I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.
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The PhD considers how an intimate understanding of the wave-like properties of light, sound, form and materiality can inform the practice of interior design. As a designer and design educator, my practice involves a constant questioning of the basis of creative thought and the ways that ideas can be manifest into reality. Such a practice requires a continuous expansion of the perceptual and cognitive tools that are brought to the manipulation of objects and spatial phenomena. Over the last decade, my activities as a designer and lecturer have involved the development of a theoretical and perceptive base to design, which eschews the conception of materiality and physical form as the central concern in the fashioning of objects and spaces, and embraces the comprehension of the physical fields that shape sensorial experience as its primary concern. In this process, the conceptual base for design is envisaged as the harnessing of fields of energy rather than the shaping of inert matter. Addressing the foundations of the design process in such a way has exposed a creative methodology in which the consideration and manipulation of the material and immaterial aspects of the physical world transcend the traditional boundaries that lie between the distinction of matter and phenomena.

Central to the development of this design ethos was the embracing of the idea that the manipulation of our physical environment can be enacted through the shaping of fields of wave-like phenomena. The elaboration of this thinking involved the investigation of the origins of physical thought and the philosophical and cultural influences that surround the physical comprehensions of the world. Interpretations that define the physical world as a manifestation of specific pulsations, vibrations, rhythms, forces and energy fields can be found within: the roots of archaic knowledge and belief systems, the geometric principles of sacred art and architecture, the hermetic foundations of natural philosophy, the rationalist explications of modern scientific method and the sublime conundra of contemporary physics (see appendix 1). In appreciating the complexities that such diverse models of the universe hold, it became apparent how the poetics and metaphors inherent in these descriptions can resonate with the modern psyche and how archetypal and symbolic comprehensions of the physical world lie at the base of contemporary western thought. Within the scope of the project, the eisegesis of the perceived links between physical knowledge, symbolic representation, cultural meaning and human perception served as a guide from which to manifest a contemporary design practice.
In developing a design methodology that could embrace the expanse of the history of physical thought and be seamlessly integrated within the creative process, the project explored the interactions between the technical understanding of the manipulation of forms, materials and phenomena and the ability to engender meaning that lies within the shaping of the physical world. Through the production of experimental design pieces the project illuminated how interpretations of the physical world could be appropriated to inform the act of design in which the understanding of the nature of physical phenomena becomes a technique to elicit deeper perceptual resonances. In this methodology the technical manipulation of media and the manifestation of its expressive potential were considered to operate simultaneously.

While the act of design requires a theoretical and critical framework to work within, the nature of the design process is iterative and involves the honing and development of skills and perceptions toward the manipulation of media used in the shaping of the built environment. Within the project the development of such expertise grew from the establishment of a conceptual understanding of the physical principles at play within a range of design proposals and the testing of these assumptions through the experimental exploration of the nature of specific phenomena and materials. In investigations such as these the intention was to expose the physical qualities of the phenomena and media being manipulated and refine the perceptions that can be brought to the act of design. In such an approach the creative act is seen as both the mechanism and the product of the research.

An important aspect of this methodology was the development of a series or collection of works around each phenomenon. These series of works manifested themselves through the use of specific media and materials, the concentration on particular working techniques and the referencing of external metaphors in the adoption of a finite form of expression. The individual works produced from this approach were conceived as essential and iconic sculptural forms which displayed a clear relationship between their material form and the phenomenal field which they manipulated. Singularly the works exposed a particular nature of the phenomenon they engaged with while collectively they built a complex understanding of the manipulation of spatial experience. This development of the practice through the production of a series of interrelated works and a series of complimentary series introduced a narrative of concerns and principles that over time extended into a vocabulary of design. In this process the narrative threads of a series of works and the rigor and expertise developed to execute them constitute a body of design knowledge.

The core of the project engaged with the manipulation of light, sound, form and materiality as four separate yet interrelated areas of investigation. Each investigation was founded on an appreciation of the phenomena being manipulated and involved the development of design briefs and conceptual scenarios in which techniques for the manifestation of physical effects, sensorial affects and expressive properties were tested. While the works were used to identify the nature of the medium being employed and the parameters of its manipulation, they also sought to invoke an experience that seemed contradictory to one’s preconceived knowledge of spaces and objects. In seeking to produce works that expressed themselves as fields of energy the pieces sought to generate powerful effects that extended the viewers’ perception beyond the scope of the everyday and into the qualities of the extraordinary. In this way the works acted as provocateurs of the senses confronting the viewer with the conundrum of experience, challenging them to question their understanding of the physical world. In the adoption of such a research methodology the aim was not to seek definitive answers or proofs or to construct an argument for the application of such techniques, rather the aim was to broaden the perceptive base from which approaches to design evolve and to develop a body of work and knowledge that ultimately begins to reference itself in the generation of design responses. Through the development of works around the specific investigations of generative processes and innovative use of media the intention was to define the scope of an ongoing design oeuvre.

The Phenomenology of light projects explored the wavelike properties of spectral colour and developed an approach to the manipulation of fields of light which uncovered the relationship between phenomena and perception. Inspired by the development of scientific studies and colour theories of the eighteenth, nineteenth and twentieth centuries, the projects sought to expose the nature of the band of radiation wavelengths perceivable by the optic nerve and develop a particular approach towards the dichotomous relationship between darkness and light within this perception. This involved an appreciation of additive and subtractive colour effects, the observation and generation of coloured shadows and an engagement with perceptual qualities of vision such as complimentary contrast, apparent colour, after image and gestalt. The pieces generated within this study sought to master the manipulation of visual effects that subtly shift as they are experienced through the eye and in the mind of the viewer. From the development of startling experiential gallery-based pieces through to proposals for more permanent architectural lighting scenarios these investigations evolved a sensibility that can engage with the principle manipulation of lighting technologies and uncovered the expressive potential of light and colour as an emotive and communicative tool.
The Archetypes of Sound investigations sought to uncover the intrinsic order that lies within the propagation of sound. The tracing of the deep connection between the comprehension of the nature of sound and its role in defining the fundamentals of musical theory, mathematics and geometry informed an approach to the conception of sound as a sculptural and spatial medium. The visualisation of sound fields as standing wave interference patterns and the appreciation of the resonant properties of particular forms and materials forged a conceptual platform from which to create dynamic acoustic interactions of sound, object and space. The development of these perceptions allowed for the conceptualisation of sounds and tones as physical entities with specific size and pattern making properties that can be shaped as a tangible spatial physical field. The works that evolved from this thinking expressed different aspects of sound wave-based phenomena while drawing upon the metaphors inherent within their historical references to infer an expressive poetic dimension in the final pieces. The knowledge gained from the sound installations acted as a guide to comprehending architectural and urban space not only for their acoustic potentials but as opportunities to create complex, dynamic and dramatic juxtapositions of sound and space.

The Gravity of Form series considered the shaping of form as an expression of a field of forces and explored the potentials that the adoption of such thinking would bring to the conception of sculptural objects and their interaction with architectural space. The project grew from an ongoing fascination with the subtleties of three-dimensional curvaceous organic forms which has been one of the hallmarks of twentieth century sculpture, design and architecture. In exploring the roots of organismic a link was made to the developments of the combinatorial mathematics of calculus which formed the foundation of the principles of engineering, differential geometry and topology and which was adopted by physicists to shape the abstract and theoretical descriptions of the unseen forces of nature. The parallels in the comprehension of field-like qualities of material and immaterial phenomena fuelled the sculptural exploration. These concerns were developed through the manipulation of stainless steel rod and mesh constructions in which tensile elements were carefully balanced to create elastic transformations of surface planes into three-dimensional objects. The pieces are expressions of the forces that bind them together while alluding to the essential and familiar nature of organic form. This understanding of the energies contained within an object was then expanded to encompass how such works can interact with the dynamics of architectural void spaces either as monolithic floating forms, as fields of geometrically arranged arrays or as compositions of spatial trajectories that challenge and compliment the existing energies of an architectural volume.

The Transient Materiality works were developed through the study of the geometric principles and physical representations observed in optics and acoustics which were brought together to explore an approach to the development of structural form and perceptual gestalt. Initially the works produced were generated by the conceptual overlapping of specific curvatures and frequencies of compositional elements to produce compelling three-dimensional marriages of decorative pattern and structural logic. This approach to the generation of form was then extended so that the arrays of structural elements not only produced decorative surface patterns but began to create effects which played upon the perception of the object and dissolved the solid forms into overlapping fields of interference patterns. These projects synthesised the essence of field-like phenomena by creating works that seem to alternate between solidity and immateriality. This design approach sought to extend the transparent and translucent nature of the contemporary city by transmuting the boundaries of materiality into pulsating, structural, optical fields which hovered at the edge of physicality and illusion. In addressing the transient materiality of the urban realm and creating works that continually change with the shifting light of the city and the relative movements of the viewer, the projects sought to develop an approach toward the act of design which placed the viewer’s perception as the primary medium that is being manipulated.

The work that was generated in developing these sensibilities was considered as a continuous spectrum of creative practice which traversed the nexus between art and design and led to the development of new and hybrid forms of expression. These hybrid conditions work on many levels throughout the project and are manifest through the consideration of seemingly polar opposites. On one level the works express the bringing together of the concepts and principles of art and science in order to develop methodologies that can consider matter and energy as manifestations of a unified continuum of conditions. Intermingled with the cross fertilization of these physical properties is the potential that lies in a form of practice that challenges the distinctions between art and design. These distinctions are questioned through the blurring of boundaries between interior design and installation art, furniture and sculpture, and sculpture and architecture. In these situations the expressive and confrontational nature of an artwork and the functional intent of a design solution form a simultaneous fusion of concerns.

The works contained within this document expose a design methodology that moves back and forth between research and production. The interpretations of the nature of the physical realm were translated to inform the production of experimental investigations and sculptural pieces, while the knowledge gained from these works was then extended into strategies for the shaping of phenomenal affects in urban spaces. In a sense the project itself is a field-like construct which does not seek to give a linear narrative description of the development of the work and which does not assign more value to any one point within the field. Rather the project derives its power through the uncovering of the potentials that exist in the interrelationships of its discrete elements. The separate works within each series have a profound influence upon each other yet stand alone as independent and complete entities, while each series borrows observations and principles from the other series to inform its development. In this way the works that constitute the PhD can be considered as nodes within a field of ideas which create certain consonances between themselves from which new insights are generated and new works are conceived.
The understanding and manipulation of the qualities of light has in many ways defined the nature of the modern life. Developments in the technologies of illumination in the twentieth century have seen our private and public spaces transformed by the potentials afforded by artificial light. We are in a generation that has come to rely on lighting systems. In our homes, workplaces, retail and cultural environments, on the facades of our buildings, along our streets, boulevards and freeways we are assisted, directed, informed, amused, entertained, comforted and confronted by myriad forms of lighting. In recent years, the pace of development in lighting and material technologies has increased to such an extent that the contemporary designer needs to constantly keep pace with the engineering innovations available to them. The control of light now far exceeds the specification and diffusion of appropriate lamps as new technologies such as data projection, light emitting diodes, plasma screens, optical films and sensors systems present a whole new set of parameters in the approach to lighting.

In order to be able to employ contemporary lighting technologies one needs to be equipped with a sensibility that can assimilate the potentials of new lighting media and forge new and refined methods of their manipulation. A key to the creative manipulation of light lies in the identification of the relationship between phenomena and perception. The qualities of light can only be fully appreciated when they are considered as a dynamic system. The perception of light and colour can be seen as a question of relativity, as the apparent affect of a lighting condition is dependent upon its relationship to the nature of the ambient light and darkness which surrounds it. Our perception of a particular hue, saturation or brightness of light is dependent on its contracting effect with the contiguous environment. Similarly the workings of the eye and brain have the ability to manifest further gestalts, illusions and after images that can be manipulated to shift and alter our experience of a particular lighting scenario. The potentials of manipulating that space between the stimulus of the optic nerve and the interpretation of the mind offers a new dimension in the thinking of light for designers.

In coming to terms with the manipulation of light and colour from a design perspective it was useful to consider Goethe’s observations of light, particularly his focus on the experience of the viewer in the comprehension of light’s properties and his postulation that ‘colours are the deeds and sufferings of light, the deeds and sufferings of light with darkness’. Goethe pictured that light and darkness relate to each other like the north and south poles of a magnet, and that colours arise at the borders where light and dark meet. In this thinking darkness can be seen to weaken light’s power and conversely, light can limit the energy of the darkness. So it is possible to think of yellow as a light which has been dampened by darkness and blue is a darkness weakened by the light. In negotiating the boundary between darkness and light, it became apparent that white light (be it natural or artificial) obliterates coloured light’s intensity and that darkness provides the perfect backdrop from which to achieve the full depth of projected colour. Between these two extremes lie the ideas of colour emerging from darkness and that colour can be manifest as a shadow within a field of light.
The development of an appreciation of the perception of coloured light and shadow and the subtleties involved in its controlled manipulation was conducted through the direct physical engagement with the medium of light through the undertaking of a series of experimental design projects. These projects grew out of a series of observations and discoveries which over time developed into a complex ordering of the principles of light and the design methodologies that are employed in its manipulation. The first project in the series began as a response to the ‘Chrysalis’ exhibition brief, that was sent to a number of designers in Melbourne, inviting them to produce a piece of work that would redefine the idea of design in the new millennia. As I had been a designer predominantly interested in furniture and the use of natural materials I took the opportunity to expand the scope of my design practice and to question the nature and identity of objects that we interface with everyday. As a result the Vessel piece was designed to defy the categories of typology and use. It was conceived to simultaneously be both a piece of furniture and a sculpture, a seat and a light source.

The form was derived by the consideration of folded plate structures and the potential development of curvilinear shapes through the composition of flat panels. The resulting shape was created by the intersection of two overlapping arcs which were traversed by gently twisting vertical side planes, bringing to mind the graceful hull of a ship. The piece was made from green tinged transparent fibreglass impregnated with metallic dust. Upon completion of the moulded shell a series of investigations were conducted which explored the potential effects that could be achieved by lighting the pieces from the inside. As the initial installation of white fluorescent tubes tended to overpower the form with light, it was decided to experiment with ultraviolet fluorescent lights. The UV light’s diffraction off the metallic dust particles within the piece’s shell, produced an ethereal glow, that engulfed the work as a tangible cloud-like haze and created an otherworldly effect. Further investigations involved the combination of ultraviolet and red fluorescent tubes that coalesced to create a captivating illusion in which the surface of the piece and the cloud of coloured haze that surrounded it merged to create an indistinct boundary between materiality and phenomena. This experience of colour, opacity, density and immateriality shifted and changed across the surface of the piece as one viewed it from different angles.

The piece was exhibited at Span galleries in Flinders Lane Melbourne, in this setting it was found that the Vessel responded to ambient light conditions in a curious way, subtly shifting its appearance from a steel-like sheen of metallic opacity when illuminated by the gallery’s overhead skylights during the day to glowing with shades of phosphorescent pink, purple, blue and a dazzling white as the ambient light shifted from day to night. Appreciating the effects achieved by the Vessel and its response to changing light conditions, led to a renewed consideration of the phenomena apparent at the twilight hours, when the refraction of light in the atmosphere, caused by the setting of the sun, makes the sky dance with colour and interact with the spectacle of artificial light. In these circumstances, the qualities of natural light have a tangible reaction with the colours and surfaces of buildings. Opaque and reflective windows slowly become translucent and the lights from within seem to subtly change their colour and intensity as darkness descends. At the edge between darkness and light, the qualities of inside and outside, materiality and immateriality, colour and luminosity undergo a complete transformation.
Spectral Shadows

The making of Vessel and the subsequent study of its ephemeral light effects established a direction for the further development of the understanding of the interplay of light, darkness and colour. The next piece in the series, Spectrum, created for the “Light” exhibition at Span Galleries, was initially conceived of as an exploration of the behaviour of additive primary colours (red, green and blue). In this sense, the piece adopted the techniques used by Stephen Holl in the design of Shaw Offices and the Chapel of Saint Ignatius, in which the façade walls are designed so as to bounce light from externally painted panels into the spaces as glowing fields of projected coloured light. However in the production of prototypes and the testing of the piece’s qualities, a whole range of other phenomena was exposed.

The design of Spectrum consisted of three gently curving elliptical reflectors that were mirrored on the front surface and backed with brightly hued fluorescent acrylic paint. The reflectors were supported above fluorescent tubes that were housed in rectangular light boxes so that no white light split across the walls or the sides of the other boxes. Only light which was reflected off the coloured surfaces was visible. Each unit was carefully positioned parallel to each other so that the pools of reflected coloured light interacted with each other to create a secondary hue. Between red and blue reflectors a deep pink purple field became apparent, between green and red reflectors a powerful and pure yellow light was manifest. The secondary colours appeared as subtle gradations from one primary to the next. The affect of these mixed pools of light was dazzling as the interplay of complementary colours tended to makes the viewer’s vision flicker with faint after images. One’s gaze would continually move across the work while never quite settling upon it.

Beyond this immediate affect of the piece there lay another level of phenomena. The sides of the light boxes, which sat in the shadow of the reflectors and received no direct light, glowed with unexpected hues. The colours of the sides of the boxes were in sharp contrast to the pools of mixed light transmitted to the walls. This effect was highlighted by the light on the edges of the box which received the most intense concentration of the original reflected hue. Further to this, complimentary hues of colour sat in the shadows created by the end of the boxes. The composite affect was a carnival of unexpected colour and an intense illumination of perceptual gestalt. This effect was reinforced in a different way when the piece was taken to photographic studio to be documented for the exhibition catalogue. The coloured reflectors were moved into the studio and laid on the white floor and the photographer turned on the powerful halogen photographic lights. From underneath the reflectors an intense coloured shadow appeared. Yet from beneath the blue reflector sat a pink shadow, under the red reflector was a yellow shadow and beneath the green reflector an aqua blue. These serendipitous discoveries began an appreciation of what I describe as a spectral shadow.

The discoveries about the nature of coloured shadows and the careful shaping and mixing of pools of reflected light were adopted in a much more formal and pre-emptive way in the conception of the Pixel light fittings. Using circular fluorescent tubes and an array of shaped reflectors the project initially sought to hone the focusing of light and to create intensified concentrations of particular hues within a variety of bowl forms. These studies led to the development of ray tracing techniques that were used to develop specific shapes of reflectors that would interface with the circular fluorescent tubes. The Pixel piece was ultimately developed as a work of product/lighting design in which the spun aluminium base and reflector was carefully designed to allow coloured reflected light to wash the perimeter of the fitting while a different colour of light collected as a seemingly gelatinous pool at the piece’s centre. The fitting was designed to function as a table, standard, hanging or wall mounted light shade. The fitting was envisioned to be employed as a singular lamp or could be organised in arrays of any shape to create complex mixes of additive light and coloured shadows within large public spaces.
In the creation of the Vessel, Spectrum and Pixel pieces it became increasingly apparent that not only was there incredible effects to be found in the nature of the manipulation of light but there was also an equally important manipulation of our perception that could affect our experiences of such conditions. My first exposure to the potential power of the mixing of additive and subtractive colour to create powerful perceptual gestalts came through the viewing of the works in exhibition on Op art held at the Museum of Contemporary Art in Sydney in 1996. In one installation, inside a darkened room, concentric circles in various colours were painted on a wall, in front of which a number of chairs were positioned. Mounted on the ceiling were three coloured lamps (red, green and blue) which were set on a simple timing device to turn on and off at regular intervals. After taking a seat and viewing the painted circles for a few minutes with no apparent optical change, the painting, which had seemed static and uninteresting, suddenly began to pulsate with the affects of after image. The affect was cumulative, so that at some point one’s eye seemed to be responding to the apparent after image of an after image that cascaded with increasing speed. The experience was thrilling and mildly disturbing and ultimately one had to look away from the wall as the spiralling colours of the concentric rings became too much to bear.

With this experience in mind, I produced a projection piece entitled Targets in which the simple geometries of concentric circles were shaded in specific hues to create compelling tonal contrasts. Over time I developed a refined understanding of the manipulation of colour harmonies as specific colours (hue), shades of grey (value) and intensities (chroma). Using the after-image affects brought about by the transition of one image into the next, these works sought to manipulate and orchestrate the experience of coloured after images so that a perceived coloured shape would pulsate, scintillate and dissolve within one’s vision. This knowledge in turn informed a succession of projects in which the manipulation of residual optic effects became the key to the success of the work.

In Pause and Descend, these principles were combined to interact with a soundscape produced by Bruce Mowson. The piece begins with complete darkness and subtly introduces small squares of coloured dark greys which are barely distinguishable from the black background. Almost imperceptibly these tonal areas dissolve into each other, slowly becoming larger and brighter. As they grow larger, areas of colour remain and new smaller squares appear at their centre. The intensity of colour and the level of contrast between these framed squares within squares gradually increases to a point where the screen is filled with oscillating after images and a complete saturation of colour. The accompanying soundtrack matches these visual effects, starting with complete silence from which a low soft broad hum begins to emerge, the sound pans between speakers and upward in pitch and volume as the corresponding colour contrasts on the screen intensify. At its peak one’s senses are assailed as the screen is filled with the dance of intense after images and the frequency, compression and stereo qualities of the sound seem to oscillate between one’s ears in unison with the visual stimuli. The intensity of this experience lasts only a moment, then the colours and sounds begin to recede to darkness and silence, however subtle residual affects halo the darkening grey squares and they seem to pulsate with rims of colour. The quietening drone does not dampen the thrill and intensity of the sensorial event one has just experienced. The piece plays upon a synaesthetic confluence of colour harmonies and musical chords, the qualities of after image production inherent in the act of seeing and the spatial overlays of the stereo nature of hearing. In doing so, it alludes to the complex interaction between sound and vision that we experience every waking minute of the day.
Immersive Atmospherics

The lighting for the Hybrid Objects exhibition at the Melbourne Museum provided the opportunity to enact the ideas on the dynamics of light and colour on a larger scale. In collaboration with the museum’s technical staff and with access to a high-quality computer-controlled lighting system, the project provided the opportunity to test the ideas on additive and subtractive light, complimentary contrast and after image in ways that enhanced the spatial experience within an exhibition context. With the use of the extraordinary and powerful lights of the museum it was possible to create a completely immersive environment in which one was bathed and surrounded by the ethereal glow of colour.

The exhibition was a presentation of works by thirty-two Australian furniture designers which had been on display at Tokyo Designers Block. The brief for the exhibition, called for participants to seek to blur the boundaries and definitions of what constitutes design. The exhibition represented cross-fertilisation from many different sources and included objects whose functions were ambiguous, that juxtaposed different materials and processes, and which mixed craft skills and high technology production techniques. The pieces in the exhibition included furniture, products, home ware, lighting, sculpture and architectural forms which ranged from experimental and theory-based speculations to fully-realised and marketable products.

The lighting for the exhibition attempted to create a zone of space that was distinctly different from the permanent display areas of the rest of the museum. As you entered the gallery space you were assailed by the subtle yet dazzling sweep of colour. Turning around in the space would elicit a momentary tingle of after image as your eyes adapted from one colour to its complimentary. The most compelling of these was the affect as you turned from looking at the orange-red section of the exhibition to a corner that was lit in a subtle blue light. With one’s eyes filled with the after image of the orange wall, the blue would seem to be an intense mist of colour that danced off the surfaces of the gallery. As your vision lingered, this elusive blue would then seem to disappear into white light.

Each wall and alcove was lit with a different hue of light which was precisely masked to create crisp edges on the corners where two colours met. Lighting pieces in the exhibition were placed to balance their colour temperature with the affects of the luminous interior while the furniture and artworks were distinguished from this field of colour through the use of carefully focused and shuttered spotlighting. A number of pieces were placed in colour fields that were the complimentary colour of the material from which they were made. These pieces appeared neutral grey when left in the wash of opposite colour, however when lit by a focused spotlight they would glow in sharp contrast with their surroundings, and seem to project themselves forward into one’s field of vision. The overall affect was a stunning alchemy of additive and subtractive colour, an otherworldly experience in which the subtle optical affects of the background lighting worked in concert with the desire to draw the viewer to the objects on display.

The Hybrid Objects exhibition lighting represented a synthesis of the principles that had been developed in previous studio-based work. As a designer with a developed sensibility to the contradictory nature of light, it was possible to show a new way of thinking about exhibition lighting to the group of museum technicians who assisted in the set up of the show. Over the course of the week in which the show was put together, a creative partnership was forged between the sensorial qualities and poetic vision sought by the designer and the technical specifics involved in the colouring, focusing, dimming and masking techniques used by the technicians and the lighting system. The exhibition lighting proved to be a watershed in my understanding of the potentials of creating illuminated environments through the implementation of immersive light fields and optical affects. The application of these qualities and the size and scale of the exhibition space also shifted the scope of my vision, from the design of object-based lighting elements to the realm of architectural lighting installations and the spatial atmospherics that they can manifest.
Orchestration

Colour Fields

During the last decade developments in programmable Red-Green-Blue Light Emitting Diodes (RGB LED) lighting systems has greatly enabled the ability to control the qualities of coloured light in an architectural situation. The flexibility and dimming properties of these light sources makes it possible to change the combinations of primary colours with an infinite number of compositions which has seen their large scale adoption as architectural and media facades and interactive immersive environments. Orchestration was designed to explore the potentials of programmable LEDs to manipulate the physical and perceptual affects of fields of coloured light and shadow by integrating shifting optical gestalts and rhythms within a structure’s composition. Instead of using the lights as the primary source of colour mixing, as in most examples of RGB LED works, the project adopted the lessons learnt from Spectrum and Pixel and looked at amplifying the affect of these pieces through the generation of large scale wall sized works that manipulated a complex field of light.

The piece was composed of as a system of blades, that projected perpendicular to the wall and which divided the light sources in a vertical rhythm. These elements were accompanied by a configuration of shades that sat over the light sources and created a syncopated interlacing pattern with the blade pieces. These shades acted to reflect the changing coloured light back into and within the arrangement of blade forms. Adding to the rhythmic composition of the physical components was a simple system of colour settings in which there were five different circuits of lights, each of which could be red, green or blue (or turned off). The combination of the changing primary colours with the blades and shades of the structure set up a dynamic confluence of complimentary shadows and secondary light affects. The piece was designed so that much of the colour perceived in the work was actually the result of colour mixing from different light sources. Within the composition there was a number of crossing perspective lines, that were manifest from the gaps in the alternating rhythm of blades and shades, and which collected a range of colour affects within them. From the front view, the coloured light manifest in the work seemed to be emanating from predictable light sources, however as one approached the work the complexity of colour mixing became apparent as seemingly solid bands of coloured light were shown to be made up of a spectrum of mixed hues.

Rather than be seduced by the endless potentials of RGB LED systems that can interface with DMX controllers and produce any colour imaginable, the work sought to explore the range of colour combinations that could be achieved through the manipulation of the additive primary colours and their interaction with a fixed physical geometry. In this way the piece became analogous to a musical instrument in which the combination of a confined set of interacting wavelengths could be orchestrated to harmonise with a particular structural arrangement in order to create a continuously fluctuating and harmonious temporal composition. The expense of RGB LED and programmable controlling systems meant that the studies and proposal for the piece were produced virtually using Rhino and Flamingo software packages to model and render the intended design. Working with the rendering program in such a way led to the development of a comprehensive system for representing of the lighting channels as layers within the program’s interface provided a mechanism for not only the accurate rendering of the desired outcome of the design but also became the methodology and logic through which the lighting circuits would be coordinated.

The Orchestration piece established the parameters for the conception of architectural walls and facades in which the dynamic interplay between the surface configuration and the system of programmable light sources is mediated and controlled. In this case, the ability to create extraordinary colour fields which shift in hue and intensity from every viewing angle and varying light conditions elevates the potentials of lighting design practice made possible by the latest generation of lighting technologies. Beyond the washing of walls with coloured light or the turning of cityscapes into vast television screens, this project alludes to a mature and poetic adoption of the revolution taking place in lighting technology and suggests that the creative application of the principles of light and its perception can define a new sensibility and aesthetic value in the illumination of the contemporary city.
Orchestration
Test Patterns

While the production of virtual renders of the Orchestration piece provided an invaluable methodology that can be used in the conception and representation of lighting design proposals, the rendered image falls well short of the subtleties and moments of unintended discovery that are made in the actual production of built works. To this end the Test Pattern piece was envisioned and produced. Using sheets of tinted polypropylene, I began a series of investigations into the colour mixing properties of the material and the affect achieved when it is back-lit. It quickly became apparent that the slightly frosted nature of the tinted sheet and the intensity of its colours provided a perfect medium in the creation of softly focused yet striking colour contrasts and harmonies. Using the large window in my office at RMIT as the site for the project I developed a series of sixteen frames that, when assembled, would fit in the window frame as a four by four grid. These sixteen frames became the test pattern through which I explored the potentials of manipulating the colour balances between four layers of polypropylene sheet.

The geometry of the Test Pattern was a simple arrangement of cut out squares within squares, (a homage to both Itten and Albers, subtractive colour studies of the twentieth century), although in contrast to the pigment-based work of these artists, the frames of tinted film which I was manipulating exposed the nature of progressively mixing light through a series of differently coloured densities. Through these sixteen studies, I explored a range of possible combinations of colour mixing, from the generation of the ephemeral and indistinct boundaries that can be achieved between blues, yellows and greens to the vibrant pulsations that can be made apparent between red, pink, purple and orange and the mixing of the soft pastel greys, achieved by overlapping of complimentary colours in the right balance. These affects were refined through the careful cutting of the square holes in the inner layers of the constructions so that a colour contrast could find an appropriate balance of size and intensity. In this way the Test Pattern became a refresher course and a honing of my perceptual skills towards the capricious nature of colour and light. The work, which is now a permanent feature of my office, provides an energetic counterpoint to the drab fluorescently lit corridors of the institutional building. The joyful reaction to the window by students and passers-by reinforces my belief in the restorative and life affirming qualities of light and colour when it is expressed powerfully in a work of art.

While producing the panels for the Test Pattern piece, I was aware that once installed, the piece would create not only a powerful source of harmonic colour contrasts and dazzling optical affects when looked at directly, but that it would potentially generate a plethora of colour shadow effects in the confines of the room. Understanding that the intensity of the hues of the coloured shadows work best in a darkened space, I began the experiments by blocking out incidental fluorescent light from the clerestory windows in the office that face the corridor. I then produced a simple rig that would allow me to hang panels of cardboard and medium density fibreboard at different distances from the wall. With this set up it was possible to test the effects of a number of panels that had different patterns laser cut through them. The panels created astonishing affects through the manifestation of deeply coloured umbras, penumbras and antumbras. When cut as vertical strips, these shadows manifest themselves as clearly defined bands of hues of the colour spectrum. When the panels were cut as a grid of equally spaced squares the shadow effects would create an interweaving pattern whose colour and intensity could be changed by moving the cut panel either closer or further away from the wall. In a further experiment large arcing curves were cut into the panels creating multiple rings of different coloured shadows that intertwined with each other on the adjacent wall. While the Penumbra investigations are still in progress, they do suggest the potential to create large scale architectural screen elements that could respond to facades of coloured glass. Such works would create ethereal and atmospheric window corridor spaces which would glow from the intensity of the window elements on one side and interweave delicate patterns of coloured shadows on the other.
Shortly after finishing the Test Pattern piece, a project presented itself that serendipitously provided the opportunity to take the window-sized explorations of polypropylene sheet conducted within the confines of the studio/office and explore their effects on a much grander scale and public space. The work was commissioned by the Stylecraft showroom in Flinders Lane to be part of the ‘The Project’ at Saturday in Design, Melbourne in 2010. In this project the client’s brief and vision for how they wanted the showroom to function for the event helped guide the design development. After a series of design proposals and discussions the concept for a two storey high light wall, entitled Auroral, which framed the staircase of the showroom was agreed upon. However rather than confronting the visitor with powerful optical affects, as produced in earlier works, the wall needed to act as a focal point and a backdrop for the showroom’s furniture collection and provide a sensuous and colourful counterpoint to formal corporate austerity of the showroom.

The eight metre by four metre back-lit luminous wall was made from twenty framed panels which housed multiple layers of semi-translucent polypropylene sheet. Departing from the strict regularity of the square geometries used in the Test Pattern piece, the Auroral project explored the potentials of incorporating a number of overlapping geometries that transcended the boundaries of the structural frame and created a large-scale pattern that ran across the length and breadth of the wall’s surface. The abstracted circular patterns of the piece and the use of subtle pinks, greys and whites were derived from the Stylecraft logo however the regular geometry and colours at the top of the wall progressively transformed into an exuberant tapestry of concentric geometries and interaction of vibrant colours at the bottom.

The installation was designed as a companion piece to the glowing angularity of Christina Fogale’s floating cloud-like installation called Cirrus, an intricate folded floating form which hung in the ten metre void space above the staircase and that cascaded down from the ground floor entrance to the basement showroom. The wall was designed to ensure that the eye danced across its surface continually finding different relationships and juxtapositions within its overlapping curves and hues. As one moved around the showroom the wall’s interaction with light shifted and changed. Viewed from behind, the wall took on a lustrous sheen and the colours blended as soft pastels, while from the stairs the wall’s colours would intensify and fade as you moved past. At night, from the street, the wall seemed to project itself onto the window glass and merge with the furniture forms and corporate graphics, instilling a dynamic vibrancy and a visual presence within the showroom.

Working on Auroral seemed like a fitting conclusion to this phase of development in my approach to the manipulation of light and colour within the context of architectural space. In many ways the project brought together the knowledge, skills and sensibilities that have evolved through the undertaking of the research into the physical nature of light and the specific and personal path to this topic that the individual design works mapped out. In working within tight constraints of time and budget and in taking on board the wishes and desires of clients, the project highlighted the creativity, flexibility and responsiveness that a designer must bring to their profession. This involves dealing with the day to day dramas that the project entails while holding true to a creative intention and being guided by a personal understanding of the physical world that is subtle and rarefied and not easily articulated to the layperson. Ultimately the success of such a design revolves around how the elements of light and it’s perception have been fused in the built work, and how these qualities and affects are instinctively appreciated by the users of the space.
Future Light

In the twenty first century, the act of design must respond to ever-rapid cultural and technological change while developing new ways of inhabiting and interacting with the spaces we occupy. The role of design research in this context is to uncover new and original methods of thinking which anticipate the currents of progress and in doing so extend the boundaries of contemporary design practice. In considering the orchestration of light within architectural spaces, the design approach to the preceding projects has encompassed the physics, psychology, artistry and technical scope of light and in doing so provided the framework for the comprehension of a new imagining of light’s interaction with space. The development of such sensibilities has involved the appreciation of the aesthetic and phenomenological concerns embodied within contemporary art practice and an understanding of the potentials that new technologies offer while implementing strategies for the codification of light’s qualities within specific design contexts.

The works documented here explored the wavelike properties of spectral colour and developed an approach to the manipulation of fields of light which identified the relationship between phenomena and perception as a critical component. These projects reveal the primacy of perception and the value of careful observation in developing a refined perceptual sensibility to the subtleties of the phenomena associated with light. However beyond the purely physical experience of light, lies its ability to be used as an expressive medium. Light’s curious nature provides the designer with a powerful tool with which to engender warmth, safety, wonder, delight and drama. Light can confound, astound and amaze. It can be used to intensify an intimate moment or overwhelm us in spectacular fashion. While it is highly speculative to attempt to assign any absolute or specific value between light, colour and emotion there is no doubting that light plays a tangible role in the enhancement of our experience of the world. Ultimately this shaping of a spatial experience through the manipulation of light must be considered as a response to specific places and spaces and involves the interpretation of the qualities of light in a contextual, cultural, programmatic, functional and poetic way.

James Dodd in his seminars on Phenomenology, Architecture and Light describes this potential of light’s interaction with architecture;

“Ultimately it is the promise of space that draws us to light, the hope that built space holds out for us as places in which our interest and concern for our being can be pursued and realized. Built space, must unfold in certain definite ways in order for it to be engaged at this level. I need to be progressively introduced to its forms and structures as articulations of the possible; I need to be able read it, to grasp it, to follow it, to let it lead me. I need, in other words, to discover something like a language that is not a language. This, I would argue, is precisely the function of light.”

James Dodd in his seminars on Phenomenology, Architecture and Light describes this potential of light’s interaction with architecture;
Notes

References
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archetypes of sound

While vision has largely been regarded as the dominant sensorial faculty through which we negotiate the world, it must not be forgotten that human beings are constantly gauging the spatial aspects of their environment through the conscious and unconscious cognition of sound. In many ways our perception of sound is truly three-dimensional, the stereo nature of our ears and their position on either side of the head make hearing an all encompassing act of perception. With this facility we are both able to perceive the depth, size, shape and materiality of our environments and can monitor and respond to the movement, speed and proximity of people and objects as they move around us. We most often take this aural acuity for granted and it is perhaps only when the acoustics of sound sources we are hearing are either extraordinary or intolerable that we become aware of our aural environment. Likewise, within the profession of Interior Design, the control of a particular space’s acoustic field is either largely ignored or if addressed is undertaken as the act of dampening sound by using acoustic panelling and soft furnishings such as carpet, fabric and curtains. For designers it is often considered that the manipulation of sound in spatial environments is a specialised field serviced by artists, audio technicians and musicians. Beyond this it is seen as the realm of acoustic engineers to deal with the complex acoustic demands of concert halls, opera houses and recital centres. In many cases the solution to an acoustic problem in spaces such as cinemas and live music venues is to provide sufficient acoustic dampening to allow high quality multi-channel surround sound speaker systems to be the primary and highly controlled source of sound. This transformation of the understanding of sound from its acoustic properties into the realm of electronic media has distanced contemporary society from the essential qualities of sound and the value of finely tuned acoustic spaces in our daily lives.

In order to transcend the abstract and highly technical nature of sound manipulation and contemplate its control from an object maker’s and spatial designer’s viewpoint it became necessary to define sound as a sculptural medium, a tangible physical field which can be shaped into expressive and compelling compositions that set up dynamic relationships within architectural space. In this undertaking it was important to come to the understanding that sound is in fact moving waves of air and that hearing is a physical reaction to the frequency and pressure of those air waves. In this sense sound can be considered as the ultimate haptic experience, as it is the result of a physical medium being felt by the sensitive membrane of our ear drum which is then converted into the electrical impulses that are perceived. When it is of significant amplitude its vibratory power can be felt through the body, skin and bones. Coming to terms with the idea of sound as a three-dimensional spatial configuration of moving air requires an appreciation of the geometry of wave like behaviour that lies at its core. While the wavelengths of light are infinitesimal and as such perhaps too fine for us to imagine, sound’s wavelengths and frequencies are at a scale that is closely related to the size of human beings and the architectural constructs that they inhabit. In this way we can start to imagine the dimensions of sound as specific fields of vibrating air through which we pass every second of the day. Adopting these perceptions in the formulation of a conception of sound as a physical entity required the understanding of its behaviour as a combination of specific frequencies and amplitudes which create fields of interference and degrees of resonances and reverberation within the objects and spaces that surround us.
Acoustic Geometry

The initial design investigations into the physical and spatial properties of sound sought to expose ways of visualising sound fields as standing wave interference patterns. The first project took its cues from the celebrated experiments of Ernst Chladni² and set out to explore the nature of the vibration of sound and its visual representation. The project involved the construction of an apparatus in the studio which manipulated a shallow pool of water via a series of speakers which were placed underneath. As tones were played through the system the relationship between the frequency of the sonic vibration to the shape and depth of the water pool manifest different standing wave patterns. Changes in the sound intensity and the addition of other frequencies caused corresponding alterations in the patterns on the water’s surface. In the course of undertaking these experimental design projects a number of variables in the process were tested, these included: the size and output specifications of the speakers; the frequency and amplitude of the tones played through the system; the size and the shape of the pool; the thickness and flexibility of its materiality; and the depth and viscosity of the liquid that filled the pool.

Through a series of refinements a rig was set up that utilised an elliptically shaped, vacuum formed polystyrene dish that was partially filled with water. This dish was mounted on two eight watt speakers, positioned at each foci of the elliptical shape which were connected as two channels to a simple amplifier. This rig interfaced with Cool Edit Pro mixing software and a tone generator which allowed for the manipulation of different frequencies and amplitudes to be produced in the separate channels of the apparatus. The rig made it possible to generate a vast array of ‘frozen geometries’ in the pool’s surface by manipulating frequencies from almost subsonic rumbles to high-pitched ear piercing whistles. Over time the rig’s use was fine tuned to produce a compelling and varied set of standing wave patterns that corresponded to specific frequencies. Many hours were spent tuning the frequencies and testing the relationship between the harmonic proportions of two distinct tones in order to create certain patterns and in appreciating the influence of the amplitude (or relative volume) of these tones in controlling the patterns manifest on the water’s surface.

In generating these standing wave geometries, it became obvious that the quality and angle of the light striking the water’s surface and the colour of the water in the dish were vital in presenting the effects with a clear visual acuity. An equally compelling effect to that of the patterned ripples on the water’s surface could be achieved through the reflection of light from the surface onto an adjacent wall. A light source (with a very tight beam angle) was set up so that it would reflect off the elliptical body of water and produce a circular image of the water’s effects onto the wall. With this arrangement of apparatus it was possible to reflect a perfectly symmetrical and frozen pattern of light on the wall. Interestingly the frozen patterns of light were best achieved when the amplitude of the sound was low and that there seemed to be no standing waves visible on the water’s surface, while when the frequencies and amplitude were set to create clearly visible standing waves on the water’s surface the reflected light would display moving vortices of flows and circulations.
The work was finally conceived as an installation entitled Mantra, which exposed sound fields as standing wave interference patterns and imbued this phenomenon with a poetic dimension and sculptural presence. The soundscape was composed by the careful orchestration of a looped sequence of extended musical notes of a seemingly human voice that subtly and rhythmically faded in and out and overlapped each other. This created an array of geometries in the water filled elliptical dish, which sat within an inverted cone shaped altar-like form. A red coloured beam of light reflected off the water's surface to create an ethereal and meditative spatial affect of frozen mandala-like symmetries and swirling vortices which were magically manifest within the darkened space. The work’s title, Mantra, alludes to the inherent connection between sound and geometric form documented in ancient Vedic verses. In the Vedic conception of the world sound and form were considered to be inseparable as all the properties of form are considered to be in sound and conversely all form is considered vibrating energy, a movement which produces sound. In this system every object in creation is seen to have its subtle constituent sound, and it is through the knowledge of these sounds, the science of mantra, that the world can be understood and organised.

The uncovering of the connection between sound and form mirrored the work of Hans Jenny, who in the nineteen fifties used crystal oscillators to vibrate metal plates and membranes at specific frequencies, upon which the affects on a variety of materials like sand, spores, iron fillings, water and viscous substances were tested. In his studies Jenny gave numerous examples of ‘vibrations, oscillations, pulses, wave motions, pendulum motions, rhythmic courses, serial sequences and their effects and actions.’ Jenny’s startling images suggest that events in the natural world do not take place in a continuous sequence but are in a ‘continual state of vibration, oscillation, undulation and pulsation and that where once we could consider the physical world as formations, textures and forms it is now possible to conceive of the physical world as movements, currents, circulations and rotations that are constantly being regenerated in a mythical, serial vibrational character.’

Philip Ball in ‘The Self Made Tapestry’ extends the concepts of vibrational and wavelike geometries to encompass observations and analysis of self-organisation that can be seen to be continuously occurring within the patterns and structures of nature. In these observations it seems that science is echoing the ancient tantric Aphorism that, ‘form is the envelope of pulsation.’ These insights into the connection between sound and form became the foundation for concurrent projects in which an approach to the conception of structural and material designs were informed by the geometries of wave like behaviour found in the qualities of sound fields.

It is interesting to note that while I was researching these phenomena and conducting the standing wave experiments it seems that similar ideas were being explored in synchronicity by different artists across the globe. In 2002 the French Canadian collective [plumb] produced Ondulation, a temporal sculpture composition for water, sound and light in which the three elements were intertwined and choreographed into a forty-minute composition. In 2003 New Zealander Lyndal Jefferies exhibited Amoebase a work in which low frequency electrical resistance was transmitted randomly through sound into pools of a variety of materials including mercury, oil, pigments in order to create intricate patterns, wave forms and crystallizations and won the national Sculpture Award for Cymatic Field, a vibrating ‘sound pool’ on a tank of polished stainless steel overlooking the ocean. While in Helsinki in 2003, the Finnish sound artist Finnbogi Petersson produced the installation Sphere, in which sine waves within a frequency range of 50 to 60 Hz were channelled into a large, clear bowl of water, creating reverberations on the water’s surface through which light was then projected from beneath the water onto the ceiling, creating an undulating orb of light. As in the Mantra installation, these works allude to the idea of the use of ‘sound as a tool to generate visual works that chart the terrain between sound and vision, creating temporary and invisible physical phenomenon that is visible and almost tangible’ and evokes ‘the primal nature of sound’.

These works give a ‘visual form to sound by creating a new experience of the sonorous world for the viewer’ and manifesting effects that are ‘not quite music, sculpture or cinema but a hypnotic and compelling mixture of all three.’
Resonant Objects

The further development of a specific expertise toward the crafting of acoustic environments was conducted through a series of experimental design installations that used a simple testing rig to uncover the principles of the nature of sound and its relationship with materiality, form and spatial volume. These test rigs revolved around the disassembly and reconfiguring of inexpensive computer stereo speaker kits, in which the speaker boxes were taken apart so that the amplifier and speakers became discrete elements to which any number of speaker arrangements could be configured so as to interface with a laptop or iPod. This rudimentary set-up was employed in conjunction with the use of Sound Forge digital audio editing software that made it possible to engineer multilayered sound tracks that could interface with the configuration of speakers and be used to test different mixings of frequencies and amplitudes of sound. The construction of this simple device provided a certain level of freedom through which the intricacies of sound production could be demystified and ensured that the experimentation with sound propagation and acoustic qualities could be explored in a responsive and intuitive way. With the rig it became possible to uncover how specific sounds reacted with different materials and volumes, how the construction of simple enclosures enhanced the performance of the speakers and how different arrangements and combinations of speakers relative to the listener achieved different levels of sound quality, clarity and spatial affect.

These experiments evolved into a series of briefs for what became known as Resonant Objects. These works were considered as being a cross between a speaker box, a musical instrument and a sculpture. They differed from the specifications of the typical stereo-speakers in that rather than being devices that were designed to produce clear reproduction of music they sought to respond to a specific range of frequencies in specific ways to create tangible spatial and physical effects. In many ways they held similarities to the design of a light fixture in which a specific source of a particular wave frequency is directed and shaped, however in this case rather than light waves it was soundwaves that were being modulated. The design process for these pieces differed greatly from the purely visual techniques a designer is used to employing, as they were made primarily to perform and react to the specific invisible vibrations of sound. In order to come to terms with this approach to design it became necessary to identify and control the principles of sound such as propagation, frequency, amplitude, diffraction, diffusion, absorption, reverberation, resonance and harmonics and to develop an ‘ear’ that was tuned to the subtle changes that different conditions would engender. The familiarising of oneself with these qualities of sound through their direct manipulation meant that the media could be thought of as a spatial tool that could be readily used by the designer rather than an abstract and specialised field that was the exclusive realm of specialist technicians.

The initial iterations of these experimental works were conducted through an undergraduate interior design studio entitled The Museum of Sound, which was run in conjunction with Nicholas Murray, who was engaged in a doctorate entitled ‘Sound and Space: an Architect’s Investigation.’ After being introduced to the physical principles of sound the students produced a sound piece as a response to a space in the city whose acoustic properties they had studied and recorded. From these two starting points the students created carefully crafted instruments that attempted to express visually the idea of resonance through its form and in doing so defined an architectonic volume which beautifully amplified and affected a range of aural experiences. The safety, simplicity and inexpensive nature of the test rig provided an immediate gateway into the production of sound and the testing of acoustic effects. The finished resonant objects ranged from constructions that displayed the visualisation of the nature of sound through: the reaction of colored springs, water and sand on vibrating plates; the qualities afforded by sound’s interaction with different materials; the resonant properties of air columns in cylindrical forms; the focusing nature of domed shapes; the spatial potentials of stereo affects; the diffusing nature of low frequency sounds and the directional nature of high pitched ones.

These works were then presented in an exhibition in the School of Architecture and Design Gallery at RMIF in which each resonant object was wired up to a central amplifier and sound source that allowed the individual computer speakers to act as line amps in the control of the overall sound field. For this installation it was decided to incorporate all of the soundtracks the students had produced onto one large looping masterwork, so that while individual pieces would respond periodically to the sounds for which their objects were designed, they would also find new resonances and qualities in the way they responded to other student’s sound works in the mix. The set up of the exhibition provided another level of research and refinement in the understanding of the shaping of a complex sound field, as each piece was carefully positioned within the gallery relative to their sound quality and the acoustic affect they would create within proximity to each other. The looping soundscape interacted with each piece in different ways as specific tones moved through and around the pieces and were effected in different ways relative to the individual resonant objects materiality and sculptural form.

The final installation required many hours of careful tuning as the volume of each individual resonant object and the mixing of the soundscape was adjusted so as to intermingle the effects of each individual piece into a balanced, unified, fluctuating and defined field of sound that was structured within space and time. A key to the success of this work lay in the fact that the visitor could comprehend the relationship between each individual physical resonant object and its material and geometric dimensions and the affect that it had on the swirling soundscape that engulfed the collected works. One could experience the work by either wandering through and around the sculptural objects and appreciating the sound field they created or one could stand still and perceive how an individual piece translated particular parts of the score into tonal and spatial expressions and compare this with how an adjacent work performed. The overall affect was an enchanting spatial composition which shaped a series of subtly shifting aural encounters that confounded and delighted visitors to the gallery.
Harmonic Fields

With the principles of acoustic geometry and the performative aspects of resonant objects clearly defined, the next phase of the project examined the creative manipulation of the elements of sound, through a number of propositional works. These works sought to develop design strategies which considered the medium of sound as a geometric construct that would enable the merging of the quantifiable aspects of aural and acoustic control with the expressive scope of the medium in a unified and holistic way. The projects sought to clearly quantify the ideas of resonant frequencies and their response to certain geometries and materials and provide a guide to understanding the shaping of sound as manipulatable fields within architectural spaces. The investigations revolved around research into the physical dimensions of sound when it is expressed as clearly defined wavelengths and how such knowledge could be directly translated into the conception of sculptural form that is carefully calibrated so as to generate harmonic resonances, acoustic beats and other spatio-aural effects when they interact with particular sound sources. At the core of this approach to design is the idea that it is possible to create sculptural works and architectural spatial elements that directly relate to the specific frequencies, tones and noises that interact with them and that there can be an intimate relationship between sound and form that guides the design process.

The establishment of a conceptual framework for such thinking involved research into the history of the comprehension of sound that lies at the base of mankind’s physical and metaphysical understanding of the world. In tracing the connection between the intrinsic order and archetypal properties that lie within the phenomena of sound and its role in defining the fundamentals of musical theory, mathematics, geometry, architecture and the physical sciences, an approach to the conception and manipulation of sound as a physical and spatial practice was developed. The work that evolved from this thinking expressed different aspects of sound wave based phenomena while drawing upon the metaphors inherent within their historical references to infer an expressive poetic dimension within their constitution.

The Chora piece was developed as a way of visualising these premises and providing a measurable technique for considering the effects of sound fields on objects and spaces. The title of the work refers to the ancient Greek concepts of both chora and chorus. In this project the term ‘chora’ was considered as a space from which the idea of form can be manifest, a receptacle for the genesis of the concept of spatiality that forms the foundations of the attributes of place and place making. These allusions were integrated with the idea of the chorus in traditional Greek theatre, in which a group of performers would use vocal techniques such as synchronization, echo and ripple to provide an accentuated aural layer of commentary to the unfolding drama onstage. With these influences in mind, Chora was conceived as a sculptural vocal choir that could adapt its output and spatial arrangement in response to different environments, circumstances and moods to create unique spatial aural events. Rather than being a musical piece or non musical soundscape, the Chora is based around the conception of a composition of carefully tuned tones and their interaction with specifically dimensioned forms so that they create tangible and specific spatial sensory affects. In this way the work was conceived as a way of matching the arithmetic, geometric and harmonic aspects of sound fields, sculptural forms and their surrounding space.
The concept for the tonal system that interacts with the Choro piece was based on the diatonic scale (which correspond to the white keys on the piano) these musical notes were chosen as their wavelengths have a direct proportional relationship with one another. Initially the conception of the piece was based around Pythagorean tuning, in which multiples of the 3:2 proportions of the perfect fifth were used, to create a fractional system for the understanding of specific notes and their relationship to specific lengths of hollow cylindrical forms. The visualisation of this concept highlighted the idea that it is possible to produce a number of different resonant frequencies, harmonics and overtones with air columns within the specific length of tubes and in doing so create an array of potential harmonic juxtapositions. It was envisaged that the individual columns would resonate with the tones of musical scales, creating multiple harmonic arrangements between the carefully tuned chambers. In order to achieve this, research was done to ascertain the absolute lengths of specific musical notes in both open ended and closed volumes which in turn informed the calibration of lengths of cylindrical pipes used in the design of the final piece.\textsuperscript{47}

The study of the dimension of sound waves led to the generation of a series of sculptural forms that employed specific horizontal tube lengths so that complimentary harmonic relationships between two notes could be employed to resonate within them. These columns were punctuated by a smaller intersecting tube that acted simultaneously as: a device for the modulation of specific resonant frequencies of the tube; a base reflex vent that improves the efficiency of the air column at low frequencies; and a listening portal from which an intimate experience of the sound produced within the chamber can be heard. The installation was made up of three column-like forms that are laid out in plan on the points of an equilateral triangle. The standing columns were of different lengths and the portal tubes intersect them at different heights relative to dimensions of the notes which will play through them. The outer skin of the column forms were abstractly reminiscent of the human figure, the different ratio of the wavelength columns giving each individual figure its own slightly different personality. The idea that the arranged objects were members of a chorus was heightened by the human sounding tones that resonate from deep within the standing sentinels.

In this sculptural/spatial/harmonic composition, the precise distance between individual sound sculptures was considered as being essential so as to set up the optimal relationship between sound sources for the creation of clearly defined patterns in the acoustic field. The geometric interaction of the sculptural forms and the patterns of sound that they generate, orchestrates the experience of the space which surrounds them. These concepts were first visualised through the construction of a series of drawings/diagrams that sought to map the nature of the interference patterns that the arrangement of forms and notes would possibly create. These diagrams not only became an important tool in the conception of the potential soundscape in a visual and spatial way, they were also particularly informative in the way they expressed the intensities and dispersions of the sound field. Through the gestalt of the visual patterns generated, the diagrams acted as a way of illustrating how the mixing of nodes and antinodes creates various amplifications, cancellations, beats and composite effects within the sound field. The diagrams also highlighted the need for a degree of acoustic isolation of such a sound field, as its affects work more clearly as one enters the perimeter of the resonating forms but could be destroyed by reverberant conditions of the surrounding space. Through these considerations it became clear that the relationship between a carefully composed sound source, its qualities when interacting with resonant sound sculptures and the acoustic condition of the space it is situated within, is a symbiotic interaction in which all elements need to be considered and finely tuned.

\begin{table}
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\begin{tabular}{|c|c|c|c|c|c|}
\hline
\textbf{Harmonic Proportions and Dimensions} & \\
\hline
\textbf{Note} & \textbf{Frequency (Hz)} & \textbf{Wavelength (cm)} & \textbf{Resonant frequency Length cylinder(open) cone (i)/2} & \textbf{Resonant frequency Length (closed) cm (w/4)} & \textbf{Harmonic Ratio} & \textbf{Musical term} \\
\hline
\textbf{C} & 261.63 & 132. & 66 & 33 & 1:1 & Middle \\
\textbf{C} & 277.18 & 124. & 62 & 31 & 16:15 & Pure Minor Second \\
\textbf{D} & 293.66 & 117. & 58.5 & 26.25 & 9:8 & Pure Major Second \\
\textbf{D} & 311.13 & 111. & 56.5 & 27.75 & 6:5 & Pure Minor Third \\
\textbf{E} & 329.63 & 105. & 52.5 & 26.25 & 5:4 & Pure Major Third \\
\textbf{F} & 349.23 & 98.8 & 49.4 & 24.7 & 4:3 & Perfect Fourth \\
\textbf{F} & 369.99 & 93.2 & 46.6 & 23.3 & 45:32 & Pure Augmented Fourth \\
\textbf{G} & 392.00 & 88.0 & 44 & 22 & 3:2 & Perfect Fifth \\
\textbf{G} & 415.30 & 83.1 & 41.55 & 20.775 & 8:5 & Pure Minor Sixth \\
\textbf{A} & 440.00 & 78.4 & 39.2 & 19.6 & 5:3 & Pure Major Sixth \\
\textbf{A} & 466.16 & 74.0 & 37 & 18.5 & 9:5 & Pure Minor Seventh \\
\textbf{B} & 493.88 & 69.9 & 34.95 & 17.475 & 15:8 & Pure Major Seventh \\
\textbf{C} & 522.25 & 65.9 & 32.85 & 16.425 & 2:1 & Octave \\
\hline
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\end{table}
The development of an approach toward the designing of the sound sculptures and resonant object installations revolved around the conception of a sound rig that could produce up to eight independent channels of output so that an overlapping field of sound sources and resonant responses could be orchestrated. The principles employed in the crafting of these compositions varies from traditional musical scores in that they are conceived of as integrated loops of sound of different lengths and character that set up a constantly changing set of relationships with each other when played concurrently. The individual tracks are mixed and looped in such a way that they are constantly doubling back on each other to create different sets of relationships with one another, so that a series of simple soundtracks can produce a complex aural condition. The sound compositions are conceived so as to move from rudimentary tonal arrangements which highlight fundamental spatial qualities of the installation to complex orchestrations and effects that have powerful expressive possibilities. In the conception of these pieces the works are considered as an assemblage of resonant sculptural objects organised in a variety of spatial arrangements for which soundscape pieces are composed. The works are orchestrated so that the different channels establish an extended cycle of sonic relationships with each other and the resonant chambers they emanate from and in doing this create sound fields that can be considered as clearly defined sculptured forms that exist within the parameters of space and time. In the Monstro and Chora pieces the ideas of ancient notions of sound from different cultures became the driving force behind the design of sculptural sound pieces. These designs were based around particular aural archetypes which informed the design of the object and the shaping of the sound. In both works, the idea of the human voice being the medium through which specific sounds are produced was seen to be an intimate and compelling approach to animating sculptural resonant form. In this way the pieces were considered to be simultaneously an evocation of particular knowledge toward sound as well as powerful artistic expressions of metaphorical intent.

In Babel, the use of the human voice was envisaged as an obvious central metaphor that exploited the different aural qualities of languages from around the world, in order to create a swirling and cacophonous tower of the spoken word. The concept of the piece was to create a phalanx of sound that is created by the translation of a simple phrase into multiple languages (English, Chinese, Japanese, Arabic, Spanish, Swahili, Greek, Latin, etc). The phrase used was, ‘they are one people and have one language’, which was taken from the Genesis chapter in the Old Testament which describes the Tower of Babel. The phrase is combined with the repetition of the word/name ‘Babel’ which unsurprisingly sound similar in most languages. The resonant chambers take the form of terracotta vases that are stacked in groups of four, facing each cardinal point. The vase form was chosen for both its resonant properties and for the fact that it is an archetypal form that can be found across cultures. Each layer of the tower of vases is offset at forty-five degrees to the layer below and made up of progressively smaller vases. A specific diameter speaker is mounted in the throat of each vase which allows for sound to be projected outward in a directional manner but also affords the bulging base of the vase to act as a resonant chamber. The different layers and speaker sizes have a different frequency response to the phrases and languages being transmitted through them. The bottom layers responding to deeper masculine voices and more nasal sounding dialects and producing a low reverberating and non-directional sound field while the top layers respond to the higher register of the female voice and the more staccato dialects and provide piercing directional sound effects. The sound sculpture is wired as four stereo channels that do not reinforce the qualities of the individual horizontal layers but define the structure as four interconnected spirals. In this way the soundscape can be composed and orchestrated to create a cascading vortex of sound that circles the sculpture and seems to be ascending to the heavens. The amplitude of the soundscape is calibrated so that the sculpture is not merely working as a giant speaker box, rather the piece seeks to achieve an aural presence in the way that the voices seem to inhabit the space of the vases and ripple along the hardened clay surfaces. The sound field is kept in close proximity to the physical form so that the two become inseparable elements of the same entity.
Sonic Envelopes

In the Mantra, Museum of Sound, Chora and Babel projects a methodology was developed that enabled the combination of sound fields with the conception of physical objects. Each project explored different ways in which the nature of sound may interact with the material and the formal in order to create a specific relationship between these phenomena and the perception of the audience. The development of these projects focused on the conception of resonant objects, however through the process of uncovering the nature of sound and the material world it became apparent that the relationship between these sound fields and the architectural enclosure they inhabited was a vital component in the success of the final work. In works such as Mantra the system was set up in such a way that the effects of sound on the water’s surface were modulated separately to the sound affect in the room. The volume of the speakers activating the water were controlled through one channel while a separate set of speakers sat at the base of the altar-like form and amplified these sounds so they would resonate with the floor and reflect a non-directional field of sound throughout the room. In this case the more reverberant and cave-like a space the better, as the piece was based around the clarity of single notes and simple harmonics lingering and rippling in unison with the projected geometries of the water’s surface. In the Chora project the idea was to isolate the sound field so that a complex arrangement of tones and sound sources could be controlled. In this case, the floor and the ceiling of the space in which the resonant objects stood were to be made of hard reflective and acoustically bright materials while the perimeter of the installation was to be ringed in a light translucent curtain and the floor covered with carpet tiles. These gestures were intended to acoustically isolate the sound field of the installation so that the audience would move from an acoustically dampened environment and through the veil of the curtain into an acoustically active and charged space.

The appreciation of the relationship between the generation of complex sound fields and the control of their perception in architectural spaces led to the conception of the next projects. These works were inspired from a fascination with the ancient acoustic sounding vases described by Vitruvius, called ‘echea’, which were reportedly used to enhance the qualities of the sound in ancient Greek and Roman theatres. These chambers supposedly worked to heighten the qualities of certain frequencies of the voices of the performers and absorb the sound made by the audience. Similar devices have been found to be used in the Islamic mosques and in medieval churches. The concept behind them works the same way as a Helmholtz resonator in which the dimension of the throat of the opening and size of the resonant chamber have specific relationships with certain frequencies of sound that enter them. These ideas are used for the design of contemporary bass traps and slat wall acoustic panels where the dimensions of the gaps or holes in a plywood sheet allow certain frequencies to be absorbed by porous acoustic material. This idea of a resonant form that is integrated with architectural space was pursued as being something that could both passively and actively engage with the sound qualities of a space.
The brief for the following projects asked how an approach to design may be taken where the use of such resonant devices goes beyond their ability to dampen sound. The projects explored the potential for the conception of architectural elements that focus, amplify and enliven the acoustics of architectural spaces in specific ways. Blesser describes devices such as these as acoustic embellishments, ‘an acoustical object or geometry that produces aesthetically recognizable acoustic attributes, adding aural richness and texture to the space. Embellishments can be actively creating the sound source or passively filtering, resonating or reverberating sound. In concert halls acoustic embellishments are generally unwelcome as the acoustics of the musical space, an extension of the instruments, should match the musical repertoire. In contrast aural embellishments are welcome in social or religious spaces, providing aural variety, symbolic meaning and spatial texture.’ The development of these concepts revolves around the generation of ideas for ceiling, wall and screen elements that both generate sound sources and act as acoustic modulators that respond dynamically to the sound field of a particular environment.

The idea of constructing sonic embellishments was based around the exploration of the careful repetition and array of resonant chambers to create complex repeating geometries. This investigation began with the Herald piece which employs a constellation of bright orange ‘witches hats’ traffic cones which are arrayed to create a large two sided hanging structure that visually confronts the viewer with its dynamic form and challenges them to interact with its acoustic properties. Due to the nature of the acoustic focusing of its cone-like resonant forms, the Herald can be used as a grouping of megaphone-like devices that concentrate, direct and project one’s voice across a space. Similarly the sculpture can be used as a series of ear trumpets which aid in the amplification of ambient sound. Within the array of the cone forms, the piece was designed to operate as a large-scale receiver and transmitter of the sounds within complex aural environments in which it would collect and reflect the acoustic terrain within a space in vibrant, elusive and intriguing ways.

In Kotel, a system for the creation of large-scale sono-acoustic walls was developed in which the wall acts as a housing for multiple speakers and also functions as an acoustic element. Through its faceted geometry and different sized resonant volumes, the wall can be finely tuned to reverberate or dampen specific tones and sound qualities within a space. The design is made up of a system of truncated pyramid forms constructed from plywood. The grid like arrangement of the different sized individual elements enables large areas of wall space to be covered and a vast a variety of patterns to be produced from just ten simple base units. The intriguing quality of the exponential geometrical relationship between the individual units is their ability to generate a seemingly shifting and pulsating gestalt of octagonal and wave-like patterns in the wall’s surface. So that the hard-edged geometry of the resonant chambers becomes a flowing field of wave-like affects that seems to mirror the acoustic geometries of the standing wave patterns of sound discovered in the early experimental works. The Kotel piece marries the concerns of sound propagation and acoustic control with a visually compelling aesthetic and a refined structural logic and suggests an approach toward the design of resonant objects that could be synthesised into the fabric of architectural environments.
This phase of speculative acoustic projects culminated in the Circle of Fifths piece, in which the understanding of the properties of column-like forms that can be tuned to resonate at specific frequencies was used as a means of creating a dramatic hanging ceiling installation. The piece is to be made up of twelve concentric rings of cylindrical constructions. Each element consists of an upper and a lower length of translucent acrylic tube. These two lengths are connected by an assembly consisting of an internal tube that acts as a joining bush for the two column elements. It also houses a small speaker. The lengths of the cylinders that extend from the central housings are cut to correspond to a specific wavelength of a note of the chromatic musical scale. Each individual ring of columns represents a different note.

The assembled columns produce a subtle domed ceiling form which is intended to hover gracefully within an architectural space. The piece acts as a ‘sonic chandelier’ in which each column resonates to specific notes when a musical piece or soundscape is played through them. The arrangement of resonating columns in the circular form creates an intriguing spatialisation of the sound field as different areas of the installation resonate at different times relative to the compositions that are played through them. The piece is not envisaged to act purely as a sound sculpture which responds to specifically composed tonal orchestrations but also provides the platform for all manner of sonic interactions from carefully produced responses to its geometric principles through to the playing of musical pieces through its resonant chambers. The work is considered as an interior architectural fixture appropriate for foyers and entrance spaces of public buildings which would operate as an kind of resonating instrument that is capable of manifesting many and varied acoustic effects and sonic envelopes.

In concert with the shaping of the sound field the piece would also act as a means to modulate light within the space. Each tube construction is fitted with RGB LED ‘cats eyes’ ring lights which would illuminate the frosted acrylic tubes. This field of adjustable light sources would offer an extraordinary range of possible lighting scenarios that could work in union with the shifting sound fields produced within the resonating columns. The connecting of both light and sound systems so that they can interface with programmable controllers and audio visualisation software would allow the piece to become a device for the expression of synaesthetic connections between the seen and the heard. The Circle of Fifths may be programmed to pulsate in a direct relationship between tone and colour or could create immersive atmospheres that subtly shift the mood of the space in response to a soundwork’s emotional character.
Sound and Vision

In the final project of this phase of acoustic investigations, the principles developed from the studio-based experiments and the proposals for sound sculptures and acoustic embellishments formed the foundations for an exploration of how such works can interface with the urban environment. This exploration was undertaken through the teaching of an undergraduate interior design studio, entitled Sound and Vision, in collaboration with Dr. Bruce Mowson, a sound artist who had recently completed his doctorate which had explored the concept of immanence as ‘a subjective state that emphasises an embodied sense in time and space.’ The studio provided an opportunity for our parallel fields of research in sound to converge.

The confluence of light and sound was seen to be a particularly powerful topic to explore. While these two most prominent yet separate sensorial stimuli seem to intersect with and reinforce each other in many extraordinary ways, it is a field that is only just being explored by artists and designers. In manipulating these phenomena and the specifics of their perception, the project offered a refined comprehension of the dynamics at play within the intersection of the senses.

In undertaking this task we first established a technical and theoretical framework for the understanding of the principles of light and sound within the urban environment. The concepts of light that had been developed through my studio-based investigations were introduced to the students through consideration of the phenomena apparent at the twilight hours and the interchange that occurs between the spectral colours manifest in the fading light of sunset and the intensity of the city’s artificial luminance at night. These considerations were then intersected with the techniques of the medium of projected light and imagery within and upon architectural spaces. Through the engagement with these methodologies the studio sought ways to dissolve and transform existing architectural conditions, creating other dimensions within an environment in which metaphorical dimensions and spatial dynamics could be made apparent through the juxtaposition of light and space.

In concert with these investigations were a series of ‘active’ listening exercises designed to develop kinaesthetic awareness of the bodily position in space and aid in the construction of a critical perception toward the acoustic qualities and spatial dynamics of particular types of spaces. This knowledge was qualified and quantified through the development of techniques that would guide the sonic reconstruction of the spaces. This was achieved through understanding the layering techniques that are used in the construction of movie soundtracks which was then applied to the identification of the layers of sound at work in the space. In this approach to addressing sound, the techniques used in the acoustic mapping of a space became a guide to the use of audio editing software. These principles of sound were then used as a foundation for the composing of soundscapes that would interface with the particular acoustic properties of specific sites.

The studio questioned how light and sound can be used to augment and amplify the conditions of an architectural space and in doing so expose layers of interpretation, contextual reference and potential metaphors inherent within the urban realm. It was felt that by engaging with the cultural and historical conditions that define the city, a designer may conceive of urban spaces in ways that interweave the accretion of the past within a simultaneous present. In uncovering original approaches toward this kind of fashioning of the urban fabric, the studio considered the dynamics of selected iconic spaces within Melbourne’s Central Business District and asked how the context, history and issues of a particular site, can be exposed through the use of light and sound. The design brief asked for the proposal of a spatial transformation that would take place within the prominent urban interiors, from the hours of five and nine in the evening for one week, as part of the State of Design Festival. This task introduced the concept of designing in time as well as space and addressed the temporal dimension inherent within the use of light and sound. Within the project, the manipulation of time was embodied through the exposing of histories, myths and memories of the city and through the development of spatial strategies that altered space minute-by-minute, hour-by-hour and day-by-day.

The spaces chosen for the project included the War Memorial, the Immigration Museum, Southern Cross Station, BHP House, 101 Collins Street, the Capitol Theatre, the State Library, Melbourne University Underground Carpark and the Museum of Victoria. The sites were carefully chosen to represent the civic values, historical periods, cultural institutions and corporate sensibilities that define Melbourne’s character and architectural heritage. The resulting designed responses encompassed ideas on the construct of history, the nature of collective memory, the experience of duration and the resonance of the ephemeral and suggested how these may become key underpinnings for the development of an interior design. The bringing together of sound and light within sites which are rich with historical references and contemporary meaning highlighted the mnemonic potentials of the interplay between the phenomena to evoke mood, emotion and atmosphere and to transform interior space into a heightened dramatic and theatrical experience.

The design responses that evolved throughout the studio were ultimately seen as belonging to three different strategies towards the use of light and sound and their interaction with an architectural space. The projects that were sited in large corporate foyers and public atria used the concept of ‘amplifying the everyday’ as a strategy for the light and sound installation. Another typology of space that became apparent were the ‘spaces of memory’, in which the students found that through the nature of the program of the building, there was a compelling story that could be told through light and sound. In other projects students were challenged by the splendour of great buildings that seemed to hold deep histories and resonances within their interiors. In responding to these spaces the students developed ‘constructed narratives’ from which to they could perform appropriate accompaniments to the existing order and beauty.

In synthesizing these concerns into a vernacular that could transform our perception of existing architectural space the projects embraced concepts from the worlds of installation art, architecture, cinema, literature and philosophy to suggest a plethora of potential urban spatial experiences. **
Aural Architecture

The approach taken to this series of projects exposed how the appreciation of sound sources and acoustics within architectural space can go beyond the purely technical realm and potentially become an expressive medium in the shaping of spatial experience. Blesser describes this role as being an aural architect, a professional who:

'acts as both artist and social engineer, they select specific aural attributes of a space based on what is desirable in a given context. Acoustic architects focus on the physical properties of spatial acoustics whereas an aural architect focuses on the way a listener experiences the space. To evaluate aural architecture in its cultural context we must ascertain how acoustic attributes are perceived: by whom, under what conditions, for what purposes, and with what meanings.'

In the preceding investigations the consideration of sound as a tangible physical field that can be shaped and constructed along with other material, phenomenal and sensorial qualities of a space in order to heighten one’s experience has been the central focus. The knowledge gained from the sound installations and propositional works has evolved into a set of conceptual principles that act as a guide in comprehending the acoustic potentials of architectural and urban spaces and the identification of opportunities to create complex, dynamic and dramatic juxtapositions of sound and space. In such a design methodology the comprehension of the performative aspects of sound propagation and acoustic affect needs to be understood in unison with the conception of specific architectural geometries and spatial arrangements.

The approach to the shaping of architectural spaces in such a way involves the appreciation of the integrated and symbiotic relationship between the production of particular sounds and tones, the size and shape of the objects that resonate in their presence, the positioning of these resonant objects relative to one another and the interaction of the resultant sound field with the acoustic properties of the spatial enclosure in which they reverberate. These complex physical considerations are further augmented by an appreciation of the symbolic references and archetypal qualities that are inherent within the relationship between sound and form.
References


Notes


5. ibid., 18.


10. Murray, Nicholas. Sound and Space: an Architect’s Investigation (PhD by Project, School of Architecture and Design, RMIT University, 2010).


15. Murray, Nicholas. Sound and Space: an Architect’s Investigation (PhD by Project, School of Architecture and Design, RMIT University, 2010).


23. Bruce Mowson. Sound and Video Installation Art: Existence as a State of Immanence (PhD by project, RMIT School of Art, RMIT University, 2008).


The connection between the behaviour of different phenomena and the media used to express them was one of the continuing themes throughout this body of work. The development of the different series of studio-based projects in a concurrent fashion allowed for the cross-pollination of observations, concepts and techniques to infiltrate the approach to different projects and series of works. In considering the connections between light and sound it was appreciated that these two phenomena were closely associated through their wave-like properties and the synaesthetic qualities that exist in their interaction and perception. The nature of the approach developed towards the understanding of sound and its relationship with form uncovered the attributes of standing-wave patterns, the correlating geometric properties of vibrational fields manifest in physical media and the harmonic interaction of sound with the proportions of resonating objects and spaces. In seeking to uncover the potential relationships between these diverse phenomena and the media through which they are expressed, I delved into the history of the development of differential mathematics and geometry and began to appreciate the unifying mathematical concepts used to define the electro-magnetic fields of light, the mechanical properties of sound waves and the nature of a structure under the influence of gravity. Against the backdrop of these ideas, parallels in the comprehension of the field-like qualities of gravity were equated with my developing knowledge of the manipulation of light and sound.

The foundation of this understanding was developed through the consideration of the nature of Cartesian geometry. While I make no claim to possessing the mathematical abilities needed to comprehend the complexities of contemporary science, I was drawn to the idea that in Descartes system the geometric equivalent of x squared was not the area of a square but instead described the path of a parabola. The development of this system of coordinate geometry and the algebraic mathematical language derived from its precepts has defined the key physical ideas of mass and weight, inertia and momentum, force and energy, magnetism and gravity which form the foundations of the principles of modern physics and engineering. In this thinking the system of points and lines organised through the x,y,z axes have the ability to describe the qualities of the hard edge nature of rectilinear modernist architecture and enables the precise calculations of load, tension and gravity that define the generous and expressive qualities of complex compound curves. The interpretation of the relationship between the mathematical concepts of these physical phenomena became a keyhole through which I began to contemplate the concept of gravity as a field of force that shapes the properties of both man made and natural structures. These deliberations led to the production of a series of sculptural works in which the phenomena of gravity was considered as a field-like condition that defines the interaction of specific media within three-dimensional space. In these works, the shaping of sculptural form was seen to be the product of the balancing of the external and internal forces acting upon specific materials as they responded to the earth's gravitational field.
Expressive Dimensions

The subtlety of three-dimensional organic form can be seen as one of the expressive hallmarks of twentieth century sculpture, design and architecture. In the whiplash decorative tendril forms of Art Nouveau, the generative hyperboloids of Gaudi, the biomorphic curves of mid-century organic abstraction, the minimal surface calculations of tensile structures and the topological approaches of contemporary architects and designers, the adoption of abstracted references to the curvaceous qualities of nature, have offered a sensual counterpart to the rigidity of the modern world. Angela Vierling argues that the visualisation of mathematical concepts in the nineteenth century can be seen as a forerunner of twentieth century ‘organic’ sculptural form. These roots can be seen in the plaster, cardboard, metal, and string mathematical models of the nineteenth century in which researchers began to physically express the abstract geometries of the complexities of surface theory that had previously been the realm of pure mathematics. Vierling cites connections between the work of twentieth century artists such as Naum Gabo and Antoine Pevsner as being directly influenced by such developments. However the foundations of organic expressionism in the twentieth century extend far beyond the abstract descriptions of the physical continuum made by eminent mathematicians. While the shaping of complex compound curves in the works of sculptors such as Jean Arp, Barbara Hepworth and Henry Moore may be considered on purely mathematical grounds, the sensuality embodied within these works echo the forms seen in the human body and natural world and reflect the results of the deeply ingrained knowing that an artist gains through working directly and intimately with their materials.

Anish Kapoor’s massive tensile sculpture, Marysas, installed in the turbine hall of the Tate Modern gallery in London in 2002, offers an insight into the difference of thinking that exists between understanding a piece of mathematics and being directly influenced by such developments. However the foundations of organic expressionism in the twentieth century extend far beyond the abstract descriptions of the physical continuum made by eminent mathematicians. While the shaping of complex compound curves in the works of sculptors such as Jean Arp, Barbara Hepworth and Henry Moore may be considered on purely mathematical grounds, the sensuality embodied within these works echo the forms seen in the human body and natural world and reflect the results of the deeply ingrained knowing that an artist gains through working directly and intimately with their materials.

While in Anish Kapoor’s descriptions of the sculpture, the emphasis of intent lies within the metaphysics of the work and the manipulation of the viewer’s experience so that they think about time and space. Kapoor was more interested in creating a work of art that has ‘real presence’ rather than being just interesting ephemera and was concerned with how the experience of the sculpture’s scale could shift from being one of the perception of an impossibly enormous object, seemingly at odds with the enclosing architecture, to that of being engulfed in its intimate spatiality and immaterial qualities. He describes the experience as ‘a descent into limbo, a sort of going below, going beneath, going underground.’ While Arup’s engineers described the sculpture’s surface as a vector diagram of forces, Kapoor describes it as being ‘rather like a flayed skin’, the title refers to Marsyas, a satyr in Greek mythology, who was flayed alive by the god Apollo. The sculpture’s dark red colour suggests something ‘of the physical, of the earthly, of the bodily.’ Kapoor has commented, ‘I want to make body into sky.

In a similar vein Ernesto Neto’s site-specific hanging membrane installations possess an abstract, biomorphic quality which is evocative of skin and interior body systems. Neto suggests that the sculptures represent the ‘continuity between the body and the landscape…a symbolic representation of the body; the mathematical connection that we see here is the same as what is inside of us.’ These biomorphic sculptural environments challenge the somatic separation of subject (the viewer) and object (the art work) to become a place of sensations, a place of exchange and continuity between people, a skin of existence and relationships. The undertaking of the manipulation of physical form in this way involves an incorporation of geometric, structural and material knowledge that needs to be met with an appreciation of the inherent meanings, metaphors and sculptural presence that the manifestation of such forms imply. The synthesis of these ideas allows the conception of works that are simultaneously an expression of the combinatorial vectors at play within the generation of a surface as it counters the force of the earth’s gravity and an allusion to the connection between the psyche and the sensuality of the natural world.
Physical Knowing

In the projects that follow, the exploration of form as a ‘field of forces’ moved between an engagement with the history of differential geometry and its influence on art and design and the translation of this body of knowledge into a physical understanding of the material world. The desire to create an essential expression of form and to produce the greatest affect with the minimum of means drove the investigation. The production of complex compound curves from sheet materials has long been an interest of mine and for a long time seemed to be only possible by the shaping and distorting of materials such as plastics, fibreglass, carbon fibres and metals through the production of moulds and the application of heat or pressure or both. The development of one-off designs that incorporated three-dimensional curvatures was thus expensive and prohibitive. In the series of projects described here the ambition of exploring the language of tensioned topological surfaces became realised through the manipulation of stainless steel rod and mesh constructions in which tensile elements were carefully balanced to create elastic transformations of surface planes.

There was an essential physicality in this approach to design development work, as the formation of the double curved planes of the wire mesh were created as a direct relationship to the thickness of the material and the direction and strength of the forces applied to them. The parametric calculations involved did not require a computer with the latest engineering programs to abstractly map the forces at play. Rather the production of the pieces involved a ‘physical knowing’, a bodily reaction to cause and affect, which required both mind and body being engaged as a calibrating device. In such work the reaction to stresses upon a structure were immediate and haptic in nature. The balancing of energies in the hand making of the pieces was the key to their success. The manipulation of the structures, particularly the large ones, became a kind of yoga or tai chi exercise in which the compressing of forms and tensioning of elements in precise ways required a centred balance and subtle dexterity. Techniques of holding, hanging, shaping, stretching, tying and connecting the planes of wire were informed in response to the complex data field that the mesh communicated to my body when put under tension. The works produced in the process represent a marriage between the sensitivity of a craftsman’s movements, the qualities of the chosen material and it’s manipulation into three-dimensional objects.

Guiding these manoeuvres was an idiosyncratic designer’s knowledge of the principles of differential geometry, topological surfaces and the mappings of unseen energy fields. These notions and interpretations were directly applied to the task at hand through personal physical reactions with the material. Within this process the pieces were understood as manipulations of specific energy fields in which forms were discovered and followed rather than forced, bent, pressed or crushed. With continued rigour in the studio it became possible to be able to predict the formations of the energy field relative to the forces expressed upon the works, as they were gently coaxed and seduced into a dynamic tensile balance. The criteria for the success of a piece, was whether the physical energies put into that piece via the making process were inherent as latent sculptural energy within the finished work. The creation of these forms was in a sense the expression of the tensile and compressive energy contained by the structural configuration, the embodiment of the physical energy of the tensile system that defined them. This sense of bound energy gave the forms an intrinsic vitality. In dealing with the production of curvaceous sculptural form as the shaping of a field of forces and the expression of embodied energies, the somatosensory appreciation of a work’s sculptural power became a key to its creation. This approach implies that a work can be imbued with a presence and energy that can be felt through the viewer’s body as a tangible physical field. The tensions and balances contained in a form’s topological surface can become expressive energies that can be sensed and interpreted by our perceptual faculties.
Initial investigations involved the use of thin gauge stainless steel rod that was connected in ways where the forces generated by the flexing and bowing of elements into compressed arches were countered by the use of tensile wire elements. These Tensiles were built up through a constant balancing of forces, in this process, once a stable structure was found then new elements were added and new equilibriums were found in the growing network of forces. There was no gluing or welding of the individual flexed pieces to each other, rather every joint made use of the mechanical strength found in following the direction of forces in one element and seeking to balance them through their connection with another. These substructures were joined by a very simple hooking of one element to another, this technique meant that at certain stages in the construction of the pieces, they were highly unstable and would often literally explode if a joint failed or the wrong interpretation of the direction of the forces acting on the structure was made. This ensured that the structures grew in such ways that they were always following the line of force. The resulting conglomerate web-like filigree structures provided the basis for an approach to the generation of hanging sculptural forms in which the proportions, composition and aesthetic of the pieces evolved from a synthesis of material properties and structural dynamics.

In producing the first series of tensile works I began to introduce small areas of woven flywire. Through a tactile investigation of the materials properties and by applying similar techniques used in the flexing of the wire rod to the plane of woven mesh I discovered that it was possible to generate complex curvatures out of the initially flat material with relative ease. This phenomena is one that engineers know as anisotropic behaviour and is the principle that fashion designers understand can be found in cloth that is cut in a ‘bias’ direction, where the warp and weft runs at forty five degrees to the direction of the load the material is under, enabling a dress to cling to the body. When the tensile stresses upon a woven material are disposed in this way the individual squares of the mesh can parallelogram, forming diamond shapes (or two triangles) rather than a rigid square. In this situation the material can undergo a large lateral contraction and in doing so find its own the inherent double curvature. This curvature is relative to the gauge of the wire used in the mesh and the magnitude and direction of the stresses applied to it. This type of forming of the material creates an extremely strong curvaceous skin.
From an initial set of explorative designs in which the skill at manipulating the wire mesh was developed over many hours of experiments and tests, the Topos series was conceived. These pieces, created for the ‘Elastic’ exhibition at Span Galleries, were a series of sculptural works that abstractly referred to domestic objects in their size and shape. The works were created by following the natural flexibility of the woven stainless steel and the topological qualities it achieves when flexed on the bias. During the investigations of these forms it was realised that the material could be flexed to a degree where it would double back on itself and meet at a single common seam line. This behaviour in fact mirrored the phenomena known as zip pairs in topology in which two halves of the same surface can be zipped up to close the surface along a curve. With this in mind the series began to explore the potential of creating a flat continuous piece of mesh, that could be carefully flexed in an anisotropic way to transform the continuous flowing surface into a three-dimensional object, which was completed by zipping the edges together. These pieces required a complex and intuitive understanding of the deformations of the grid of mesh that could occur and the pattern shapes that were needed to be cut out and edged with zipper in order to achieve the pieces ultimate form.

After many hours of development of the process, I took one of the pieces to Remote Equipment Repairs to see if they could sew a heavy duty camping equipment zipper on to the stainless steel mesh. The mountaineers were fascinated by the form and agreed to take on the challenge. When I returned to collect the work however, the boys, in their excitement to see the finished product had attempted to zip the piece together and had clumsily crushed it irrecoverably with their rock climber’s hands. While in their zeal they had destroyed the prototype they had successfully developed a technique for joining the mesh to the nylon zipper strip and so a production methodology was set in place from around which I could develop the series. This experience reinforced the fact that, the subtleties of the sculpting of such delicate material into the continuous curvatures of topological forms, is an acquired art that requires many hours, days and weeks spent honing skills and perceptions, and that through the previous months trials and tribulations I had developed a refined sensibility to the behaviour of the stainless steel mesh and its ability to be shaped into a delicate skin of organic sculptural form.
Charting the Continuum

In many of the works generated within my practice I often arrive at a name for a particular series or piece before I have designed the outcome. The name acts as a brief for the consideration of the work on many levels, as due to the nature of the English language, a word usually holds multiple meanings. In this case, the name Manifold was adopted for the next series of works, as it suggested many connotations that could guide my approach. A manifold can be something that is many and varied and that can have many features and forms, it can be a whole composed of diverse elements and can come into being for a variety of reasons, in mathematics it describes a topological surface of a small enough scale so that it resembles the Euclidean space of a specific dimension. At this stage of the project I sought to synthesise a range of concerns and influences inherent in both the explorations of light and sound and their connection with the generation of topological form, the term Manifold served as an appropriate description as both noun, verb and adjective of the process I was undertaking.

When considering the next phase of development of the stainless steel rod and mesh constructions, I was concurrently exploring aspects of the visualisation of sound through the series of cymatic experiments in the Mantra project. One key source of this study was an interest in the nineteenth century scientific instrument called a harmonograph. A harmonograph is ‘a mechanical apparatus that uses two pendulums to control the movement of a pen relative to a drawing surface. One pendulum moves the pen back and forth along one axis and the other pendulum moves the drawing surface back and forth along a perpendicular axis. By varying the frequency of the pendulums relative to one another, different patterns such as ellipses, spirals and figures of eight which describe complex harmonic motion are inscribed.’ The images created by the harmonograph mirror the qualities of lissajous and chladni figures and were similar to the oscillating patterns I had generated through the reflecting of light off a vibrating of a body of water in the Mantra piece. In these manifestations of light and sound there seemed to be an implicit three-dimensionality within the oscillating lines of force. These explorations into the visualisation of the acoustic, spatial and perceptual properties of sound and the beauty and elegance implicit in the expressions of musical geometry proved to be an important catalyst in understanding the potential of form in the Manifold series.

With the aesthetic appreciation of topological manifolds and the expression of musical geometry running as an undercurrent in the work, I embarked on a series of projects that would explore the coming together of the qualities of flexing stainless steel rod into elegant curvatures and using these fluid geometries as armatures from which to shape tensioned wire mesh surfaces. These pieces were considerably larger than the previous works and needed to be suspended from the ceiling in order to become manageable in their development and construction. In a sense the works found their form from the nature of their hanging, as an exquisite tension and dynamic equilibrium was sought in their suspension and balancing within the earth’s gravity field. In these works the path of two intersecting lengths of stainless steel rod were considered as lines of force which through their intertwining established a stable, symmetrical, three-dimensional structure with a specific centre of gravity.

As above, So below
Within their conception and construction, the pieces were considered as a diagram of forces that had been uncovered via the real time testing of the stainless steel elements and their properties in supporting their own weight from a single hanging point. In works such as Sine, Alchemy and Infinite two independent lengths of stainless steel rod were woven together to create a three dimensional intertwining frame. The rods in these pieces provided the perimeter curves from which the wire mesh skin was tensioned. Finer wire elements were introduced into the construction to create hanging tensile arches which pulled the larger frames together and provided critical additional support to specific points in the flexed mesh surface. In the Vesica, Clover and Continuum pieces the geometry of the perimeter wire was refined to the point where they could be produced by the twisting and knotting of one continuous ring of stainless steel rod. This technique and the variety of balanced structures found through its testing resembled the principles of knot theory in topology and refer to the concept of ambient isotopy, which is a kind of homeomorphism in which one topological manifold can transform into another without being broken.

The careful arrangement of these forms in the studio and in exhibition spaces highlighted the delicate play of the minimal surfaces as they elegantly resisted the forces of gravity. These pieces evoked a weightless world of swirling, bulbous and primal forms, echoing the suggestion of protoplasmic life evolving into higher species or deep sea creatures collecting as shoals as they drifted in the currents. Accentuating these formal aspects was the works interaction with gallery spot lighting. As they hung in tensile equilibrium, the overlapping distorted grids of the mesh generated moire patterns across the surface of the structures. The careful direction of light across these surfaces and its interaction with the slowly rotating works that responded to air currents within the room, subtly transformed the composition into a flickering dance of interference patterns dissolving into a gelatinous glasslike immateriality as light reflected and dispersed off the taut steel surfaces. In this setting the works seemed to hover in an immaterial balance between energy and matter.

A deeper understanding of the complexities of the topological surfaces of the Manifold series was made apparent through the use of computer modelling. Using the Rhino computer program, I developed techniques of approximating the curvilinear geometries of the distortions of the perimeter frames and topological curves of the surface membranes in Cartesian space. This was achieved through the careful manipulation of Nurbs modelling, a mathematical representations of three-dimensional geometry that accurately describes any shape from a simple two-dimensional line, circle, arc or curve to the most complex three-dimensional organic free-form surface or solid. The interpretation of the physical prototypes, that I had created as an intuitive sculptural act in the real world, into forms that were modelled in the computer, provided the opportunity to understand the layers of geometry that were implicit in their formation and to virtually reproduce the pieces ad infinitum. This modelling enabled the exploration of the potentials of the Manifold series groupings and arrangements within architectural space, either as clusters of disparate geometric characters, fields of geometrically arranged arrays or as monolithic floating forms that lent their presence to a space.

Vesica + Continuum
Spatial Trajectories

The virtual modelling of the Manifold pieces provided the forum from which to imagine the works on a much larger scale and extended the scope of the studio-based design experiments by projecting the methodology of shaping force fields into the realm of architectural space. In the Trajectories series, the idea that design can be an explicit response to gravity went beyond the conception of discrete forms being considered as force fields of bound energy and began to touch on ideas of how the Cartesian nature of rectilinear space may provide the backdrop for the manifestation of an essential expression of the gravity of form. In developing this sensibility the idea of a trajectory, as being both the inscribed path of a projectile under the influence of gravity and the possible direction or outcome of a particular planned action, became a potent metaphor. Within this thinking, the concept of a spatial trajectory was considered as being a physical representation of the potential ‘lines of force’ which could map the inherent dynamics that lie dormant within a space. This idea of the ‘line of force’ mirrored the conventions developed by Maxwell in the nineteenth century in order to comprehend the geometric form and mathematical nature of electromagnetic fields and echoed Henry van de Velde’s statement in the early twentieth century that a ‘line is a force, acting like all elementary forces,’ which he used to describe the flowing abstract and organic forms that were an intrinsic element in the designs of the Jugendstil movement.

The intention of the Trajectories works was to explore how, through a minimum of means, it may be possible to inscribe Cartesian space with lines of energy and a suggestion of the invisible forces of nature. The investigation was carried out through a series of models that represented a gallery space. The walls of the gallery space were considered to provide a neutral backdrop, a blank canvas in which a fundamental investigation of the potentials of this methodology could be enacted. Within these rectangular spaces a number of lengths of wire were carefully tailored so as to traverse the corners of the space in different ways and with different curvatures. In each work the wire was introduced sparingly, as a balancing of the forces of the individual trajectories relative to each other was delicately found and a unifying aesthetic composition of the entire space was sought. The lines traced by the flexible rods used in these installations acted as a form of sculptural calligraphy and when carefully juxtaposed created the equivalent of a three-dimensional spatial drawing. In these works the rod elements perform an essential gesture that can be perceived as a physical dynamic response to the conditions of the space and create a perceptual experience in which the suggestion of curvatures, forms and volumes seem to be manifest as tangible spatial phenomena. Through the study of this system of construction in a series of identical spatial volumes it became apparent that the same elements in the same space can be employed to suggest different spatial energies. In this way each individual model became the study of a different spatial dynamic, which when considered together began to expose the nature of the language of manipulation of the spatial trajectories.
In the Centred Symmetry study, the forces of the rods were balanced in such a way that two intertwining vertical elements crossed to form a vesica-like form that hovered in the centre of the space, these two lines were met by almost identical horizontal elements that touched at a point in the centre of the vesica form. The resultant spatial affect of these meeting and balanced forces was an apparent bowing or bulging of the space as though the lines traced the perimeter of two vast domed shapes that met at a point in the centre of the space. In the Corner incursion piece, this apparent shaping of the space was defined by a series of sweeping curves which were flexed back from the adjacent edges of the room toward a specific corner to create the perception of a dished spatial field that swept up from the floor to the ceiling. In Tilted Volume the lines of the trajectories seem to create an apparent lozenge-shaped form that slanted diagonally across the space, while in Twisted Convolution two parabolic curves intersected the space and touched each other at their vertex, these two elements were entwined by two conic shaped curves that create a swirling dynamic around the central forms. In Vaulted Arc the lines of force were focused toward the ceiling and generated a fragmented composition that was reminiscent of the geometries of Gothic Cathedrals. In Pyrotechnic Trace, the eye was drawn up to the ceiling by one upwardly sweeping element that seemed to ignite a series of energetic lines that then exploded across the space in a way reminiscent of the trails of a firework or the paths of sub-atomic particles when they collide.

In these works the application of a minimal gesture and materiality sought to produce a dynamic presence within an empty and featureless space. Through these actions the pieces produced a gestalt-like affect in which the flexed rods formed the essential delineation of a latent architectural and spatial expression. In manipulating these elements it became clear that the apparent forms that the lines inscribed shifted and changed as the viewer moved around the space and viewed the juxtaposition of trajectories from different angles. In this situation the shaping of a three-dimensional sculptural presence involved a complex balancing of the lines of force so that they would create an ever-changing and aesthetically harmonic composition from whichever aspect they were viewed. The shifting nature of the web of lines when viewed in three-dimensional space and the potentials inherent in the overlapping of simple elements to create changing patterns became the genesis for the next series of works. In these pieces, the effects that lie within the construction of geometric arrays and the consequential affects that these compositions have on our perception of the material world became paramount.
Traversing the Void

Through the production of the experimental sculptural works presented here, I developed a finely tuned awareness of the force of gravity which is a constant in our lives and learned to shape the physical environment to respond to this condition in both structural and expressive ways. Through this sensibility I have come to appreciate the affect of the spinning periodic elliptical path of the earth around the sun that creates the gravitational forces which have shaped the evolution of our physical being and the earthly forms that surround us. The minimal surfaces of soap bubbles, the delicacy of fossil foams and the elegance of sea creatures, the tapering of a branch, a twig or a leaf, the muscular forms of the human body and the sensuous curve of our skin are all responses to the gravitational field we live under. While we can employ the computer to trace the mathematical generation and topological analysis in order to attain an understanding of these principles, it has become apparent that such knowledge must be tempered with an appreciation of the expressive dimensions that lie within a sculptural approach to form and space.

In the production of works that respond to the force of gravity I have attempted to not only create curvaceous organic forms but also inscribe a reference to the shaping of life on the planet and our inherent physical connection and attraction to it. With this end in mind, the works presented here attempt to harness these natural forces through a poetic imagining that touches a common inner knowing. The projects have also uncovered the potential perceptual dynamics between the interactions of form and space and suggested a methodology for the interpretation of the spatial dynamics of particular sites. Such a consideration of the nature of sculptural form and the dynamic relationship it has with the space it occupies alludes to the development of a sculptural installation practice that can engage with the architectural void spaces of the modern city in ways that can charge these spaces with gravitas, expression and meaning.
References


Notes


13. Gordon, J.E. Structures or why things don’t fall down (Penguin Hardmworth 1978), 251 - 255


The creative methodologies employed within this PhD have involved an engagement with concepts of physical thought from different epochs and cultures in conjunction with the embracing of both scientific and artistic investigations of specific phenomena. This research has informed an approach to the production of art and design that derives its aesthetic power through the careful modulation of the properties of physical form and its relationship to the phenomenal fields with which it interacts. The idea of being 'between field and form' suggests that the creative act can lie within these two poles of physical description, and in doing so may occupy a transcendent state, in which our perception of the physical world becomes the medium that is being manipulated. In this way, the shaping of light in the Spectral Shadows series can be seen as an interpretation of Goethe's approach toward the understanding of light and darkness, which was employed to produce works that integrated the qualities of coloured shadows with the affects of simultaneous contrast and after image. In a similar methodology, the elucidation of the parameters of sound in the Resonant Objects series were established through research into the roots of arithmetic, geometric and harmonic systems and the acoustic experiments of Ernst Chladni and Hans Jenny in order to explore the relationship between architectonic forms and acoustic fields. While in the Manifold and Trajectories series, an appreciation of the Cartesian coordinate system and the complex mathematics, geometry and physics that has been derived from its use, guided an approach to the shaping of sculptural form that sought to interact with the earth's gravity field to produce works that were imbued with a latent energy and presence.

In the final series of works, I sought to amalgamate these references, observations and creative responses and bring together the concepts of wave-like phenomena tested in the light, sound and form series as a way of conceiving of intricate fields of matter. In doing this I was inspired and informed by the sublime and contradictory nature of twentieth century physics and the idea that the fundamental nature of matter is no longer considered from the point of view of particles, but is knowable only through its underlying pattern of wave forms. In this model of the universe, matter can become energy and energy can turn into matter, while light can be understood as either a particle or a wave, depending on how you choose to measure it. The contemplation of the counter intuitive postulations of contemporary scientific thought led to the development of the next series of projects in which the intended aim was to conceive of material form in terms of the properties of wave-like behaviour. In this schema, the ideas of structure and pattern could be considered as examples of waveform, frequency, amplitude, rhythm, superposition and interference. In embracing this approach to the modulation of form, I began to conceive of architectural elements as intricate three-dimensional arrays, which would work as both structural entities and as oscillating fields of optical gestalt. These concerns were further contextualised through an engagement with the illusory, immaterial and transient nature of the glass walled architectural facades of the modern city, which seemed to provide the ideal backdrop for the manifestation of works whose physical composition and accompanying perception hovers between field and form.
The initial investigations into the potential conception of form as wave-like phenomena drew from the earlier studies of the properties of sound fields. These qualities were first displayed in the point source standing wave interference patterns shown in the Mantra project and were later used in the mapping of sound-field patterns conducted in the Chora project. These harmonic field diagrams were generated by the colour coding and visual mapping of different wavelengths and frequencies of musical notes which had specific origins relative to each other. The resultant graphical works produced not only a way of comprehending the nature of specifically calibrated sound fields, but also displayed these acoustic effects as overlapping moire patterns which seemed to allude to the complex compositions of overtones, chords and beats that would occur in such an installation. The overlapping of two circular forms in these works creates the shape of the vesica piscis, which has been a constant motif in the projects throughout the projects presented in this document. It can be seen in the plan shape of the fibreglass shell in the Vessel light sculpture, was used as the generator of the intersecting planes of colour in the Auroral wall, and is expressed as a result of the intertwined knot of stainless steel rod in the wire mesh form of Vesica. However beyond these tangible expressions, it has functioned as an important physical and metaphorical bridge in my comprehension of the wave-like qualities of different phenomena. In these investigations I have been drawn to the fact that the vesica piscis has represented a fundamental geometric form across cultures, and as such has acted as a signifier for my understanding of the archetypal geometric thinking that links the conception of mathematics, geometry, sound and form.

The shape of the vesica piscis can be seen in the Tantric idea of the ‘seed-sound’, in which the universe is understood to propagate itself as a set of harmonic vibrational waves that ‘span outwards from innumerable centres, their overlapping and resultant interference patterns forming nodules of trapped energy which became the whirling fiery bodies of the heavens’. It is also present in Ancient Egypt, where it is used as the hieroglyphic symbol of the supreme being Re, known as ‘the solar life giving force’, ‘the emanating word’ and ‘the mouth which speaks the names of gods’. In this context the vesica piscis was also used as the symbol for the denomination of the fractions, which were seen to be divided from the eternal one. In Islamic art the creation of the vesica piscis is described as the ‘scission of unity’, which leads to the creation of all known forms in the universe. The complexities of Islamic art are generated from the simple act of intersecting two adjacent circles. A traditional Islamic craftsman armed with a compass and a straight edge, is able to generate a myriad of regular polygons and complex interweaving symmetrical patterns, which are used to adorn Islamic architecture while being representative of the principles of the universe. Seyred Hossein Nasr describes Islamic Art and Architecture as ‘a form Abrahamic Pythagoreanism, a way of seeing numbers and figures as keys to the structure of the cosmos and as symbols of the archetypal world’. With these geometric traditions acting as a background to the reconciliation of wave-like phenomena and three-dimensional form, I embarked on a series of projects that used the concept of ‘point source geometry’ as its basic principle. In these projects the initial interweaving of the properties inherent in the overlapping of concentric circular rings in a two-dimensional fashion, evolved into techniques for the manipulation of curved structural elements into polar arrays of intersecting geometries that created blossoming roof-like forms.
Morphogenetic Shells

The initial diagrammatic and wire frame explorations of the potentials of point source geometry became the foundation for a more thorough and three-dimensional conception of architectonic form in the Modulations series. Using the idea of the circular array as the primary generative geometry, a technique was developed in which the overlapping of specific curvatures and frequencies of compositional elements enabled the production of works in which the qualities of decorative pattern and structural logic were simultaneously addressed. Over time this approach was refined to a point where a vast genus of different profile shapes and interweaving patterns could be produced through small changes made to a limited set of parameters. The structures were first defined through the parabolic curvatures of each individual rib and the properties of their tapering diamond shaped profile. These rib forms were then inclined at specific angles and mirrored in the vertical axis, to produce the primary element of each individual structure. These fundamental components were then duplicated as polar arrays at a specific distance around a central point, to create a complex and integrated whole. In the slight adjustments of parabolic form, rib profile, incline angle, number of elements arrayed and the radius of these arrays, it was discovered that an enormous variety of forms could be generated, each with their own individually entwined geometric relationships and spatial character. In this methodology an approach to design evolved, in which compelling formal structures could be manifest through the application of a set of simple rules and operations. The resultant forms are reminiscent of the rigid siliceous radiolarians and sea anemone shells that can be found at the littoral perimeter of the ocean’s edge and their conception suggests connections to the ideas of morphogenesis as described by D’Arcy Wentworth-Thompson and Ernst Haeckel.

In their conception the Modulations were considered to be forms that echoed the geometries of sacred architecture and the natural world, a cross between a cathedral and a piece of coral. As such they were thought of as remnants of ancient temples, architectural fragments that carried the suggestion of vaults, chambers, arches and façades. These subtexts were superseded by the refinement of the forms as pavilions and meeting places that would inhabit exterior public spaces, parks and waterfront boulevards. In this context the structures were designed to act as sculptures, shelters and seating elements that would respond to passage of the sun through the day and would be atmospherically illuminated at night. The pavilions would be constructed from precast reinforced concrete panels and as such adopt the traditions of twentieth century structural shell architecture, as seen in the work of Pier Luigi Nervi, Felix Candela and Santiago Calatrava. Their design sought to employ the repetition of standard elements to create complex and integrated compositions and in doing so referenced the architectural screens of Erwin Hauer and the spherical sections of the roof of Bjorn Utzon’s Sydney Opera House. The underlying circular nature of the designs allowed for the geometry to be understood as a series of identical radial segments that could be cast repeatedly to form the structure’s shell. In some cases, end segments were needed to address the specific requirements of the overall composition. In these elements, the curvatures of the primary ribs acted as the terminating edge of the structure. The three pavilions presented here, Iris, Pod and Portal each offer a different interpretation of the generative geometry at work and suggest the potentials of this approach to the conception of structural form and urban transient spaces.
Structural Gestalt

The overlapping repetition of rib-like elements in the Modulation series, made it possible to produce varying layers of patterned indentations and fenestrations in the pavilion’s surfaces. When viewed from different angles and in different light conditions, these relief patterns would seem to subtly change their composition and appearance. These shifting properties were further enhanced by the overlaying of shadows across the embossed surfaces of the forms and the ground around them. In these cases the effects of the changing patterns of the structure’s skin and their play with light and shadow, would make the pavilions apparently dissolve in a complex interplay of optical affects. The observation of these properties led to the consideration of how it may be possible to begin to conceive of structures, whose composition would create perceptual gestalts which transfigure the solid forms into overlapping fields of interference patterns. This thought began a series of projects which sought to synthesise the essence of wave-like phenomena touched upon in the earlier optic and acoustic investigations, by creating works that seemed to hover between solidity and immateriality.

The illusory qualities of moire patterns were first identified in the wire mesh skins of the Manifold series. In these pieces the layers of reflective gridded surfaces would interact with each other to create shimmering curving fields of interference that would enhance the ethereal dimension of the works. Transforming these serendipitous discoveries into a methodology of control and intent, involved an engagement with the traditions of the gestalt theory of perception and its influence on art and design in the twentieth century. Gestalt theory proposes that we primarily recognise patterns and relationships, not objects. In this thinking the idea of the field replaces the notion of discrete isolated particles. Such a field is ‘a whole whose parts are in immediate relationship and responsive to each other in which no part is uninfluenced by what goes on elsewhere in the field’. These precepts can be seen in the work of Bridget Riley and other Op artists of the nineteen sixties and have been explored in more three-dimensional and sculptural terms through the work of Jesus Soto and Eusebio Sempere. In these artist’s works the creation of an illusory optical affect caused by the gestalt field becomes the primary aesthetic concern and in doing so brings into question the relationship between the object and its perception.

The initial investigations of the manipulation of structural forms as fields of gestalt affects were developed as an extension of the discoveries made through the Modulation series. The transformation from the appreciation of form as interwoven decorative patterns to it’s conception as an illusory and immaterial construct began with the consideration of the geometries of the Arc piece. Arc was first conceived as a curving cast concrete seating pavilion in which two identical elements would be nested opposite each other to create an inner courtyard space defined by the arching rooflines of the two elements. Through a process of abstraction and translation, the geometry of the original pavilions were reinterpreted as sets of radiating curved poles. This configuration involved the alignment of the two sets of poles (with different profile curves) that were tilted at opposite angles to each other. This arrangement produced a kaleidoscope of curved upright components that generated subtle moire affects through the slight displacement of the two arrangements of elements. From this simple exercise it became apparent that it was possible to begin to think of the generation of these architectonic structures in terms of their field-like properties and the conscious manipulation of their secondary perceptual affects. Through the careful juxtapositions of both planar and sectional curvatures and the setting up of a harmonic relationship between the dual layers of elements, it became possible to create complex rhythmic effects and to dissolve a form into an apparent immaterial essence. It was also noted that these affects would constantly alter as one moved past, around or through the structures, so that the viewer’s movement would animate the work. With this in mind the structures began to be considered as prototypes for the conception of walls, footbridges and transit spaces, that acted as interactive dynamic systems, which would set up a complex responsive relationship between subject and object.
Optical Syncopation

The work on the realisation of structural gestalts and the desire to dissolve the perception of form within fields of optical interference, led to a consideration of the aesthetics of dematerialisation and its role as one of the abiding conditions that define the sensory experiences of the contemporary city. In the last hundred years the imposing stone solidity of nineteenth century construction has been replaced by the structural expression, minimalist detailing and transparent and translucent skin of contemporary architecture. This phenomena can been seen most clearly in the refractions, reflections and plays of light mirrored in the plate glass windows of retail stores and the curtain walls of the modern skyscraper. This aesthetic can be traced back to the seminal works of Mies Van der Rohe, that are defined by large frameless windows that seem to float impossibly as wafers of reflected light, as seen in the Barcelona Pavilion and the Neue Nationalgalerie in Berlin.

This condition of dematerialisation has more recently been used consciously as an aesthetic intention in contemporary art and architecture. In the works of Robert Irwin and Dan Graham, the use of transparency, reflection and illusion are employed to destabilise one’s preconceptions of the physical world, in order to bring into question the relationship of the viewer in the completion of a work of art. Similarly, James Carpenter, an artist who works closely with architects, uses such techniques to activate and animate the viewers’ experiences of architectural space. Carpenter exploits ‘the unique opportunities afforded by the transparency, reflectivity and structural strength of glass, controlling the intangible force of light as it affects the spatial and temporal boundaries of architectural spaces. His goal is to animate transitional spaces of urban architecture and engage the viewers in a rich and complex understanding of their surroundings’.

While Jean Nouvel, in buildings such as the Cartier Foundation in Paris, uses the materiality of the glass façade, to confound traditional notions of the building as definable object. Nouvel attempts to construct ‘a space that works as the mental extension of sight, performing a type of vanishing act that leaves the viewer wondering where the object went, the goal is to render ambiguous the boundary between materiality and non-materiality, between image and reality’.

With the advances in material technology enabling larger and larger surface areas of glass and the development of optical films and filters that allow for the refraction, polarization and distortion of these surfaces, an exploration of the immaterial and illusory aspects of the modern city seemed potent and timely. In reviewing previous projects, I realised that my approach toward design had moved from a preoccupation with objects in space to the crafting of patterned surfaces and optical affects. This can clearly be seen in works such as Orchestration and Kotel, in which the construction of visual rhythms and illusions emanated from a systematic application of overlayed geometric orders. The resultant arrays of these pieces held many simultaneous affects that would make the perception of the pieces oscillate between one perceived condition and another. I termed this quality ‘optical syncopation’, a condition in which the apparent dominant visual hierarchies within a piece are interrupted by the presence of other layers of pattern, which in turn create apparently changing gestalts within the unified whole.
The investigation of the manipulation of optical syncopation and its employment in creating active and engaging visual conditions was continued through an examination of the properties of the Fibonacci sequence and the various geometries that can be derived from its principles. The first experimental works in this series involved overlaying two identical images of the Fibonacci Spiral pattern (represented as dots) on top of each other and then slightly rotating one of the layers. In doing this, an amazing quality of the pattern was exposed. Small changes in the alignment of the dots would produce a complete change in the perceived patterns. As the alignments changed, an endless array of arrays would present themselves. It was then discovered that a similar affect could be achieved if the layers of spiral dot patterns were aligned with each other but separated by a reasonable distance. In this case, when the two planes were viewed from an angle, their superimposition would seem to create a changing field of moving patterns as one’s vision moved across the surface.

These observations were tested through the construction of the virtual Facade Studies in Rhino and through the production of a sculptural work made from sheets of acrylic, entitled Plenum. In this piece, acrylic sheets were laser etched with the Fibonacci spiral pattern and positioned at ten millimetre intervals within a black box. After a series of experiments were conducted to ascertain the best lighting condition from which to create a powerful effect, it was discovered that a carefully placed strip of LED lights along the edge of the assembled planes of acrylic, would cause the dot patterns to glow brightly in contrast to the darkened background. This effect utilised the principle of total internal reflection, in which the rays of light emanating from the LEDs traverse the transparent sheets at such an angle that they reflect off the inside the polished acrylic surfaces and fill the acrylic sheet with light. When this light meets the etched surface of the spiral pattern it is diffracted and escapes the acrylic sheet as a glowing luminance. These discoveries led to the consideration of the use of such techniques in the conception of the design of glass walled building facades, in which the composition and the careful alignment of patterns and planes, would seem to contain a changing condition of spiral geometries that transformed when viewed from different places and different times of the day and night.

With the principles of the optical affects of layered patterns established, I sought to develop a Fibonacci geometry that was related more directly to the rectilinear nature of contemporary glass curtain-wall, high rise buildings. This investigation began by taking the principles of the numerical Fibonacci sequence in which each number is added to the previous number to create an exponential progression (0,1,2,3,5,8,13,21,……). Using this system, a pattern was generated that translated the numerical sequence into a series of geometric strips, which represented the numbers as rectangular forms. These rectangles were organised in a progressive arrangement which expressed the Fibonacci sequence both vertically and horizontally. In creating this repeating geometric code, a periodic spiral pattern manifest itself as a longitudinal wave form, reminiscent of a double helix, which ran horizontally across the frieze. With the principles of the rectilinear Fibonacci pattern established a series of experiments were conducted on the layering of these patterns in a three dimensional array to create optical affects. As in the spiral experiments it was possible to achieve a flickering and shifting apparent movement in the layered patterns. The rectilinear geometry also afforded the creation of dynamic perspective qualities within the layered screens and gave the implied spiral form a three-dimensional quality. As in the circular spiral pattern, as one’s vision moved across the design, a number of different interference patterns would become apparent. These secondary optical affects would manifest as star bursts and shifting densities of parallel lines which when aligned would dissolve the perception of the overall configuration into a flattened spatial illusion.
Transience of Light

The consideration of the immaterial nature of the contemporary city and the desire to address the design of urban transit spaces in a transient manner coincided perfectly with the theme of the State of Design Festival which was held in Melbourne in July 2011. The festival’s theme was ‘Design that Moves’ and it’s aims were to ‘explore design in, on and around projects that are transformative, mobile and networked’ and ‘to understand how we can use design to create more active cities and present events in transitional zones: platforms, revitalised spaces, foyers and stairs’. Part of the festival’s program was the Look.Stop.Shop event in which a number of designers were selected to team up with retailers to create extraordinary in-store installations that responded to the festival’s themes.

With the work I had been doing on optical syncopation in mind as an ideal response to the festival’s brief, I approached Euroluce, a commercial lighting company, with a proposition for an optical light installation to be situated in the fourteen metre long prominent floor to ceiling glass display window shopfront of their Melbourne showroom.

The original concept for the installation involved the precise arrangement of a field shimmering reflective strips, which would spell out Euroluce as a subtle visual illusion as one moved past the window. The design employed the principles of the Fibonacci series as vertical elements (developed in previous investigations) which were to be layered behind one another to create a compelling visual affect between the superimposed graphics. The proposal was seen to respond to the festival’s themes of the use of transitional spaces and ideas of the transformative, the active and the activating. It explored these themes through the notion of transience, something that keeps changing within space and time. The work was conceived so that the movement of the viewer would expose an apparent movement within the graphics surfaces, a shifting immaterial illusion which rendered the design differently from every angle viewed. The piece was designed to entice pedestrians and commuters to engage in the perception of a dynamic, flickering and spiralling vision as they moved past the window. In doing so it sought to amplify the beauty of the transient and the ephemeral that can charge our urban spaces. Rather than being ‘design that moves’ the design encouraged the viewer to move in relation to the design and thus become more aware of the shifting light filled tapestry of the city’s fabric.

The project was first envisaged as being constructed from the layering of two sheets of acrylic between the columns that sat behind the showroom’s glass facade. In each bay of the windows the Fibonacci strip pattern would be reproduced through the application of vinyl lettering on the large sheets of acrylic, while on the actual glass window an image of the Euroluce logo would be reproduced so that it aligned with the pattern of graphic strips behind it. This concept was developed in Rhino and Flamingo and a motion animation was made to see under what light conditions the flickering effect would perform best as one moved past the window. These ideas were then tested through the production of a 1:20 scale model of the entire showroom in which the qualities of the proposed vinyl lettering on glass and acrylic was reproduced through the laser etching of two millimetre acrylic sheet. Through these studies, an understanding of the parameters of the creation of the piece where refined and a sense of the variables at play upon the successful rendering of the visual affects was appreciated. However in the precise documentation and costing of the job it became apparent that to produce the work from large sheets of acrylic would be preventively expensive for a temporal installation and that other approaches would need to be developed to realise the project.
At this stage of the project, I assembled a small group of third and fourth year Interior Design students to assist in the development and realisation of the proposal. The students were introduced to the set of ideas behind the conception of the work and through the construction of the 1:20 scale model of the showroom, became intimately acquainted with the nature of the site. Having a small dedicated group working on the design allowed for the exploration of a number of possible approaches to the piece’s resolution to be investigated. A design methodology was established in which potential techniques for the realisation of the work were developed through the production of graphic optical illusions and the construction of small models that sought to recreate these effects in a three-dimensional way. From this pool of observations and ideas, two distinctly different techniques for the creation of the final installation were adopted and taken through to full sized prototyping. Instead of producing the work from the use of vinyl lettering on sheets of acrylic, it was decided to investigate the possibility of creating a comparable affect through the use of suspended ping pong balls and alternatively with layers of black fibreglass flyscreen mesh. In order to test these two approaches, the team embarked on the prototyping of the capital letter ‘E’ of the Euroluce logo, in both mediums.

The ping pong ball solution involved the redesign of the graphic strip pattern into an arrangement of suspended balls. As the original design was based on fifty millimetre strips and the ping pong balls were forty millimetres in diameter. The entire layout had to be reorganised and scaled to accommodate the difference in base unit size. The concept for the arrangement of the balls revolved around the threading of groups of them onto lengths of fishing line which had a sinker attached to one end. The separation of individual groups of the balls to make the Fibonacci pattern was achieved through the use of jewellery crimps. Each line of balls was then terminated by crimping the end of the line around a small nail. The system for hanging the lines of balls involved the production of a top mounting panel that had three separate rows of holes laser cut into it. The mounting panel would be first suspended from the ceiling using stainless steel cables and then the nails at the end of each line could be easily slipped into the holes and hung from the weight of the sinker at the other end. Through this system the balls were arranged in two background rows in which the Fibonacci pattern was reproduced and a front row which spelt out one of the letters of the Euroluce logo which aligned itself with the pattern of balls behind.

The flyscreen mesh solution worked in an almost opposite way to the ping pong balls. Rather than creating the Fibonacci pattern and letters from solid elements, the mesh piece was created by using the geometry of the original design and cutting it out of the sheets of flyscreen. In this way the patterns appeared as voids within the layers of mesh. The piece was produced by mounting the mesh to medium density fibreboard frames and using a template to cut out the Fibonacci patterns. Each individual frame was then stacked onto the other to create a layered density of mesh. In this arrangement, it was realised that the layers with the letter cut out of it needed to be at the back of the assembled frames, as the void spaces became more legible against the dark backdrop of multiple screens. Ultimately four layers of framed mesh were grouped inside a larger external frame that neatly unified the individual elements.
With the prototypes completed, they were first taken to the RMIT School of Architecture and Design Gallery and hung for a day in order to test their properties in different spatial and lighting conditions, and to see the response of people to their affects. It was soon realised that the ping pong balls required a black background in order to make the spiral geometry visible and that the letters needed to be of a strong colour in order to differentiate themselves from the field of balls behind them. It was also noted that the ping pong ball piece would appear to be almost a solid element when viewed up close, while its optical affects worked best when seen from a distance. In contrast to the ping pong balls, the mesh piece needed to be hung a short distance away from a well lit white wall in order to manifest its full effect. In this situation the framed layers of flyscreen transformed into a nebulous glass-like surface which contained a swirling field of moire patterns that would alter in composition and intensity as one moved around and toward the piece. In the gallery setting the flyscreen piece caught the viewer’s imagination. People were astounded at the optical properties of the piece and would be convinced it was glass even when they stood near it. The work had the ability to confound the viewer’s perception even upon close inspection. Many people were startled when they realised they could put their hand through the cut out voids in the apparently solid surface.

The overwhelming success of the flyscreen piece in the gallery setting came as a surprise to the design team, as we had up until then all favoured the ping pong ball piece as being the prototype that would be used for the final installation. It became apparent that both pieces would need to be tested in the window of Euroluce in different lighting conditions and with different backdrops. Once the pieces were transferred to the Euroluce showroom window, it became immediately apparent that our preference for the ping pong balls for the final installation was the correct one. In the large brightly lit and highly reflective environment, the visual strength and physical presence of the balls came into their own, while the black mesh piece seemed to disappear. However when placed inside the controlled lighting of the showroom the mesh piece again manifest its extraordinary visual illusions. The decision was made to continue with the use of the ping pong balls for the fourteen metre long window façade and to position the mesh piece within the showroom as an intriguing backdrop to the various imported designer light fittings. With these decisions in place the team prepared themselves for what would become an intense three week production and installation phase of the project which would involve the use of over eight thousand ping pong balls, four thousand crimps and one and a half kilometres of fishing line. To achieve the optimal visual effects from the installation, the window façade display was precisely illuminated and the showroom lighting collection was carefully composed against the showroom’s black walls. In this way the installation, showroom space and lighting elements worked in a delicate harmony, in both the interior and exterior and during the day and night.

Once the work was installed, I visited it regularly in order to reflect on its qualities and to gauge the reaction of the people who saw it. A number of interesting observations arose from the contemplation of the work’s characteristics. I became aware of its subtlety when considered as part of a busy urban environment. In the context of the bustling energy of peak hour traffic and the lighting and geometry of Federation Square and the Forum Theatre which are adjacent to the Euroluce showroom, the piece seemed to take on a restrained elegance. The stunning visual affects that were originally sought from the work when considered in the studio environment were transformed into a delicate embellishment of the peripheral perception of the streetscape. While the mesh piece inside the showroom shimmered with an intimate visual richness and immediate and confronting gestalt, the window work exposed its hidden layers in a gentle and allusive manner. Alternately glowing and dissolving in response to the outside world as it rushed past.

Transience of Light
The design methodology employed in the development of the Transience of Light was centred on the manipulation of the conditions that lie at the threshold of our perception and sought to bring these subtle secondary affects to the foreground within the conception of the work. The process of comprehending and producing such transcendent qualities in the installation evolved from the development of the concept of optical syncopation and the controlled manifestation of surfaces activated through their visual affects. This bringing to prominence of the physical stimuli that unconsciously shapes our perception has been the constant aesthetic aim throughout the projects presented in this document and defines the essence of the intention to design works that lie ‘between field and form’. In the Transience of Light, a delicate balance was pursued between these two extremes, as the installation would take on an apparent solidity when viewed from a stationary position in the interior of the showroom, yet would become more transparent and evanescent if one viewed the work, when in motion and from a distance.

It was interesting to note, that the understated visual kinesis of the installation was not immediately apparent to many viewers, as the desire to perceive the piece as a physical three-dimensional object seemed to obscure the appreciation of the work’s subtle optical affects. In considering this response to the work, I realised I had seen a similar reaction to perceptual artworks before, most notably in the Rothko room of the Tate Modern in London. In this situation the majority of visitors to the gallery would charge into the darkened space, read the written description of the work on the wall, give the paintings a cursory glance and quickly move on to the next room. While the actual experience of the work required the viewer to take their time, let their eyes adjust to the lower light levels and to allow themselves to engage their vision in the quiet oscillations and layered movements of the paintings’ surfaces. In situations such as these, it appears that people are largely conditioned to perceive the world in certain ways and that the dominance of vision and the desire to differentiate objects in space can sometimes obfuscate our awareness of the subtle fields of phenomena that make up our perception of the physical world.

The reconciliation of these two poles of perception was the territory that the ‘transient materiality’ series of works sought to investigate. The development of projects and their public presentation acted as a form of research into the nature of seeing and uncovered a range of interesting responses within the viewing public. While I appreciated the intensity and startling gestalts that the Fibonacci spirals and mesh screens generated and understood the immediate attention that they would attract within a gallery situation, I found myself more drawn to the potential subtleties of such affects and how these may be used in architectural contexts as sensorial constellations that we would encounter and appreciate everyday. In such cases the intention would be to expose a dimension of responsive change within the fabric of the built environment and interweave the magic of the ephemeral within the structure of the enduring.
References


The contemplation of the themes and design sensibilities contained within this body of work has had a profound influence upon the way I comprehend the physical world and approach the practice of design. In questioning how the consideration of wave-like phenomena can inform the design of objects and spaces, the project has encompassed an extensive body of knowledge and uncovered a vast range of insights into design methodologies and working techniques that have been employed within both my design practice and undergraduate design studio teaching. In reflecting on the shaping of the body of work from a number of different viewpoints this document has sought to define the territory of an original approach to design while laying the foundation for an ongoing and continuously maturing practice.

The embracing of ideas that characterise wave-like behaviour not only informed the theoretical foundations used in the fashioning of the physical nature of designed objects and spaces but also infiltrated the development of a working style. Singularly the works can be seen as objects which seek to focus particular qualities of individual phenomena and in doing so question the nature of their own physicality. Subsequently the development of the project as a series of conceptually related design outcomes served to both differentiate and conflate the properties found in the individual pieces. By approaching the production of projects in a serial manner and by allowing the concerns of one series to influence the interpretation of another, an oscillating field of interrelated polarities was generated within the body of the work. This self-perpetuating field was further extended across different series of works and by implication across different modes of physical phenomena. While the projects served to underpin an appreciation of the wave-like phenomena involved in the manipulation of material and immaterial properties relative to the act of interior design, they also established the foundation for an iterative and continually evolving ideology toward the shaping of contemporary urban environments. This creative methodology was defined by the synthesis of subject and object, theory and technique in which the field-like dimensions of the act of design were synchronistically inscribed in a conceptual, structural, physical, perceptual and contextual manner.
Initially the direction of the project was developed through the consideration of the history of physical thought and involved the theoretical familiarisation with the principles of various physical phenomena (appendix 1). This research stream acted as a constant background condition that informed creative responses. Beyond this formal research, the primary technique employed in the comprehension of specific phenomena involved studio-based experimental work in which the production and testing of certain methods, materials and effects which was undertaken in the controlled conditions of the workshop and studio space. In this phase of the design process, the principles of the physical manipulation of specific phenomena and the conditions under which they are most successfully produced were trialled and perfected. Such a process required the direct engagement with the media involved in the creation of a work and relied on the mastering of the processes and techniques used to control the dynamic fields that manifest the piece’s qualities. The coming to terms with the generation of fields of physical energies and comprehending the subtleties of their sensorial perception became the nucleus of the study. From this vantage point a novel way of understanding and shaping the physical environment was developed, which laid the foundations for an approach to the act of design which could synthesise the control of light, sound, form and materiality as a holistic continuum within the composition of spatial design.

In structuring the description of these experimental pieces, the main body of this document involved the exposition of the collection of works of art and design through a detailed investigation of the primary media with which they engaged. In each chapter the qualities of light, sound, form and materiality were examined through the production of experimental design projects. Through this undertaking a detailed knowledge of the nature of the specific phenomena being manipulated, the media employed in its shaping and the qualities of sensorial engagement that such actions produced was refined and understood. These investigations established the principles for a particular and personal approach to the shaping of objects and spaces that employs the comprehension of field-like conditions to inform the act of design.

In concert with the formulation of a theoretical, physical, technical and perceptual foundation to the practice of design ran the contemplation of the collected design projects as an illustration of the synergies that exist within an ongoing creative process. The consideration of the body of work in a chronological way exposed upon the works produced, the cross-fertilisation of ideas between different projects and the infiltration of knowledge of the nature of the specific phenomena being manipulated, the media employed in its shaping and the qualities of sensorial engagement that such actions produced was refined and understood. These investigations established the principles for a particular and personal approach to the shaping of objects and spaces that employs the comprehension of field-like conditions to inform the act of design.

A more detailed uncovering of the potentials inherent within the manipulation of particular media involved the exploration of ideas and approaches through the production of works in a serial manner. Adapting such an approach both constrained and liberated the design process as, by its nature, the production of a series seeks to extend the application of ideas within a tight and controlled framework of thinking. The conceptualisation of the works as series of specific yet interrelated investigations allowed each work to operate in a precise manner in which its final form could be focused so as to highlight particular aspects of the sets of ideas, manipulation of materials and shaping of phenomena. When considered together, the discoveries made within each individual piece of work within the series could act as elements of a larger dissertation and would shape the vocabulary of the complex design language used in the manipulation of a medium.

Beyond the establishment of preconceived groups of works, lay the detection of undiscovered series within the spectrum of completed projects. In this case, parallels were identified between the themes and approaches of different works, done at different times, with different media and with different intentions. In this form of reflection, the recognition of unconscious methodologies employed within the evolving practice helped define new patterns of engagement with the ongoing work. The identification of such series of works spanned the concerns of the phenomena investigated within the project, so that methodologies and approaches from works whose origination came from the study of light could be seen in works that were concerned with the manipulation of sound, form or materiality. In this way the constructing of series of works in hindsight became a mechanism to inscribe the body of work with a network of interconnected motifs which synthesised issues from seemingly unrelated fields and drove the work into new and unexpected directions.

Another perspective through which the project has been evaluated is the classification of works into different modes of practice that run across the spectrum of art and design. While at the heart of the project lie the series of studio-based experiments, which are conceived of as pure investigations of phenomena and perception, the understanding of the potentials of these discoveries and their application in the wider world needs to be framed in relation to different sites, circumstances and design briefs. In positioning the adoption of the principles that have been developed through the comprehension of wave-like phenomena into the realm of the city, an appreciation of the typologies of space with which this thinking may intersect became paramount in defining the direction and concerns of the design practice.

Extending the conception and display of the work beyond the realm of the studio initially involved an engagement with the nature of contemporary gallery spaces. The gallery-based work was understood to exist within the traditions of late twentieth century perceptual minimalism and installation art in which the neutral void of the white walls of galleries act as a blank canvas in which works can operate on a primary level. In this situation sculptural and installation-based works can be presented in a concentrated and expressive form, in ways that can confront the audience with sensorial provocative encounters that challenge assumptions about perception and the nature of physical reality. However, the role of the gallery for the exhibition of new ideas is not restricted to the realm of art. In recent years the use of the gallery to display conceptual design work as part of the design festival circuit has become commonplace. In this scenario the practices and intentions of interior design and installation art infiltrate and inform each other so that abstract ideas on the nature of design and its future directions can be presented, promoted, discussed and debated.

While the studio-based experimental projects and gallery-based installation pieces tend to lie within the realm of the purely sculptural and physical exploration of phenomena and the mediums used in their expression, the works play a vital role in the development of the principles of a spatial practice that seeks to engage with the fabric of the city and the activities that take place there. The development of an approach towards the shaping of energy fields in different mediums also establishes the principles from which to identify, map and express the unseen forces which work together to create the qualities of architectural and urban environments. The introduction of these sensibilities into the site-specific nature of the urban realm provide the opportunity to expose the many layers of interpretation, contextual reference and potential
metaphors inherent within the shaping of the sensorial qualities of space. In this situation design has the opportunity to become a spatial composition that reacts to the nature of the environment with which it interacts, an augmentation and amplification of the conditions of architectural space that has the potential to suggest new spatial dynamics and new readings of the space. A primary form of this engagement with the spaces of the city is offered through the commissioning of temporal design installations within showrooms in conjunction with annual design festivals. In these cases the work is usually called upon to respond to a curatorial theme or question and the nature of the physical manipulation is informed by the inherent qualities of the site. Such projects involve the careful interpretation and interaction with a commercial space and its daily operations and call for a finely attuned appreciation of all forces at play within the space, so that programmatic, thematic and phenomenal concerns are carefully balanced in a unique embellishment of the existing conditions.

Developing the scope of an approach to design in which the understanding of the nature of wave-like phenomena and its affects upon our sensory faculties is employed to fashion the qualities of the city and its spaces, involved the teaching of undergraduate Interior Design studios at RMIT University. Within these studios the conception of design as a cross disciplinary pursuit that seeks new parameters for spatial practice within the urban environment was interrogated by engaging with the physical, phenomenological, social, cultural, historical and technological definitions which shape the city. In this way the design studio operates as a mechanism for challenging pre-existing assumptions about the act of design and the role of the designer within the cultural domain. In this approach, the idea of what constitutes an interior is continually questioned and expanded. The formulating of design studios that applied the principles of the manipulation of light, sound, form and materiality as their central focus, provided the opportunity to develop an approach to the act of design that employed the manipulation and testing of physical phenomena as a fundamental methodology. These explorations were then used to broaden the extent of potential projects that such sensibilities can encompass. The projects that emerged from this thinking ranged from temporal and ephemeral art-based installations, short-term exhibitions and expositions, sculptural interventions, dramatic architectural spatial transformations and the shaping of the interrelationships and narratives within complex interior programs (appendix 3).

The final synthesis of concerns that the project has manifest is the relationship between the manipulation of phenomena and its effects on our perception. This linking of the realms of physics and psychology reconfigures the reference points from which to consider the act of design. In such a schema the essential design act is no longer one that is concerned with the conceiving of objects, spaces and buildings but rather is considered as a cross-disciplinary practice that is involved in the shaping of spatial experience. In this approach to design, the phenomenological appreciation of the body and its sensory faculties, as the mediator between physical sensation and mental cognition is explored and exploited. Under these terms interior design is viewed as the manipulation of urban spatial phenomena which structures our perceptual comprehension and subsequent interaction with the built environment. The conception of the designer as a practitioner who orders the perception of spatial experience offers the opportunity to re-imagine the act of design within the urban realm, so that disciplinary boundaries are challenged and dissolved and the city is viewed as a continuously transforming set of conditions which the designer modulates, amplifies and attunes in order to imbue our surroundings with a deeper resonance.
The references to the traditions of physical thought that the research into wave-like phenomena exposed was organised within a memory diagram which acted as a mnemonic device for use in the development of design projects. Beyond its consideration as an historical ordering of layers of information, the diagram was most powerful as a design tool in which the potential links between different topics, suggested certain juxtapositions and correlations of ideas and fuelled the conception of new approaches to the manipulation of phenomena and the creation of new design works. In this way the diagram displayed not only the interconnecting areas of interest and inspiration involved in the project but also alluded to the complex nature of design thinking. This is a process that oscillates between considerations of the general historical and theoretical bases of knowledge, the specific understanding of the manipulation of the physical world and the resulting affects on the human psyche.

The outer ring of the diagram encompassed the geometric traditions that have defined various civilizations and epochs throughout the history of civilization; the second charted a number of seminal figures who contributed to the development of scientific descriptions of the universe; the third outlined the paradigms of physical thought that define our contemporary comprehension of the laws of nature; the fourth layer inferred that the comprehension of the principles eluded to in the outer three layers, can be applied to an understanding of the elements of the physical world with which a designer shapes the qualities of the built environment; the fifth layer considered aspects of the qualities of human perception that can be stimulated through the manipulation of physical phenomena, while the centre ring represents the interrelationship between the acts of art and design that can encompass the potentials within this field of physical knowledge.
appendix 2

project chronology

The organisation of the works in a chronological manner offered the opportunity to reflect upon the development of the design methodologies taken within the project and highlighted the importance of the fertilisation of ideas across different series of works and the media with which they engaged. In this light the project can be thought of as developing in three stages (represented on the following three pages). In the first phase the focus of the work was directed at the experimental and exploratory investigations of various phenomena and the resultant work was displayed in a number of exhibitions in which individual pieces took on a more abstract and sculptural form of expression. In the second phase the experimental work was conducted primarily through the teaching of undergraduate studio projects while my personal practice embraced the use of computer aided modelling and rendering programs in order to explore works at a larger scale and with greater complexity. Through these techniques the conception of works evolved so that they were thought of as arrayed compositions of multiple individual components which worked together to create integrated fields of form and phenomena. In this approach the potential to imbue the works with greater metaphorical power and spatial presence became apparent. The third phase of the project represents the maturing of the design methodology to the point where the experimental, sculptural, contextual and spatial dimensions of a specific project were addressed progressively throughout the designs development. In these works, the response to the conditions of particular sites and the foregrounding of the works ability to affect the audience’s perception became the paramount concerns in the engagement with the dynamics of different urban spatial typologies.
Targets, 2005.
Powerpoint Projection.

Shadowfield, 2006.
Holographic Film
Cardboard,
Fluorescent Lamps,
Fluorescent Paint.

Chora, 2006.
PVC Pipe, Flexi-Ply,
70 Watt Amplifier, Speakers,
Rhino Modelling + Rendering.

Vesica, 2006.
1000 x 1000 x 600mm
Stainless Steel Wire,
Stainless Steel Mesh.
Rhino Modelling + Rendering.

Continuum, 2006.
1800 x 6000 x 600mm
Stainless Steel Wire,
Stainless Steel Mesh.
Rhino Modelling + Rendering.

Manifold, 2006.
Rhino Modelling + Rendering.

4800 x 1200 x 250mm
Medium Density Fibreboard,
RGB-LED Lights,
Rhino Modelling + Rendering.

Adobe Illustrator.

70 Watt Amplifier, Speakers,
Rhino Modelling + Rendering.

1600 x 1600 x 450mm
Traffic Cones,
70 Watt Amplifier, Speakers,
Rhino Modelling + Rendering.

Polarities, 2008.
Three-dimensional
Digital Printing,
Rhino Modelling + Rendering.

Iris, 2008.
Three-dimensional
Digital Printing,
Rhino Modelling + Rendering.

Pause and Descend, 2008.
Powerpoint Projection,
Sound Forge.

Test Pattern, 2009.
Polypropylene Sheet,
Medium density Fibreboard.

Poi, 2009.
Three-dimensional
Digital Printing,
Rhino Modelling + Rendering.

Three-dimensional
Digital Printing,
Rhino Modelling + Rendering.

Polarities, 2008.
Rhino Modelling.

Rhino Modelling.

Auroral, 2010.
Medium density Fibreboard.

Test Pattern, 2009.
Polypropylene Sheet,
Medium density Fibreboard.

Poi, 2009.
Three-dimensional
Digital Printing,
Rhino Modelling + Rendering.

Polarities, 2008.
Rhino Modelling + Rendering.

Manifold, 2006.
Rhino Modelling + Rendering.

4800 x 1200 x 250mm
Medium Density Fibreboard,
RGB-LED Lights,
Rhino Modelling + Rendering.
appendix 3

undergraduate interior design studios

The adaptation of the body of knowledge generated from a personal studio practice into the pedagogical concerns of undergraduate design studio teaching provided the opportunity to extend the scope of the study through the input of the individual creativity, diverse fields of interest and youthful energy that the students brought to these concepts. These studies were structured around primary investigations into the manipulation of physical phenomena and led to the refinement of particular physical and sensorial perceptions which were then applied to specific sites, contexts and briefs. The design projects developed from such an approach operated to augment and amplify the phenomenological conditions of particular spaces and overlay these spaces with new dimensions of experience and meaning. The studio topics and the responses developed by the students served to expand the vernacular of design so that it traversed a wide range of modes of practice and a plethora of potential urban spatial experiences.

The Light House

The Light House studio project was situated in a Museum of Art, Science and Human Perception. The conceptual basis of the project was to manifest a space in which the visitor could experience a specific knowing of light via an extraordinary spatial experience. A group of key people, discoveries and philosophies that helped define the body of knowledge and perception of light were identified. These ranged from the Egyptian, Greek and Taoist cultures through to the scientific discoveries of Newton, Einstein and Hawking. The designed responses were spatial expositions that housed the assembled insight, knowledge and specific understanding of light of the particular subject. The spaces attempted to create a physical manifestation of a ‘way of seeing’ by focusing on the physical and phenomenological implications of the subject’s work and making their knowledge ‘visible’ in the surroundings. The metaphors inherent in the image of a lighthouse as an isolated beacon, a reference point and ray of hope were to be exploited. Ultimately the project attempted to merge the medium with the message and expose the viewer to the entwined history of light and mind, by creating a space where light and enlightenment became one.

Twenty First Century Sublime
Ross McLeod and Matthias Hausler, 2005.

The Twenty First Century Sublime studio explored ideas of the sublime in relation to twentieth century modernist architecture and art practices. The sublime was discussed in terms of the affect that encounters which overwhelm the senses and emotions have on the psyche and how they may lead the mind to a heightened awareness of what lies beyond the everyday. The project used the foyer of the original BHP House in Melbourne as both a physical site and as an example of modernist design principles. Initial research and site investigations developed specific and personal readings of the nature of the building, its usage and its context relative to twentieth century architectural thinking. The students were also asked to come to terms with the physical and phenomenological aspects of the site and develop techniques for their focusing and amplification. This involved a deep technical understanding of the affects of light, sound and materiality and the development of precise techniques for their documentation and specification. In the final design proposal the students were asked not only consider the phenomenal, physical and material concerns of space but include ideas around the social, cultural and behavioural aspects of human beings. These observations and perceptions were to be aligned with the specific conditions of the site and used as a mechanism for developing a brief and program for the building’s foyer space. Ultimately the project sought to raise the experience of the everyday into the extraordinary and transform the mundane into the sublime.
The Gravitas studio interrogated the concept of gravity as both a metaphor and technical device with which a designer can focus the spatial dynamics of grand urban void spaces within significant public buildings. The studio began with the students familiarizing themselves with the evolution of twentieth century sculptural practices and acquainting themselves with the surrealist techniques of collage, assemblage, montage and homage. The studio explored the associations inherent within specific materials and objects through the careful arrangement and assemblage of contrasting elements. The aim of this project was to produce works that communicated universally on an essentially human level and to evoke memories and emotions. In the final project of the semester the theme of the work moved from personal investigations to ideas and issues that addressed civic and community concerns. The students were free to choose a building or space from anywhere in the world and document its physical structure, spatial dynamic, history and cultural context. They then developed a sculptural and spatial intervention for the chosen architectural void. The aim of the design was to create dramatic hanging forms that would focus and amplify the site's spatial phenomena and expose specific issues and meanings inherent in the site and its spatial typology.

The Museum of Shadows explored the nature of spaces whose material and light qualities shift throughout the day and throughout the year. The studio sought to capture the play of light across the materials, geometries, textures and rhythms of a building’s fabric and in doing so define the relationship between structure of a building’s form and the shaping of the qualities of light within its volumes and spaces. Through a series of enquiries into the geometry of repetition and drawing on the aesthetic principles known as ‘wallpaper groups’, the students explored the potentials of patterns, apertures, openings, borders, edges and perforations within the generation of architectural form. The final design project involved the development a memorial space that sought to capture the psyche of a city and its population through the remembrance of a moment within the city’s past. The space was to be a composition of cast elements which poetically interwove structure, aperture, pattern and texture so as to respond to the orientation of the sun’s path and manifest constantly changing qualities of sunlight within the space. The design of these spaces sought to poetically address the metaphoric and emotive potentials of light and darkness and their interaction with space, so as to powerfully express the essence of an event etched on the city’s subconscious.

The Sound and Vision studio asked students to develop proposals for a temporary installation that would take place as part of the annual State of Design Festival. The design was to be sited within an iconic space within Melbourne’s CBD that would be transformed each evening through the careful manipulation of the mediums of light and sound. The design needed to consider the dynamics of the selected architectural space and how sound and light could expose the context, history and issues of the site. In addressing this brief the students needed to consider the temporal dimension of the design and how their installation would change the space over time. In developing the proposals the students produced a series of experimental projects that explored the constructive use of light and sound. These experimental/ sculptural pieces were produced at one to one scale and attempted to engage in sound and light technologies in a sophisticated and original way. Through these devices the students attempted to expose the principles that affect the design would create. The final presentation of the design proposal employed these light and sound experiments to communicate the nature of the design intervention and simulate the visual and aural qualities inherent within it.

The Phenomenological Filter studio explored the concepts of phenomenology as encountered in the realms of spatial art practice and architectural space. The studio focused on the development of the students’ spatial and temporal awareness of the physical world and approached the act of design as a way of structuring experience. In this philosophy, the relationship between the sensations of the external world and the internal cognitive processes of the mind were continuously examined and questioned. The studio extended this thinking by exploring how the sensorial could become a metaphorical narrative that is attuned to the programmatic ordering and experiential qualities of different typologies of space. Through the unpacking of the actions, rituals and encounters inherent within particular spaces the students began to think about the idea of the architectural program as a series of phenomenological encounters. Ultimately the studio involved the development of projects which challenged the students’ conceptions toward the ordering of space and defined the act of design as a process which engages in a refined understanding of our perceptual faculties and their interaction with the complex phenomena that constitute the spaces which we inhabit.

**Gravitas**
Ross McLeod and Jason Parmington, 2006.

**Museum of Shadows**

**Sound and Vision**
Ross McLeod and Bruce Mowson, 2008.

**The Phenomenological Filter**
Ross McLeod and Jason Parmington, 2009.