of work, and have played a formal role in every work. *span*, the most recent work in this series, is in many ways the simplest Pythagorean triangle of them all, the solid architectural walls provide the right angle, the known sides, the a^2 and the b^2 of the famous theorem, while the uncertain, fragile *span* provides the result of the equation, the hypotenuse. The decision to situate *span* in a corner was influenced by all these factors, while the orientation against gravity was the point of the work.

Conclusion

> *'By changing space, by leaving the space of ones sensibilities, one enters into communication with a space that is physically innovating... For we do not change place, we change our nature.' Gaston Bachelard, 1969, (41)*

All of my works discussed here evolved from the same basic idea, to push two-dimensional spatial drawing systems into the three-dimensions of the physical world. This is a shift from drawing to sculpture, from a benign, idealised environment to the harsh uncertainty of the ephemeral physical world. As sculpture these works must occupy the same space as the human body, and it was the aim of activating this same space, “affecting” the viewer viscerally that drove this research. Three factors were identified that were crucial to resolving this; material, scale and gravity. Discussed separately here, these factors are intimately related and interwoven with each other, in a sense they are all aspects of the actual resolution presented here. This investigation has sought to make the work’s relationship with gravity, its palpable potential to succumb to the inexorable pull downwards, understood on the bodily level of affect. Gravity is a mundane force, acting constantly on us and our surroundings, necessarily implicated in all our activities. If sculpture occupies the same space as we inhabit then it must also be subject to this omnipresent force. Both *span* and *survey* are works where this relationship with gravity is utilised in a new manner. The fragility and uncertainty of the work are emphasised through this interaction, where the implied demise of a complex system is perceived through the body's instinctive knowledge of gravity and its inevitable consequences.

The choice of material was key to the resolution, the use of mechanical pencil leads cemented the link with drawing, both as mass produced drawing media and in the appearance of the fine lines. The tiny graphite components were also responsible for both the fragility and the complexity of the work. The brittle nature of the material emphasised the uncertainty of any structure it composed. This unsuitability also played a role in determining the form of the work; rather than being a limitation this informed the work. Only the trigonomic format, of spatial drawing technologies such as diagrams, cartography and vector mapping was effective enough for this dubious media to persist in space. *span* and *survey* are engaged in an ongoing negotiation with gravity. The unresolved nature of this negotiation provides much of the works impact, and this uncertainty is largely due to the media utilised and its obvious unsuitability to the task. The material and its attendant fragility and susceptibility is also one of the main factors differentiating the work presented from superficially similar works. While an identifiable vector-like aesthetic can be recognised in work by artists like Tom Friedmann, Tomas Saraceno, Gego and Anthony Gormley, my material is so contingent and ephemeral that these works are maquettes rather than static, illustrative models.

Material is also key to the complexity of the work. The uniformly small size of the graphite leads necessarily becomes optically complex when large numbers of them are deployed to create large forms. This is a systematic complexity, one built of simple components repeated until it becomes emergent. This complexity resides more in our inability to apprehend the full system than any genuine sophistication in that system. While this complexity is largely a function of scale, it is also implicated in the implied collapse of the

work, being symptomatic of a system developed beyond its capabilities. An optical complexity, partly a function of scale, is also a feature of these works. This optical element is a result of the interaction of the thousands of tiny components from which the works are constructed.

Scale was a critical issue with these works, both in achieving the complexity discussed above, and in establishing the bodily affect I sought. Both *span* and *survey* were planned to be of a minimally monumental scale, albeit in slightly different manners. These works needed to occupy the same space as the audience, and hence be palpably subject to all the same physical forces as the viewer. Below this minimum size, the works became models, mere illustrations of ideas. Above this minimum scale, the affect of the work, its implied collapse, make it an uncertain, therefore active object, an ongoing experimental maquette.

The new knowledge presented here, an activation of bodily affect through the manipulation of gravity's effect, was resolved largely through the placement of the work. The resolution came with the decision to mount the work directly to the walls of the gallery, cantilevered out into space, Material and scale were deployed in a manner where gravity's effect on them was emphasised, made physically apparent. Gravity is a force whose actions and proclivities are completely understood by any viewer and its potential to affect is powerful and immediate.

This gravitational affect is discussed above with reference to Richard Serra's large steel works. These are brilliantly placed within the gallery to tentatively stand unsupported, their instability readily apparent to the viewer. Here Serra makes excellent use of exactly the physical affect that I have sought in my own work. In my work however gravity is used to create uncertainty and an implied collapse of the spatial systems depicted rather than existential unease in the viewer as Serra does.

Gravity has always played a role in sculpture, three-dimensional art having little option but to deal with this ubiquitous force. Traditionally though gravity has been something to overcome, the plinth for instance, has always functioned to raise the work out of the mundane space we all inhabit, by being raised in opposition to gravity, the work is made special, conspicuous. In my work I have aimed for a much more complex interaction with this force, gravity is overcome, but not in a final manner. The negotiation with gravity, the interaction with the realities of the space, is ongoing, the final outcome uncertain. Gravity is not defied but finessed into a temporary accord. This is a bilateral contingent compromise rather than a unilateral final ruling. The uncertainty inherent in this relationship is integral to the work being read (felt) bodily by the audience.

This exegesis has asked 'How can sculpture explore and offer new insights into the territory of what appear to be contingent systems and our visceral response to their apparently inevitable decay? Through the translation into three dimensions of an essentially two-dimensional system (although traditionally used to model and inform three dimensional space) this system has been forced to inhabit real space, subject to all the same physical forces as the human body. Once this rational system has undergone this translation it shifts from being an absolute complete model to being a tentative uncertain maquette. Like the mathematical diagrams that inspired this research the system is not perfect, it is adequate, useful but flawed. This uncertainty is communicated through the systems struggle to cope with gravity's incessant drag.

This uncertainty of a system and its ability to continue to function is a complex assessment of many factors. Yet this apparently sophisticated prediction can be felt rather than thought, understood through the body's perceptions of space instead of rationally deduced. That this is possible is due to the complete understanding of gravity and its effects that people possess. A lifetime subject to gravity has left us all with a tacit knowledge of a set of rules, seldom actively perceived but never contravened. The intuitive nature of this understanding is illuminated by contemporary theories of affect that emphasise a bodily cognition. Theorist Bruno Latour describes the body as *"…an interface that becomes more and more describable when it learns to be affected by many more elements"* (42) and it is precisely through this interface that the uncertain nature of the system and its relationship with gravity is communicated. The relationship with gravity has been crucial to the resolution of these works, and affect theory, with its emphasis on phenomenology, provides a means to understand this interaction. Editors of *The Affect Theory Reader,* Gregory J. Seigworth and Melissa Gregg write of "*...visceral forces beneath, alongside, or generally* other than *conscious knowing, vital forces insisting beyond emotion- that can serve to drive us toward movement, toward thought and extension..." (43)* and this emphasises what I have sought in this work. The resolution of these works has come about through making the body an interface, whereby "visceral forces", here gravity specifically, "can serve to drive us toward movement, thought and extension".

This is an interface that is activated through the translation of the spatial drawing system into three dimensions. It is as sculpture, art that exists in and is subject to all the same environmental factors as the human body, that this interface is able to address these issues of physical and systematic uncertainty. The bodies intuitive appreciation of physical forces, allows these complex issues to be viscerally understood, emphasising the affect/effect of these resolved works, *span* and *survey.*

Appendix; installation

With such fragile works, the point of connection to the walls will always present a challenge. To find a satisfactory solution several factors must be balanced, the work must be secure, the method should be visually discreet, and the relationship with gravity must not be compromised. The first method used to attach early versions of *survey,* such as that exhibited at Pataka, was simply to place small nails in the wall on which the work could be hung. When carefully placed, so as to support the work at its strongest points, the work could hang, just like a framed painting or photograph, on a minimal number of these nails. This provided a simple solution that satisfied the above criteria, however it was a solution that suited the modest, early iterations of this work, and was not suitable for the larger, more ambitious *survey* works that would follow.

With the larger *survey,* like that exhibited at Christchurch, the work was constructed in several parts that were then assembled in the gallery. Key to the work's success was establishing a straight baseline, the flat undersurface to the work. This created a need for the position of the work to be adjustable to some extent, so that the separate portions of the work could be convincingly aligned. To achieve this it was necessary to use a combination of the earlier technique of hanging from small nails or thin plastic rods to get the work up, and then gluing the work directly to the wall once final adjustments had been made. While this technique was successful on this larger, more challenging scale, the adhesive used resulted in substantial damage to the work when when it came time to deinstall.

My intention to find a superior method of hanging *survey,* was given further impetus when the Christchurch Public Art Gallery expressed an interest in acquiring *survey* for their permanent collection, obviously this would be dependent on the work being capable of installation and deinstallation without significant damage. The solution I found to this was to modify the work so that slender threads were attached to strong points of the work's rear surface. Then a small hole could be drilled at the appropriate place on the wall, the work could then be threaded onto the wall and the attached lines fixed when the various sections were aligned. This method provided a perfect solution, it was very discreet, and had the added attraction of providing a relatively supple attachment, the work was less vulnerable to small impacts, it was however necessary to have access to the rear of the wall to which *survey* was to be attached. This is not a problem for a large public gallery with the resources to build entire walls especially for the installation, it was not however an option for installation in the submission accompanying this exegesis.

For the installation of *survey* for submission, I utilised the attached threads merely as the link between the work and the nails of the previous technique. Once installed and aligned, the thread was attached to the wall with small plastic squares and the prominent nails removed. This technique was entirely successful in enabling a simple installation and removal of the work without damage but not as discreet as the preferred method of attachment by threading through a hole and attaching on the rear of the wall.

When installing *span,* a far more precarious work than *survey,* the same technique was utilised, however for slightly different reasons. *span* is so fragile, so tenuous that a single flaw or fault could easily result in its complete destruction, a fate I could not afford in the submission. It was paramount therefore that the work be installed in a manner that minimised its risk of failure. The work was therefore hung from threads that were attached at its utmost extremities in a manner similar to *survey.* This method meant that the work was not physically attached to the work in a brittle fashion, where small vibration passing through the wall, or small touches from the audience could easily destroy it. The work actually had a supple contact with the wall, allowing small movements and deviations to be accommodated without catastrophe, while on display the work survived an earthquake of 4.1 magnitude, I strongly doubt that it would have survived this if rigidly attached. I must stress that the thread was only attached to the outermost extremity of *span* and in no way contributed to, or interfered with its relationship to gravity as it crossed the space between walls.

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