MESOPARASITE

A Symbiotic Affair

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Design strategies that explore the parasitic habitation of Auckland Harbour Bridge as a destination in its own right.
“By their very nature bridges enable change because through them people cross barriers and see a different world on the other side.”

ABSTRACT

This project seeks to explore potential options for parasitic adaptation and habitation of unused space in a bridge structure where organic will meet infrastructure. It is a call for habitation that, looking at nature and machines for inspiration, would merge historical, existing and future elements showcased in a symbiotic addition to an iconic landmark. It is an attempt to renew old steel bones with facilities creating transit that would highlight environmental and technological concerns, cultural preservation and social interaction. Illustrated in structure, form and proportion, this project uses architecture’s remarkable capability to blend utility and beauty through a unique interpretation of behavioural strategies.

The Habitable Bridge concept is used as a starting point for the examination and execution of a nature based structure, in which a multitude of urban functions are brought together. The bridge as infrastructure will be approached in an architectural challenge, pushing boundaries that will provide a new attitude in which architecture and infrastructure will be considered equal mediators in the connection to the city. Through analysis, parasitic architectural typologies will be employed to negotiate, stimulate and accommodate a symbiotic proposition on a host structure in the organic tradition. An architectural solution will be developed and introduced to adapt to the built environment of the Auckland Harbour Bridge, without affecting the stability and primary function of the structure during construction and operation. It should complement the bridge, boost the economy, create valuable real estate for the benefit of the city, and contribute to the diverse character of the City of Auckland. The symbiotic interface, between human and nature, re-evaluates the importance of nature in our built environment. This project explores the potential of reintegrating the relationship between human, architecture and nature.

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Preface

“Architecture begins where engineering ends.”

Walter Gropius

In our modern context, urban bridges do not contribute to urban life apart from traffic needs. Therefore, rethinking the role of bridges appears necessary. The inhabited bridge not only provides a link between two points for pedestrian and vehicular movement, but also supports superstructure that can serve residential and commercial purposes, creating a continuity of the urban area from one bank to the other. While respecting the landscape and maritime character of Auckland, what are the future architectural solutions in order to generate space inside the structure of the Harbour Bridge?

“By their very nature bridges enable change, because through them, people cross barriers and see a different world on the other side.”

Investigation by design will be focussed around the following strategic objectives: the habitable bridge concept; infrastructure as architecture; parasitic architectural applications that will utilize infrastructure as host to organic architecture. The structural constraints and limitations of the bridge will be considered to arrive at a suitable, nature based, conclusion.

4 Blockley, Bridges, 150.
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To my family for reasons that can never suffice in writing.

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My friends with whom I was blessed to share my life.

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Fig 1. Auckland Harbour Bridge, New Zealand.
INTRODUCTION

“From very early times bridges have been at the heart of the way we think about the human condition: the enigmatic connection between heaven and earth and between the natural and the supernatural. Bridges are links between the known and the unknown; they are part of how we deal with what we don’t understand. As a consequence bridges stimulate new ideas and new understandings - often with interesting and colourful traits as the myths ancient and modern, reveal.” 5

5 Blockley, Bridges, 112.
RESEARCH QUESTION

Can the Harbour Bridge be inhabited through a symbiotic interface between human occupation, architecture and nature, without affecting its primary function and the maritime character of Auckland?
Fig 2. Auckland Harbour Bridge, New Zealand
“It is a question not of copying a historical model, [the habitable bridge], but drawing from its ethics and dynamism.” 6

AIMS AND OBJECTIVES

This project is an exploration of the adaptive use of the unused space inside the “bones” of the superstructure of the Auckland Harbour Bridge: an experiment in structure and poetics of space. The approach will be to construct a programme that can be used to reference traditions and forms that stem from the cultures and context they are designed for. The design will strive to focus on atmospheres, vistas, and establishing connections to the site that will mark innovative spatial arguments. 7 It will investigate different strategies that will reference and influence one another. The aim is to investigate how this building will become a mediating element, creating a symbiotic, parasitic relationship between nature, culture and context on the one hand and an architectural intervention on the other. What will be required to make this bridge “come alive”?

This project takes the liberties awarded any student project in terms of budget and feasibility responsibility, and will strive to adhere as much as possible to the New Zealand Building Code requirements and sustainability principles.

6 Murray and Stevens, Living Bridges, 34.
Fig. 3 Auckland Harbour Bridge,
An organic connection
THE BRIEF

“The Engineer’s Aesthetic, and Architecture, are two things that march together and follow one from the other... The Engineer, inspired by the law of economy and governed by mathematical calculation, puts us in accord with universal law. He achieves harmony. The Architect, by his arrangement of forms, realizes an order which is a pure creation of his spirit; by forms and shapes he affects our senses to an acute degree and provokes plastic emotions.”  

A habitable bridge should be evaluated on its connection to the city and its ability to draw the public into this new setting. What will the bridge rely on to attract people? Is it just a journey that happens to have a secondary programme installed or will it be a unique and cohesive development? 

This research developed from an interest in the habitation of a bridge structure in a way that would easily merge with the historic character of a piece of infrastructure, and the city. The architectural intervention would act as a landmark connected to an iconic structure, offering Auckland a contemporary, habitable bridge in the tradition of the Rialto Bridge and other grand living bridges before. The design must show the ability to make correct compromises and be able to create equilibrium between the influences of economics, commerce, culture, context, scenic beauty and social interaction. The proposed design should illustrate sculptural, plastic, site sensitive, and sensory design principles. 

Why design a hotel and restaurant?

Tourism is one of New Zealand’s biggest export industries. It directly and indirectly contributes almost 9% of the gross domestic product for New Zealand. ¹¹ For a factual discussion, see Appendix 2

The Auckland Harbour Bridge provides an opportunity to extend the city’s previous boundaries, creating additional real estate that will contribute to the expansion of the cityscape as a whole. The study builds on the “Habitable Bridge” concept, and aims to introduce a mixed-use space connected to the Harbour Bridge. This project will rely on cultural and contextual influences in the creation of the design. Looking at historic precedents and the needs of the city, the intent is to create a viable, inhabitable architectural solution, under, inside, over and around moving traffic. The programme will consist of an upmarket, vibrant boutique hotel and restaurant that will utilize and maximize all available visual angles and views of the Auckland cityscape, Waitemata Harbour and the North Shore of Auckland. The success of this project will rest upon the place that is created and whether or not it illustrates the underlying principles of integration, coordination and of recognizing relationships.  

The project will seek to achieve a habitation that would merge historic, existing and future elements, showcased in a sensible addition to an iconic landmark. The different speeds of life evident in the city will be integrated in the concept and design of the proposed structure in which a variety of streams will be accommodated: walking, biking, living, working and commuting. It will propose spaces that encourage different behavioural patterns, inviting activity that lingers, a counterpoint to the continuous flow of traffic on the bridge: watch and be watched inside a space imbued with visual punch, sporting a dynamic, gravity defying form. Contextual extractions and symbolic objects would be researched and referenced to ensure a good design outcome. By implementation of the principle of Kaitiakitanga, a deep kinship between humans and the natural world, the fundamentals of environmental sustainability will be achieved. By extracting conditions from the site, the objective will be to ensure that the resultant programme, spaces and forms will adapt to the given context like a chameleon would to its environment by mimicking. This will be a form of imitation by the application of natural and biological analogies.

12 Ibid., 134.
Fig. 4. Te Onewa Pa, Stokes Point. Auckland, New Zealand
A. 1 THE SITE

Cultural Background

Stokes Point, the northern anchorage of the Auckland Harbour Bridge, was the site of Te Onewa Pa (Pa refers to a fortified village with an emergency food supply), a stronghold of great strategic importance and previously home to a busy Māori community. Māori fished the bays and gathered berries and roots from nearby forests. The oldest known natives of the district were Ngati Tai, who in ancient times suffered severely from raids by Ngati Whatua and, in 1650, of Ngati Paoa. Ngati Whatua then conquered the whole of the Auckland isthmus. Ngati Paoa took over Onewa’s Ngati Tai villages, but was driven back by Ngati Whatua. The remaining Ngati Tai returned in the early 19th century to their old villages at Onewa. After the musket wars of the 1820s, peace returned to the Auckland area and a few Ngati Tai, including their last chieftain Heteraka Takapuna, continued to live at Onewa for some years.  

In 1841 the North Shore was included in the vast Mahurangi block sold by Māori to the Crown, and Onewa Pa passed from Māori ownership. Following the founding of Auckland in 1840, what is now known as Northcote Point was named Rough Point after Captain David Rough, Auckland’s first harbour master and superintendent of works. In 1848 the name was changed to Stokes Point by Captain J.L. Stokes of H.M. Survey Ship Acheron, during a survey of the Waitemata Harbour. The Stokes Point district was renamed Northcote by Major Benton in the early 1880’s, after the British aristocrat, Sir Stafford Northcote. Pataka Hapi and Anaru Makiwhera described the site to accountant and historian, George Graham (1874-1952) as a pa at the end of the Point that protected nearby kumara (sweet potato) cultivations and fishing grounds. The pa itself was protected by a fortified trench that divided it from the rest of the Point. The name, Te Onewa, “divided earth”, is a reference to this trench.  

15 Ibid.
Fig. 5. The Auckland Harbour Bridge construction.

Fig. 6. The Auckland Harbour Bridge, construction.
The Bridge Background History

A draft prospectus written in the 1860’s for the North Shore Bridge Company, noted that “A bridge will open up the whole countryside and make its wilderness cultivated fields, gardens and towns whilst the value of the portions at present under cultivation or built upon will be greatly enhanced, the social state of the present inhabitants will be greatly improved, and their convenience and means of wealth and economy brought to a par with the neighbouring city”. In 1860 members of the farming community of the North Shore of Auckland formed the North Shore Bridge Company and appointed Frederick A. Bell, a bridge engineer and architect, to design a bridge. He designed a floating bridge on 137 pontoons between Stokes Point and Ponsonby. This bridge was never built, and twenty years later, the need for a bridge was recognized.

The Auckland Harbour Bridge Authority, chaired by Auckland mayor Sir John Allum, was established in 1951, to design and build the Harbour Bridge. The bridge, designed by Freeman Fox and Partners and built by the Cleveland Bridge and Dorman Long Partnership, crossing the Waitemata harbour between Stokes Point at Northcote and Point Erin at the city side. On May 30th, 1959 the North Shore and Auckland were connected for vehicular traffic. Opened by Governor General John Lyttleton, the lifeline took four years to construct and claimed four lives. The four lane bridge, 1020 metres long with a 41 metre clearance at the highest point, accelerated the development of the North Shore. Two more lanes, supported by a box girder underneath, were added on each side in 1970 by Ishikawajima-Harima Heavy Industries Co Ltd. The Auckland Harbour Bridge is operated by New Zealand Transport Agency with constant ongoing maintenance projects to ensure undisrupted functioning. Investigations are underway to establish another harbour crossing and a future tunnel system under the seabed is proposed.

THE PROJECT DEFINED

“Bridge building is more efficient than any other form of architecture as it is accessible to everyone. Bridges are accessible to people who are not interested in art. One single gesture transforms nature and gives it order.” 18

Theoretical Influences

This section presents selected theories with critical thinking in order to cover all different aspects and influences envisaged for this research project.

The first section presents the Habitable Bridge concept followed by discussion and information on the character of Parasitic Architectural structures in combination with addressing infrastructure as architecture. The third discussion will be on structure as architecture. Theories regarding the connection to nature, relationships and the referencing to and extraction of natural objects and cultural symbols from the site, will be discussed. All mentioned topics will be researched as separate entities but the aim is to interweave all theories in the final design outcome of this project.

Fig. 7. Old London Bridge
The Bridge as a Destination

Background History

Habitable bridges were once the rule rather than the exception. At one time nearly every city in Europe showcased at least one chaotic span that balanced people, shops and accommodation over a water mass. The historic example of the old London Bridge was a town or destination in itself; it had beer-houses, bakeries, food markets, manufacturing industries and even a church. Children were born, reared, grew to old age and some died without ever having to set a foot upon any part of the world other than London Bridge. 19

In an interview with Jean Dethier by Peter Murray in Living Bridges, he stated that the historical development of inhabited bridges can be identified in phases. Inhabited bridges appeared in Europe during the Middle Ages and enjoyed a heyday at the end of the sixteenth century. During the seventeenth century they went into decline and most were demolished during the eighteenth century. Over a hundred inhabited bridges were built in Europe between the Middle Ages and the Enlightenment, but only about ten survive today. Before the Middle Ages bridges were inhabited by virtue of the fact that they provided anchorage for mills, making use of the river below, examples would be at Zurich and Tournai. The bridges gradually accumulated multiple functions such as the Old London Bridge. It had a life span of over six hundred years before it was demolished in 1823. The main function of most habitable bridges was commercial and it developed from relatively modest shops to an increasingly prestigious nature. This is illustrated in the case of Ponte Vecchio, where butchers surrendered their stalls to jewellers, and, in 1141, all money changers in Paris concentrated their activities on Pont au Change. These bridges, lined with shops, can be regarded as the ancestors of modern shopping malls. 20

See appendix 2 for a discussion on the factors that contributed to the disappearance of inhabited bridges and needs to be met by modern inhabited bridges in the twenty first century.

19 Murray and Stevens, Living Bridges, 46.
20 Ibid., 25.
“The inhabited bridge provides a continuity within the urban fabric that is not only social and economic but also cultural, emotional and symbolic at a point where a natural break would otherwise exist. Indeed, it is both seductive and functional.”  

The Twentieth Century

In 1995, The Thames Water Habitable Bridge Competition was organized by the Royal Academy with the support of the Government Office for London. The competition called for a bridge which would reduce the diverse nature of the River Thames and become a destination in its own right. It should be buildable, structurally sound, commercially viable and capable of meeting navigational demands. Seven architects were invited to enter and two were selected: the projects of Zaha Hadid Architects and Antoine Grumbach. The submitted designs confirmed that sufficient accommodation can be included within the bridge to fund its construction. The major factor for the acceptance of these proposals, however, was a social and aesthetic judgement based on a poll of the reaction of the general public.

Is it possible to provide a convincing contemporary rationale for an inhabited bridge in order to argue for its introduction into current and future town planning?

21 Ibid., 20.
22 Ibid., 135.
Parasitic Architecture: a Symbiotic Relationship

“An organism living in, with, or on another organism,” 23

In biology, the term parasitism refers to an ecological relationship between two organisms, where one organism, the parasite, benefits from its host. The biological host is both literally and metaphorically the carrier of the parasite. In architecture such carriers exist as well, namely the systems of the city. Parasites can be categorized by their relation to the hosts as either endoparasites which live inside their hosts, or ectoparasites that live on, but not within, their hosts. Parasitic architecture can be defined as an adaptable, transient and exploitative form of architecture that feeds off a relationship with its host, in order to complete them both. The parasite has to understand the working of its host and exploit this knowledge in order to survive. However, this cannot lead to the destruction of the host, since this would also mean the end of the parasite. The parasitic organism, in this case the proposed hotel structure, will distract from the host both in terms of form and space and will be bound to it by a state of necessity. Parasitism as architecture represents an invitation to rethink the capacities and possibilities of design and the necessary bond between architecture and the design of the city. The term parasite as a semantic idea demands reflection on the urban model and its sense of design. It is no longer an unconditional increment of space, but articulates parasitic links with existing host bodies to densify the city. The rethinking of the value of territories illustrates to us that the city can grow on its infrastructure. 24

Parasites are considered as embedded networks to existing infrastructure and offer possibilities of creating space above and below the built environment. The adaptation of a new, generated system into the existing allows for investigation of extending space and producing new patterns to available paths. Parasitic systems have different strategies for surviving, methods of attachment, reproduction and sustaining themselves on the host. Collaboration between architecture and biology can help to angle design towards organic based outcomes as both architecture and biology deal with entities operating in context. 25

25 Ibid.
Biology can usefully inform architectural design because architectural design aims to resolve challenges that have already been resolved by nature. It increasingly seeks to incorporate concepts and techniques that have parallels in nature and share a common language as both attempt to model growth and adaptation.26

The objective of the introduction of parasitic architecture to the habitable bridge concept will be to simulate the attachment as a three dimensional model on, or inside, the harbour bridge superstructure, a mesoparasite. The hypothesis is that, using parasitic behaviour to develop forms, the functional space within the city will potentially extend and inefficient, unused space will be rejuvenated. The intention is that this section will provide an extensive foundation from which to promote and potentially extend this subject field, and the introduction of parasitic structures to a piece of infrastructure that will ensure the forms adapt harmoniously with their host, the Harbour Bridge.

The term Symbiotic architecture will be used in combination with Parasitism as the proposed project illustrates and adopts the characteristics of both concepts: a parasitic intervention that will showcase a symbiotic relationship over time. A symbiotic relationship is an interaction between two diverse organisms living in close physical association, to the advantage of both. It can be seen as a relationship of mutual benefit or dependence. 27 Mutual benefit is a symbiotic goal and architecture can play an important part to ensure survival of all parties; the engineered bridge and the newly inserted architectural structural parts would be a hybrid of parasitism, symbiosis, commensalism and mutualism. The parasite firstly, has to understand the working of its host and exploit this knowledge in order to survive. Such a symbiotic relationship between parasite and host, in which the former takes advantage over the latter, would be explored and applied to see if it will be notably worthwhile and imaginable in an architectural intervention on the bridge. The challenge would be to develop a space within, or upon, an existing structure that not only provides a new programmatic element, but also a method of maintaining an attachment and ensuring structural integrity.

Infrastructure as Architecture

When infrastructure becomes an object, artefact or a space, infrastructure of mobility becomes the prime candidate to develop into a public space, or better yet, a public form that is true and proper to the needs and demands of a modern urban society. Such an approach would privilege infrastructure by imposing on it all the demands that culture and the arts usually reserve for themselves but rarely apply to the technocracy that structures the very society in which they operate. 28 We should investigate any possible means of applying these demands on our used and unused infrastructure space. Infrastructure’s primary mode of operation is as a static connection; it moves goods, people, energy and information, establishing pathways that make connectivity possible. It is the heart of the next generation’s public sphere since public spending on dedicated public space has taken a back seat in the general planning and funding of our cities. Infrastructure systems will, in future, give back to their neighbours in various forms. It should yield to hybrids and multiple programmes that will push its public capability. This newly envisaged, inhabited infrastructure will become a local amenity, creating a liveable, sustainable and dynamic community. Infrastructure is in need of programmatic reinvention. This could take the form of responsive environments, spaces of communication and other kinds of engagement, and it will bring forth new ways to inhabit, experience and participate. The more things happen at once and at the same place, the richer the experience. This double duty concept can be found in architectural fantasies like Le Corbusier’s plan for Algiers, Yona Friedman’s Linear City, and even in Florence’s Ponte Vecchio. 29

Modular infrastructure, such as the Auckland Harbour Bridge, provides a firm “foundation or outline” for architecture, and presents an opportunity to make the city more flexible. The attempt to translate information and architectural solutions will make architecture stronger as a whole and enable it to deliver solutions that will enhance the effectiveness of design. 30 It will be an objective of this document to explore these theories. It will search for a thread that will connect the theories to a natural, organic based philosophy that will benefit the design process and the creation of a purposeful building on an extreme, unusual site. The proposed design will show a harmonious transition from natural to industrial.

29 Ibid., 79.
30 Ibid., 78, 21, 39, 110.
Fig. 8. Nature to industrial, from Stokes Point to the Bridge
PART 1

DRAWING FROM NATURE

“In all things of nature there is something of the marvellous.” 31
“Architecture has much to learn from Nature. The primary function of architecture is to provide a shelter that protects from predators and climate shifts, to keep nature out. We could improve the psychological impact by implementation of the wild and organic in informing design choices, engaging with the outdoors will bring a new wealth of architectural possibilities.” 32

Humans have an inborn connection with nature and landscape configurations. Throughout history nature has always been an inspiration for human creativity and acted as the ultimate model of sensibility, flexibility, intelligence and ability. As humans we have an intuition that nature is good for us. We are intrinsically fascinated by it. In architecture nature has always been a source of inspiration, both in writing and in form. In this research I consider nature as a creative source by integrating a nature based form in the development of a hybrid-parasitic structure. 33

1.1. A PHILOSOPHICAL BASIS FOR AN ORGANIC ARCHITECTURAL APPROACH

The history of marine biology can be traced back to 1200 BC when Phoenicians began ocean voyages using celestial navigation. It was also evident in Greek mythology as references to the sea and its mysteries were used in the Homeric poems. Philosophers and theologians have been seeking advice from Aristotle to define both nature and technology. It was not until the writings of Aristotle (384-322 BC), arguably the most influential philosopher in history, that specific references to marine life were recorded. Because of these observations, Aristotle is often referred to as the father of marine biology. He based his philosophy on biology with explanations that rely on material things and properties of “this world” and observed that certain regularities occur in nature regardless of what humans may believe or decide. Aristotle argued that “essences” make things into what they are and that bodies of plants and animals are purposefully structured. Only natural things have essences while man-made things retain the essences of the natural things from which they are composed.

Aristotle was the first to describe the functions of the human soul and the five senses: the data combined in a central function called common sense. A Phantasm is formed by imagination, stored in the common sense, like a model of the thing being perceived: it represents its properties analogously. He argued that we cannot think without phantasms. This connection regarding the human senses and its relation to architecture and nature will be researched and introduced to the space and structure proposed on the Harbour Bridge. The principles of representation of nature in the context of the site, merged with symbolic representation, would be an attempt to form phantasms of the structure representative of identified parts of nature. It would form regularities and transform these essences that exist in plant and marine life into an architectural statement.

“It is not imitation that justifies an intense study of the past. It is inspiration that is badly needed. Inspiration is an indispensable element of all growth, an intuitive response to related problems that are successfully solved. It derives from the eminent prototype an understanding of that which is timeless against that which is time bound... Every creative effort is a metamorphosis of the spirit that must feed on the admired precedent.”  

Nature influenced and played an important part in the lives of the ancient Greeks: it was translated into art, literature and architecture. The gods were representative of nature and its occurrences, the earth, sky, water and forest. The geometry found in the decoration of their temples was nature based, such as the Corinthian column. For the Greeks nature existed in the sensual form or in the physical reality which could be felt, seen and experienced and in the spiritual and cosmic aspect of nature. They positioned their structures to strictly adhere to spiritual laws and careful observation of holy views. All of the Greek temples developed in a different form as each temple was specific to its site and spiritual intentions: the approach to building and developing the site produced a pattern found in the shape of the landscape and in the general form of the temple.  

Nature has always inspired the creative mind. Architects have used nature as a departure point in design for hundreds of years. The organic tradition is one of the philosophies this paper will draw from in an attempt to situate architecture and nature in a harmonious relationship developed into a final design solution. The two separate but related kinds of interpretation, visual and functional, of the organic analogy will be explored and applied to the final design. The idea of functionalism and beauty can be traced back to Aristotle who demonstrated this theory with the use of animals: each limb serves a definite purpose, yet adds to the function of the whole. In architecture it can be interpreted as illustrated in a structure with clear and identifiable parts which serve specific functions and create the form based on function. It is hoped that relying on nature and its processes, a symbiotic relationship between man-made and natural will be created.

The rapid development and ubiquitous impact of modern technology make people feel that nature is in danger of extinction. The physical relationship and cooperation with the natural environment is necessary for humankind’s development and survival. This research will be an attempt to trace a line of a nature-based organic design ethic and to explore the common principles in such architecture. Historically, myths and traditional spiritual beliefs revealed an holistic understanding towards building and nature, the relationship between life and land, or life and water mass, the processes of nature and man’s role in maintaining the equilibrium. 39 An architectural approach will be followed in keeping with nature’s behaviour in alignment with the chosen site and contextual elements that will include culture and climatic conditions. The principles established will be expressed through the architectural vehicle of a restaurant and hotel combination attached to the Auckland Harbour Bridge. It is hoped that this organic approach will create a design that forms an harmonious parasitic and symbiotic relationship with nature and the spiritual and historic roots of the place and time.

The proposed project will respect the ecological relationships of the climate, the superstructure of the bridge, the ocean, plant, animal and marine life of the region. In nature, survival depends on two forms of cooperation: the physical cooperation with the natural environment, and the symbolic relationship that represents a consciousness of the human biological place in the universe. Objects and cultural artefacts acquire a symbolic link with places and regions whereas structures maintain a symbolism in their association with past cultures. 40 These principles are illustrated in numerous ancient cultures and will be illustrated in the symbols and historic structures of Maori in New Zealand. They understood the physical and symbolic relationships of natural and man-made that derived from a metaphysical appreciation of the human connection with the universe. They showed respect and sensitivity towards the balance of natural processes that stems from man’s survival instinct.

“For the artist, communication with nature remains the most essential condition. The artist is human, himself nature; part of nature within natural space.”

Nature is imbued with one common life force: the living water and living earth, plants, trees, animals and man. We have to take stewardship, protect and preserve nature, managing the environment based on the traditional Māori world view. All life is connected. People are not superior to the natural order; they are part of it. To understand the world, one must understand the relationships between different parts of the web. We must illuminate the relationship between life and land, the processes of nature and man’s role in maintaining the equilibrium.

“Study nature, love nature, stay close to nature. It will never fail you.”  
Frank Lloyd Wright

Frank Lloyd Wright writes of cosmic laws as the physical laws of man-made structures and the laws of the landscape. Nature provides man the ultimate forms of beauty and economy that inspire his creative impulses. Man, he said, acts as a positive creative force when he builds upon the landscape and should be considered an equal with the other natural features of the landscape.  

We have to search for an architectural and environmental ethic in keeping with nature’s behaviour and the way we perceive our relationship with nature. The re-examination of ancient beliefs and paradigms of nature will offer a new perspective on the relationship between what man builds and how to bring human habitation into an intimate and stimulating rapport with the expressive processes and cycles of human growth. Following this model may lead to an harmonious connection between architecture, people, and the natural environment.  

Contemporary architects may have lost sight of the spiritual roots of the place and time in which they are building. They prefer to draw upon archetypes and forms of unrelated culture and place. In this research paper, the aim would be to step back in time and to explore and find inspiration in historic guidelines based on nature and the organic.

“The Function of all functions is the Infinite Creative Spirit. Nature’s lesson is one of spirit – spirit both powerful and beneficent.”

Louis Sullivan. 46

The roots of organic architecture can be traced to Europe. The Industrial Revolution left many people dissatisfied with culture and many felt that it was time to create a doctrine of nature based organic development. 47

Louis Sullivan was one of the first Americans to translate the search for an organic architecture into building. His approach was two-fold: socially motivated and mechanically motivated. He understood nature in a metaphysical sense, he was aware of the underlying interconnectedness of all life and nature. The search for a symbiotic relationship between man-made and natural resulted in an architectural philosophy entitled organic architecture. Inherent in this philosophy is the exterior expression of the interior or form follows function in combination with structural expression and the inventive use of structure and materials. The emphasis is on the experimental, emotions and sensations aroused by moving through the structure. Louis Sullivan believed that architecture was the medium through which nature manifested itself. 48 The organic architect is closely aligned with the spiritual and metaphysical attitudes expressed in ancient and indigenous architecture. Organic architecture does not follow a strict doctrine of form as each building is an expression of its particular place, culture and time, or genus loci. The organic architect will look at nature, its geological and biological forms, in order to create a building that showcases the relationship between organic and inorganic.

47 Lesnikowski, Rationalism and Romanticism in Architecture, 157.
Frank Lloyd Wright was fundamentally influenced by the transcendentalist philosophies of Walt Whitman, whose writings were inspired by and united with nature. Whitman said nature would inspire and instruct the artist, providing economic forms and a process of creation. It is the artist's mission to follow and create a method of development, not to imitate nature directly, but to parallel the process of life and growth that develops to abstract form. The architecture of Wright expresses form as a direct consequence of movement and function and offers extremes of visual experience. Wright outlined various ways of fusing buildings with their environment. His philosophy included several directives that would inform an architecture and nature unity. The organic approach and work of Sullivan and Wright was largely rejected by the architectural community at the time, but the tradition somehow managed to persist through the twentieth century. Bruce Goff, influenced by Wright, developed a new dimension in the organic approach with a more liberal philosophy. He used circles, triangles, stars and logarithmic spirals as ordering devices in an imaginative organic exploration of three-dimensional geometry, and non-traditional materials such as airplane parts in design development and in construction.

Richard Neutra searched for an architectural and environmental ethic in keeping with nature’s behaviour, the alignment with a region’s characteristics and climate, inclusive of man’s own physiological and psychological constitution. Neutra stated that “[It] is the inclination to interweave structure and terrain, to bring human habitation into an intimate and stimulating rapport with the expressive processes and cycles of natural growth, and to verify our everyday awareness of man’s inextricable bond with the natural environment.”

Fig. 1.1. Back cover of *Survival Through Design*. 
The back cover of the first edition of *Survival Through Design* provides a remarkably literal statement of Richard Neutra's design theory. The metaphor is clear: architecture provides the skeletal protection for man's exposed nervous system. It illustrates design can safely integrate and heal man's sensory life. This image inverts Lloyd Wright's famous description of the evil effects of ill-understood machinery on modern man's inner life in *The Art and Craft of the Machine*. Lloyd Wright on the other hand, intended this image as metaphorical of the relationship between man and machine, but when Neutra inverts the famous image, suggesting that the machine can heal the frail nervous system of a neurasthenic populace, he meant it with complete literality. Wright argued in *The Art and Craft of the Machine*, against the hand-crafted aesthetic of Ruskin and William Morris and in favour of an architecture that would use the machine as an aesthetic inspiration. This statement could be interpreted as an argument against the organic.

John Ruskin was instrumental in creating a philosophy that would establish architecture as being reflective of culture and civilization. The philosophy was based on painting and took its ideals and forms from nature; it was a product of a race and its civilization and not from the artistic conventions of the Renaissance. The quality of architecture is reflected in the quality of society. Ruskin, in *The Seven Lamps of Architecture*, outlined an approach through his study and analysis of nature, of transferring the lessons of nature to the man made. In the *Lamp of Beauty* he established that beauty can only derive from organic understanding of Nature, everything else is false beauty. Ruskin established ways of looking at nature from every possible angle, selecting forms and processes as he searched through landscapes, clouds, and mountains or looking at flowers, birds, or bird’s nests. Louis Sullivan had been greatly influenced by the writing of John Ruskin and it would be fair to say that it might have influenced even Lloyd Wright even though he argued against Ruskin’s aesthetics.

Throughout time, man has been immersed in the search for a universal form, collecting and integrating to create new forms. The design of the building on the Auckland Bridge will explore and strive to apply these methods of finding the appropriate form. A form that will be expressive of its site and surroundings, to show a capacity for growth, display the sensitive symbiotic relationship between structure and site and the direct relationship between form and function that stems from the organic tradition.

“All things in nature have a shape, that is to say, a form, an outward semblance, that tells us what they are, that distinguishes them from ourselves and from each other... These shapes express the inner life...the beauty, the exquisite spontaneity, with which life seeks and takes on its form in an accord perfectly responsive to its needs. It seems as ever though the life and the form were absolutely one and inseparable, so adequate in the sense of fulfilment...form follows function and that is the law.”

Louis Sullivan

1.2. ORGANIC STRUCTURE

Symbolic structure usually recalls an idea, a quality or a condition. There is a proposition that our experience of space is mediated through the senses. We must strive to create architecture, mediated through the senses that will emphasise a physical and mental interaction between occupants and built spaces.

Organic structure is discussed in more detail in Appendix 2.
Fig. 1.2 Drawing by Hugh Ferriss.

Fig. 1.3 Drawing by Hugh Ferriss

Fig. 1.4 Viva Hotel by Bruce Goff.
1.3. VISUAL INFLUENCES

“Laughter is timeless. Imagination has no age. And dreams are forever.”

This research was influenced by the drawings and projects of two historical figures, Hugh Ferriss (1889-1962) and Bruce Goff (1904-1982). Ferriss illustrated projects for architects Louis Mullgardt and Raymond Hood. They proposed habitable bridges over San Francisco Bay and the Hudson River. They were designed to accommodate approximately 25,000 and 100,000 people. Neither project was ever built due to the economic crisis of the 1920’s. Ferriss, an American Delineator, never designed a single noteworthy building, but it is said that he influenced a generation of architects more than any other man. His dream world drawings of un-built habitable bridges were an immense influence for setting a starting point to this project. Leading to drawing a personal dream world of a habitable bridge, and inventing a way of expressing this into a realistic architectural design solution.

Bruce Alonzo Goff was an American architect well known for his challenging, eclectic, and often flamboyant designs. He developed a singular style of organic architecture that was client- and site-specific. Goff's design portfolio demonstrates a restless, sped-up evolution through conventional styles and forms at a young age, to the Prairie Style of his heroes and correspondents Lloyd Wright and Sullivan, then into original design. He found his inspiration in sources as varied as Antonio Gaudi, Balinese music, Claude Debussy, Japanese Ukiyo-e prints, and seashells. His drawings, as well as the roots of his architecture based in organic design, served as an alternate inspiration for this project.

The illustrations of initial concepts were inspired by these masters of illustration and would remain only concepts as it would not be a realistic approach in the current economic climate to propose a total habitation of the Auckland Harbour Bridge.

59 Murray and Stevens, Living Bridges, 95.
Fig. 1.5
First attempt at the Habitable bridge concept, Auckland Harbour Bridge. Flowing Mass.

Fig. 1.6 Contemporary Elliptical Clamshell
Fig.1.7 The Residential Habitable Bridge Concept, Auckland Harbour Bridge. Elevation.

Fig.1.8 The Residential Habitable Bridge Concept, Auckland Harbour Bridge. Perspective
Fig. 1.9 First attempt at the Habitable Bridge. Day scene.

Fig. 1.10 First attempt at the Habitable Bridge. Night scene.
PART 2

PRECEDENT SURVEY
Bridges have meaning.

"Sometimes, the role has been a connector of people, and other times a divider of people... bridges have also been used as living invitations to integration and interaction. Bridges now bring people across this blue planet of ours together, in every conceivable way." 61

2.1. HISTORIC OVERVIEW

Habitable bridges are “thickened” with programme and layered with additional uses. Four examples will be analysed, namely: the Ponte Vecchio in Florence, the Ponte Rialto in Venice, the Galata Bridge in Istanbul, and the vertical strip in Las Vegas. All precedents illustrate a different approach and the results will be compared to the proposed project on the Auckland Harbour Bridge.

61 Bernard Graf, Bridges that Changed the World (Munich: Prestel, 2002), 9.
Fig. 2.1 Sketch, Ponte Vecchio
The river Arno swept away the predecessor of the Ponte Vecchio except for two central piers. The city fathers started re-building the bridge to fit the increased height of the riverbank to prevent more flooding. The main guiding criteria for the design by Taddeo Gaddi were aesthetics, stability and commerce. The new Ponte Vecchio included forty four shops that produced a good income to the city. Grand Duke Cosimo I of Tuscany instructed Giorgio Vassari to add a corridor to the east side of the bridge and a covered walkway above. This would give Cosimo direct access from his residence to the Uffizi and the Pallazzo Vecchio, the administrative and political heart of Florence. The shops on street level were leased only to wealthy gold and silversmiths. 62
Fig. 2.2: Sketch, Rialto Bridge
Andrea Palladio wrote that the proposed bridge would have looked splendid at the spot where it ought to have been built, in the centre of one of Italy’s largest cities. The bridge would have been built where merchants from across the world usually met to conduct their business. The purpose of the bridge was to serve the dignity of the city. Palladio entered a competition to design the Rialto Bridge. His design was inspired by the architecture of Roman antiquity and consisted of a four-columned loggia surmounted by the personification of justice that would have included space for statues. The design was rejected. The judges felt that his architecture would be ill-suited to the demands of everyday life. The old moving wooden bridge of 1432 was still in use and accommodated twelve small shops on either side of the bridge. A new competition was organized and won by Antonio da Ponte. He designed a bridge with a single arch spanning 27 metres. High enough to allow the doge’s state barge beneath it and shallow enough to accommodate twenty four shops beneath two rows of arcades rising towards the centre. The Rialto Bridge is possibly the most famous of all inhabited bridges.
Fig. 2.3 Sketch, Galata Bridge
The first Galata Bridge at the mouth of the Golden Horn was constructed in 1845 by the Valide Sultan, used for eighteen years and replaced by a second wooden bridge built in 1863 by Ethem Pertev Pasa to improve infrastructure. In 1870 a British firm, G. Wells, constructed a third bridge which was completed in 1875. This bridge was 480 metres long and rested on pontoons. It was used until 1912, when the bridge was moved upstream to replace the Cisr-i Altik Bridge. A fourth floating bridge was built in 1912 by the German firm Hüttenwerk Oberhausen AG. It was damaged in a fire in 1992 and removed upstream to make way for the fifth Galata Bridge built by SFTA, a Turkish company, completed in 1994. The bridge is a bascule bridge, 490 metres long and 42 metres wide with three vehicular lanes and one walkway in each direction. Tram tracks were added making it the only moveable bridge in the world to carry electrified rail tracks. The bridge became an inhabitable bridge with the opening of the market area on the first floor and the rest of the programmes opened to common use in 2003. The action is tucked underneath or behind a wall of cars. 64

Fig. 2.4 Ponte Vecchio

Fig. 2.5 Ponte-Rialto
2.2. PRECEDENT ANALYSIS

**Ponte Vecchio, Florence, Italy**

**Massing:** Lined sides with circulation inside a relief in the centre.

**View:** Mostly inward looking with occasional outward breaks at the centre path of the shopping level.

**Programme:** Jewellery and souvenir shopping.

**Levels:** Single pedestrian level with an unused upper level.

**Context:** The Bridge is integrated into the city through an arcade featuring a very prominent architectural style.

**Stature:** Iconic design that benefits from the novelty of history and the waterfront.

**Experience:** Picturesque views are the best, looking at the bridge from outside.  

**Ponte Rialto, Venice, Italy**

**Massing:** The Bridge consists of a pair of linear strips, sandwiched by paths.

**View:** Looking outward and inward.

**Programme:** Jewellery shops and souvenirs.

**Levels:** Stepped single level, strictly pedestrian.

**Context:** Ponte Rialto is integrated into the city through necessity of a major canal crossing.

**Stature:** It features an iconic stature, but also a necessary functional purpose.

**Experience:** Looking out or at the bridge is equally important.

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66 Ibid.
Fig. 2.6 Galata Bridge

Fig. 2.7 Auckland Harbour Bridge Concept
Galata Bridge, Istanbul, Turkey

**Massing:** The bridge consists of a central linear pathway, with occasional cut-through voids.

**View:** Outward looking view with peripheral paths. It consists of linear seating and glass walls that create a transparency to the exterior.

**Programme:** Restaurants below road level, fishing and traffic above

**Levels:** The structure was designed with two levels: street and tram above, pedestrian and restaurant below.

**Context:** The bridge is integrated into the city through infrastructural connections.

**Stature:** The waterfront benefits from the functions of the bridge.

**Experience:** Unfolds through programmatic use with the lower paths tucked away and sheltered. 67

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**Massing:** One central linear pathway inside the superstructure with regular cut-through to maximize views.

**View:** Mostly outward looking, maximizing city and ocean views. Views would be allowed from the bridge for motorists to observe occupants inside the restaurant.

**Programme:** Marine and land based entry, walkway with uninterrupted views.

Boat access to water level cafe and lifts.

Multifunction rooms and office levels, below road surface.

Restaurant and hotel above road deck.

**Levels:** Three levels of activity:

Pedestrian traffic below road surface,

Vehicle transport on existing bridge,

Pedestrian stepped levels to highest viewpoint.

**Context:** The bridge is integrated into the city, serving its primary function as traffic mediator. Connected to Stokes Point at Northcote point via pedestrian walkway entry or water based traffic.

**Stature:** Iconic, connected or part of an iconic landmark, unfolds through use and benefits from waterfront.

**Experience:** Looking out or at the bridge. Extreme gravity defying experience, tourism based, unfolds through programmatic use. The walkway will be tucked away and sheltered.

67 Ibid.
Fig. 2.8 Google Earth Images showing clockwise: Ponte Vecchio, Ponte Rialto, Auckland Harbour Bridge and Galata Bridge.
Massing

The massing of the three precedents plays the most significant role in how they operate. Ponte Vecchio and Ponte Rialto invert the massing strategy while the Galata Bridge is focussed outward. Ponte Vecchio has a central path lined with shops and the focus of the bridge kept inward. The massing on this bridge is no different than any other streetscape. All the visual interest ends at the shop front and the opportunity of using its extension over the water by maximising views is missed. Ponte Rialto has a central path with inward facing shops, but the addition of paths on the exterior of the shops expands the views out to the city as well. This bridge is popular to look at and from. Ponte Vecchio and Ponte Rialto both cater to tourists with similar commercial programmes, jewellery and souvenirs.

The Galata Bridge has its massing played out in section as well as in plan. The upper level allows for transport such as any other bridge or street, cars between two pedestrian walkways. Below the road surface, the bridge is thickened with a central core of restaurants and pedestrian walkways on the outer edges. The views are maximized outwards even from sitting inside the glazed restaurants in the central core. The bridge offers a unique sense of place reinforced by the strengths of the waterfront context. Its main programme is restaurants which cater for residents and tourists and invites an activity that lingers in contrast to the traffic above. It serves the local community as a central point for fishermen to gather on the upper deck. The layering of the programmes and the successful maximizing of views from different levels all add to the successful habitation of this piece of infrastructure with the unique attribute of holding the attention of the pedestrian away from the infrastructural duties.68

The Auckland Harbour Bridge serves one primary purpose only, vehicle traffic from one side to the other. The only other human activity under the bridge deck is the Bungy operation under the bridge deck at pier two, and maintenance on the bridge. There was never any intention in the original design of this infrastructure that indicated any planned habitation of the structure.

68 Ibid.
Fig. 2.9 Image showing Comparative Massing Proportions.
Fig. 2.10 Comparative views showing the inverted strategy of Ponte Vecchio, as opposed to the in and outward strategy of the other precedents.

Fig. 2.11 Comparative views from the three precedents and Auckland Harbour Bridge proposal.
Fig. 2.12 Google Maps, Images showing the Urban connections of the three precedents. Clockwise: Ponte Rialto, Ponte Vecchio, Auckland Harbour Bridge and the Galata Bridge.
Urban Connection

“A habitable bridge should be evaluated on how it ties into the city to draw the public in.” 69

What does it rely on to do so?

The Ponte Rialto has become popular due to necessity. It once was the only crossing over the Grand Canal in Venice and still is a popular icon. Likewise the Ponte Vecchio is also the main link between the population of the Uffizi Gallery and Pitti Palace in Florence. The bridge has garnered its reputation from its history and picturesque splendour, better observed from the banks. It is truly articulated as a part of the city and remains a recognisable monument. However, it does not take advantage of its unique place in the city. It is said that the experience of spending time on both Ponte Rialto and Ponte Vecchio is disappointing. They are iconic and pleasant to be near to stop and take a view.

The Galata Bridge ties very successfully into the Instanbul infrastructure and benefits from proximity to major urban squares serving restaurants, boats, ferry docks, major bus stops and a fish market. The Galata Bridge is a hub of activity and transportation, public and private, and it is a major connection between two sides of a city. The pedestrian crossing on this bridge is said to be an unforgettable experience. 70

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69 Ibid.
70 Ibid.
Fig. 2.13 Google Earth Image showing Las Vegas Strip location

Fig. 2.14 Google Maps showing Urban Connection.
Unbuilt Precedent

Vertical Strip, Nevada

Location

Designed in 2011 by Stephan Sobl, the design features an upside-down, futuristic skyscraper over the Colorado River in Nevada, beside the Hoover Dam. This project forms part of the precedent survey mostly because of the similarities to the Auckland Harbour Bridge project in terms of the extreme site selection, visual approach, proposed construction technique, and programme development.

Development

The hanging tower was generated with a particle simulation based on gravity. In order to accomplish structural logic, the cables or strings that the structure hangs from are rotated clockwise and counter clockwise. The design in a lightweight carbon - fibre structure would be suspended from a concrete cantilever and supported by a spiralling metal shell, not physically connected to the existing bridge.

This extreme, design is the result of an exploration of the environment that distributed the architectural language in a vertical hanging position, defying gravity, creating extreme, spatial sequences in the process. It illustrates the conventional vertical tower, including its plinth and orientation, and turns it upside down. The building stems from the interplay of opaque surfaces, capable of incorporating this lightweight structure. 

Fig. 2.15 Images, showing Plan, section, and perspective of Vertical Strip.
The programme consists of:

- an entertainment resort,
- hotel,
- restaurant,
- casino,
- boxing ring and concert hall.

It will showcase top quality accommodation and entertainment, in line with nearby Las Vegas.

The massing layout sequence from the top down:

- An event space on top with a framed view of Hoover Dam
- The casino underneath leading to
- The hotel lobby and the hotel
- At the lowest level there is a dramatic area for happenings and ceremonial occasions. It includes a breakfast room and high end dining on a glass floor, providing views into the canyon.

The building provides access to pedestrians and vehicles from the adjoining road. Its circulation and programme focuses on three elements based on the maximizing of the views on offer, namely:

- Views of the structural details of the Bypass Bridge,
- A view of the opening to the Hoover Dam,
- Breathtaking diagonal views of the hanging tower itself when passing through on the Bypass Bridge.

The structural system is divided into three tectonics:

- A concrete structure to act as anchor and the cantilever for the hanging tower
- A lightweight hanging tower
- A metal shell embracing the structure. This shell provides shading for the tower and its panels orientate themselves according to wind conditions.\textsuperscript{72}

This unbuilt, gravity defying precedent, illustrates principles that will be filtered, researched further, and applicable qualities will be applied in the proposed project. The approach of this project on a horizontal axis to arrive at a vertical extreme building, generated to maximize the views on offer will be applied to ensure the best outcome for the design on the Auckland Harbour Bridge.

\textsuperscript{72} Ibid.
Auckland Harbour Bridge Proposal

The Habitable Bridge, a Contemporary Twist.

The aim of this research is to eliminate the shortfalls of the precedents and maximise the positives that can be applied to create a successful implementation of habitation on the Auckland Harbour Bridge. The entry from Stokes Point will display a pedestrian walkway with lookouts to the east and west making the most of the views from inside the super structure of the bridge. The more romantic arrival will be at sea level, displaying a typical waterfront cafe setting and entrance for vertical circulation. The proposed programmes below the road surface will benefit from views in all directions. Above the road deck, a restaurant is proposed that will exploit breathtaking views of Auckland city and its surroundings moving upwards into a boutique hotel space. The dream would be to convert the landmark into an icon.

It is evident that one of the most important characteristics that shape a habitable bridge is the views on offer. These views are the direct result of the programme and massing layout of the different functions on the precedents analysed. Views should be maximized to their fullest extent to ensure the success of the bridge occupation envisaged in this project. This paper will consider existing understandings of the historical models analysed in architectural design and engineering, infrastructure as architecture, parasitism and the golden thread that binds it all together - Nature, not a comparison, but a collection or collaboration of different typologies to create one architectural expression.

Fig. 2.16 Auckland Harbour Bridge proposal. East Elevation.
PART 3

DESIGN DEVELOPMENT

Ancient Spirit Modern Voice
“When we look deeply into the pattern of an apple blossom, a seashell, or a swinging pendulum, however, we discover a perfection, an incredible order that awakens in us a sense of awe that we knew as children. Something reveals itself that is infinitely greater than we are and yet part of us; the limitless emerges from limits.”  

An engagement with biological understandings of nature via investigative design will be essential for the development of this project. This section will look at the experimental implementations and implications to establish a framework for development and consideration of possibilities that can emerge from a purposeful knowledge transfer between Nature, the Habitable Bridge concept, Infrastructure as Architecture and Parasitic Architecture, underscored by Symbolic Representation.

Can the harmony that is apparent in natural forms be adapted to represent a more powerful force in our social and architectural forms? Nature’s most basic pattern-forming process will be analysed, researched and applied to the development of the proposed project. The proportions of nature, art and architecture can help us in this search for proportions and shared limitations that create harmonious relationships out of differences. They teach us that limitations are not just restrictive, but also creative. The order inherent in the proportions and configurations of natural phenomena and in the ageless harmonious works of man, are evidence of the relatedness of all things. Through the limits of discipline we can get a glimpse of and take part in the harmony of Nature.

74 Ibid., 141.
Fig. 3.1 The Golden section

Fig. 3.2 The Golden Triangle
3.1. THE GOLDEN SECTION

The equation \( A : B = B (A+B) \), the formula of the celebrated golden section, a uniquely reciprocal relationship between two unequal parts of a whole, in which the small part stands in the same proportion to the large part as the large part stands to the whole. The golden section derives from the uniqueness as well as the distinctive value attributed to this proportional relationship. Harmony and pleasure lies in the complete reciprocity of the proportions. A simplification of this proportion would be 1:1.618 or even 5:8 where 5 would be the short side of a rectangle. This relationship is also evident in other examples such as the square inscribed into a semi-circle.\(^{75}\)

The golden section can also be found in spirals moving in opposite directions in a pattern-forming process. This universal pattern creating process is called “Dinergy”. This energy is the creative energy of organic growth. Harmony in this context would be a fitting, orderly and pleasant joining of diversities, creating a dinergic relationship with contrasting elements that complement each other by their combination and joining. The word *harmony* is at the heart of all dinergic joining in nature. The power of the golden section is embedded in its ability to create harmony. It arises from its distinctive capacity to unite the different parts of a whole. Each part preserves its own character, and blends into the superior pattern of a single whole.\(^{76}\) Throughout history the principles of sacred geometry have been expressed in architecture, music, painting and observed in the natural world.

\(^{75}\) Ibid., 3, 8.
\(^{76}\) Ibid., 13.
“From a sequence of these individual patterns, whole buildings with the character of nature will form themselves within your thoughts, as easily as sentences.”

Christopher Alexander

The Auckland Harbour Bridge will be host to a semi-parasitic structure and great care must be exercised to retain its identity and original function. The new proposed structure that will connect and join to the bridge will also have its own, newly created, identity. As a whole it must bring beauty to the experience by the harmonious unification of all the parts. The application of harmonious proportions and forms, interwoven into the very fabric of our existence, nature’s greatest known secret will be applied in order to achieve this goal. In Nature, the pattern-forming processes can be found in leaf outlines or musical harmonies. They all indicate the same dinergic harmonies that delight our eyes and other senses.

See Appendix 2 for a discussion on The Golden Section and the application on the Crafts.

On the molecular level the joint three-dimensional spiral pattern of the double helix, was found to be the true shape of the DNA molecule which contains in its coded pattern: the master plan of the entire development of living organisms. Red and white blood corpuscles group themselves in double spiral patterns known as *axonemes* and once enlarged, we find a faithful match to spirals of prehistoric tombs, Maori tattoos and the Mother Earth patterns of the American Indians.\(^7^9\)

\(^7^9\) Ibid., 28.
3.1.2. Symbols and Cultural Objects

Symbols bridge the gap between tangible and intangible in a dinergic way such as the pentagram, a pattern that helped the Pythagoreans understood the intangible realities of harmony and health. The fact that it is still used today illustrates the dinergy of certain symbols as being both universal and timeless. Pythagoras studied the harmonious proportions in music, and drew relationships between the mathematical, Pythagorean Triangle, and the musical diapente proportion; the result was a close approximation of the golden section's 0.618 ratio. For music being purely in time, and architecture being purely in space, each is convertible into the other. The elements which in music are expressed by means of harmonious intervals of time and pitch, may be translated and applied into corresponding intervals of architectural void and solid, height and width, creating harmony between the different relationships. 80

The same unity with Nature is to be found with the Māori of Polynesia in their concepts of mana and tapu. Mana is described as a strong feeling that life in unity, in which not only gods, but also things, which to us are lifeless have a part", it is a direct experience of the sacred force that permeates existence. Tapu is the Māori word that describes responsibility to comply with mana. 81 Mana and tapu are expressions of the sense of relatedness and oneness with the universe, illustrated in wood carvings and spiritual symbols tattooed on Māori people. Graphic spirals can be traced back to the spiral images from Neolithic times found in prehistoric tombs such as the Cretan Labyrinth that bears similarities to that of the Māori tattoo 82 and the American Indian Tapu'at. 83 These spirals have been interpreted as symbols of death and rebirth and reveal evidence of the energy - creating power of symbols in different cultures. The constant in these spiral symbols brings home the realization that life and death are interlocked.

80 Doczi, The Power of Limits, 8.
Fig. 3.6 Nautilus shell image with Logarithmic Spiral, typical of Shell growth

Fig. 3.7 Whirling Squares, The Abalone Shell

Fig. 3.8 Proportions of the Coho Salmon

Fig. 3.9 Section through the torso of Mackrel, Herring and Perch
3.1.3. The Anatomy of Sharing

The context of the chosen site will require research and reference to the marine life to enable a purposeful development of a design that will share harmonious proportions with Nature. The shapes of shells and shellfish show their harmonious shapes unfold in logarithmic spirals, characterized by the golden section’s proportions. These spirals can be applied in all three dimensions of the growth process in shells. Each consecutive stage of growth is encompassed by a golden rectangle, called the pattern of whirling squares. 84 Fish shapes reveal similar rhythmic and harmonious proportions and analysis of certain shapes reveals the existence of the golden section and the 3-4-5 triangle. The fish outline fits into golden rectangles and in some instances the mouth is at the golden section point of the body’s height. This is illustrated in the image of the Coho Salmon, 85 similar in shape to the typical Kawhai found in New Zealand. These proportions can also be applied to the dimension of thickness in fish in a transverse section of the body as illustrated. This project will strive to apply these natural proportions.

Sharing is creative; it is a basic pattern-forming process that shapes harmonious relationships in nature. There is a mana of sharing evident throughout nature. Bees share detailed communication about food sources by using a body language of dance, they share energy and excitement which induces other bees to swarm out and gather food upon which their life depends. The folds of the rock and the cloud formation share the same wavelengths of the ocean, the very nature of Nature. 86 The sharing of structures in architecture must be harmonious in relation to the inhabitants. As designers, we should strive to apply the correct proportions to buildings and their human occupants, who by themselves illustrate perfect proportions in their creation. The occupant must be inspired by architecture; it must inspire them to share energy and excitement.

84 Ibid., 53.
85 Ibid., 58, 62.
86 Ibid, 77, 121.
Fig. 3.10 Vitruvian Man, Leonardo da Vinci

Fig. 3.11 Golden section superimposed on the Ise Shinto Shrine, Japan

Fig. 3.12 The Golden section superimposed on the Māori Pataka Food House.
“Architecture is an imitation of Nature”
Vitruvius \(^{87}\)

The perfect proportions and applications were illustrated by Marcus Vitruvius Pollio, first century Roman architect and writer in his manuscript: *Ten Books on Architecture*. He recommended that temples should be constructed on the analogy of the well-shaped human body in order to be magnificent. These proportions were illustrated by Leonardo da Vinci in his Vitruvian Man, showing the figure of man and his proportions by squaring the circle.

We must create a unity between the proportional harmonies of the whole and its diverse parts. Only then will we design beautiful buildings. \(^{88}\)

“*Beauty is the harmony and concord of all parts achieved in such a manner that nothing could be added or taken away or altered except for the worst*”, the words of Leon Battista Alberti in Rudolf Wittkower’s book: *Architectural Principles in the Age of Humanism*. \(^{89}\)

Proportional relationship of Māori architecture as seen in the traditional “Food House” or “Food Store,” \(^ {90}\) and first structures built by Māori to be the threshold and entry point to the *Pa*, show obvious similarities to that of the Ise Shinto Shrine, East Treasure House in Japan. \(^ {91}\) The plan is a single golden rectangle, the gable sits in two golden rectangles and the side elevation fits two golden rectangles. It is not known if the Māori designs were built on purpose to adhere to the golden section, but it will be applied as much as possible to the proposed project, in order to show respect in the design approach to the first inhabitants of this land and the historical and cultural anchor point of this project. The Māori style of design will be researched and used as reference in the design.

\(^{88}\) Doczi, *The Power of Limits*, 74, 93.
\(^{91}\) Doczi, *The Power of Limits*, 121.
“Although architecture produces original formations and is not imitative art like painting and sculpture, it has over the centuries created its own store of forms from which it borrows the types for new creations.”

3.1.4. Symbols and Myths

Indigenous Representation

Myths developed as abstract descriptions of first-hand observations and encounters with Nature, serving as an abstract description of this interaction. They deal with the delineation of truth to explain something metaphorically. Myth may be defined as a “traditional story of ostensibly historical events that serves to unfold part of a world view of people, or to explain a practice, belief, or natural phenomenon.” 93 Myth represents beliefs of a particular culture while architecture serves as a medium for the representation of the myth. 94 In Nature there are flowing transitions and dynamic connections between all phenomena. Man reduced it to discrete parts and components, giving everything a scientific name, category and classification. 95 This spiritually detached view of nature divided the cosmos into two categories: the organic and inorganic. The inorganic explains land as a commodity, an economic resource that can be bought or sold.

Symbols as Representation in Architecture

The great originality in the representation theory of Gottfried Semper was the centrality of the symbolic or representational role of architectural forms and the belief that those forms could be traced back to fundamental social practises. Fundamental to his aim of formulating an architectural theory of invention in a natural way, was a history of becoming that evoked dual spectres of academic convention and eclecticism. Semper reflected continually on the parallels between the inner dynamics of architecture and the patterns of change in Nature. 96 The way of Nature according to Semper, can be found in symbols, a major part of Maori identity and culture. Māori patterns are based on social relationships and follow the patterns and rules of Nature

95 Neutra, Nature Near, 15.
96 Ibid., 233.
Fig. 3.13 Sketch of Traditional Maori Fishhook

Fig. 3.14 Fishbone structure, John Dory skeleton.
The Fish Hook, *Hei Matau*

Originally Māori were fishermen. The main food source was the sea, so a fish hook was a very valuable item to own. It was a symbol of prosperity, abundance, good health, power, authority and respect for the sea and marine life.  

Fishbone

Fishing was both a practical and a spiritual activity to Māori. Fish were also seen as the descendants of *Tangaroa*, god of the sea. Rituals and talismans were an important way to ensure his favour and protect the bounty of the ocean, lakes and rivers. The structure of the fishbone is referred to in order to generate the basic structure of the proposed building.

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98 Ibid.
Fig. 3.15 The Circle or disk

Fig. 3.16 The Triangle

Fig. 3.17 Poutama Meeting House, Whanganui region, New Zealand
The Circle or Disk.

“The closed circle represents the circle of life, and the belief it has no beginning or end.” 99

We usually start the design of our modern day buildings by thinking about how we want them to look. Usually we will start with a rectangular design because we are used to rectangular thinking. Lord Raglan, made an intensive study of housing. He found that the majority of people in all civilizations have lived in circular houses. They were trying to accomplish the most with the least. It took less material to go around the same amount of area in a circle than it did any other way. The circle was stronger as well. 100 This research proved that geometry and economics were at the core of ancient construction techniques, implemented in the physical structure or used as spiritual reference. The Māori show a spiritual connection to the circle, illustrated in tattoos designs and carvings, rather than an architectural connection.

The Triangle

“The triangle as a symbol represents independence, creativity and spiritual clarity.” 101

The superimposed shapes on The Poutama meeting house at Galatea, in Wanganui region display the triangular shapes evident in original and historic Māori Architecture. 102 The existing triangular shapes would be extracted from the bridge structure by means of deconstruction and developed to as a starting point for the walkway design. It will be further researched and applied to the proposed new structure on the Harbour Bridge.

100 Welch, ed., Goff on Goff, 211.
101 “Aotea Designs: Meaning of Maori Symbols.”
Fig. 3.18 “The single and double twist.”
The Single Twist, *Pikorua*.

“The spiritual merger of two people for eternity.”  

This symbol is usually carved in wood or stone and worn around the neck as a pendant. It represents the figure eight or the path of life, a symbol of eternity, symbolizing the strength of a bond between two people.

Double Twist, Triple Twist.

“The path of Life.”

The double twist is also an eternity symbol and refers to the bond between people or cultures rather than just individuals. It also refers to the “three baskets of knowledge”. First, the experience of our senses. Secondly, our understanding of what lies behind our sense experience. Thirdly, the experience we have, particularly in ritual, of our oneness with each other and with the past. The three baskets are believed to have been brought from the heavens by *Taane*, a spiritual power responsible for the birds and the separation of Heaven and Earth.  

It is evident that this symbol is not only an object or ornament, but reveals a higher level of spiritual meaning. It is based on ritual experience, relationships and action.

During research several underlying principles began to emerge which were reminiscent of ancient attempts to design structures that were informed by nature, both structurally and spiritually. The ancient philosophies and myths illustrate a spiritual unity of architecture and Nature and this will be applied in the concept design of this project. The Maori viewed the earth as a sacred place, a belief that was integral to their religion and expressed through their myths and legends. Maori built in response to these beliefs without losing sight of function and cultural conditions.  

This philosophy must be respected and we must strive to continue and apply these principles in future New Zealand.

The aim would be to apply these symbols to generate a structure that will symbolize and showcase a reference between historic culture and modern day technologies. The design must strive to weave the cultural past into a modern habitable bridge, creating a direct cultural and spiritual link and reference to the original inhabitants of Stokes Point.

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104 Ibid.

105 Ibid.

106 Ibid.
3.2. THE SITE

Site Background

By the mid twentieth century the need for a bridge across the Waitemata Harbour was a pressing matter for connecting Auckland city to the North Shore of Auckland. A huge amount of reclamation around the harbour coastline was carried out as part of the original Auckland Harbour Bridge project. St Mary’s Bay was filled in and the Shelly Beach baths were also demolished as part of the work. Sulphur Beach, on the North Shore of Auckland, disappeared and the toll booth plaza was built in its place. More reclamation was carried out around Shoal Bay so that the motorway could be built. Excavations for the foundation of the bridge began in September 1956. Two 9 metre deep holes that carried the anchorage supports were filled with concrete to a height of 3 metres above ground. Altogether 5000 tonnes of concrete were poured to make the northern anchorage connection to the land-based site identified for this project at Stokes Point. Increased traffic led to the building of two extra lanes on each side of the bridge, nicknamed “Nippon clip-on’s”. Motorists continued to use the bridge while the clip-on’s were being attached and they were opened to traffic in 1969. Fifty years later the bridge still carries eight lanes of traffic, with access to lanes from the north or south controlled during the morning and evening rush hours by a moveable central barrier. 107

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Site Location
Latitude: -36.85 (36°51'00"S)
Longitude: +174.76 (174°45'36"E)
Time zone: UTC+12 hours
Continent: Oceania
Sub-region: Australia and New Zealand

Fig. 3.19 Google Earth Image, Site Location.
Auckland Harbour Bridge Statistics

Carries: Eight Lanes of New Zealand State Highway One also known as the Auckland Northern Motorway.
Crosses: Waitemata Harbour.
Maintained by New Zealand Transport Agency.
Design: Box Truss.
Material: Steel.
Total Length: 1020 metres.
Longest span: 243.6 metres at Span B, between pier one and pier two.
Number of spans: 9.
Load Limit: 13 Tonnes (13 long tonnes; 14 short tonnes) on outside lanes
Vertical Clearance: 43.27 metres at high tide

Fig. 3.20 Auckland Harbour Bridge

Fig. 3.21 Orientation Graph  
![Orientation Graph](image1)

Fig. 3.22 Annual Wind Direction  
![Annual Wind Direction](image2)

Fig. 3.23 Wind Speed Rose  
![Wind Speed Rose](image3)

109  Gaisma, “Sun Path Diagram,” accessed March 12, 2012,  

110  Statistics, New Zealand, “Digital Year-Book Collection,” accessed July 9, 2014,  
http://www3.stats.govt.nz/New_Zealand_Official_Yearbooks/1913/NZOYB_1913.html#ect2_1_6632

111  Bob McDavitt, “Metservice,” last updated February 15, 2011,  
http://blog.metservice.com/2010/12/wind-warnings-for-recreational-marine-areas/
Orientation

The proposed building will be orientated to cross the bridge from North West to South East. This will create the opportunity for the collection of solar power on the North facing façade. The South facade will be designed to respond to the orientation. The bridge was built on an axis North, North East to South, South West.

Wind Analysis

The aerodynamic "wing" and mussel shell shape that the building design derives from, would be tested to extremes in this unprotected open water site. The structure will have to be engineered in such a way that it will be able to withstand maximum wind loads, especially when facing stormy weather from the North and North-West as well as facing the South Westerly prevailing winds head on. The introduction of wind disrupters will be a requirement in order to eliminate the airfoil effect.
Fig. 3.24 **Corrosion Zones New Zealand** 112

Fig. 3.25 **Tidal Range New Zealand** 113

Fig. 3.26 **Seismic Zone C** 114


Corrosion Zones New Zealand

Material selection and maintenance issues will be determined by the site location and the corrosion zone. The runoff of conflicting metals must be eliminated in order to protect the existing structure.

Climate

Tidal Range New Zealand

The tidal movements will be employed in energy harvesting and sea level decks and floors will be designed appropriately to accommodate the tidal movement of up to 2.5 metres.

Average Temperature

The climatic conditions will be considered in the design to ensure comfort to occupants in all seasons and on all levels. The temperature at North Cote Point range between 5 degrees Celsius, and 24 degrees Celsius.

Seismic Zone C

Despite the area having the lowest earthquake activity in New Zealand, the structure will have to withstand a moderately high earthquake and will adhere to the NZ Building Code regarding seismic activities. The following design principles will be followed:
A. Marine Foundations - Cofferdam and pile foundations, driven into the seabed or bedrock.
B. Base Isolation.
C. Cross Bracing fishbone structure.
D. Lift Core Shear walls.
E. Diaphragm Flooring.

115 Bob McDavitt, Metservice.
Fig. 3.27 Google Earth image
Natural Vegetation at Stokes Point

Fig. 3.28 Image showing Ferry routes

Fig. 3.29 The planned “SkyPath”,
Cycle and pedestrian route

Fig. 3.30 The planned second Harbour Crossing
Natural Vegetation

Natural Vegetation on the North Bank at Stokes Point Reserve, will not be disturbed. It will be preserved, respected and referenced in the organic, nature based design approach. The landscaping reflects the importance Stokes Point has had, and continues to have, to many different generations.

Site Access

Entrance and car parking to the project will be at Stokes Point. Waterlevel access will connect to the existing ferry routes and drop-off areas will be created for private boat access. Pedestrian access will be provided via the proposed connection to the “SkyPath” development that will be inserted on the Eastern side of the bridge. 116 The SkyPath would be slung under the city-bound clip-on and feature observation decks.

Second Crossing

With the population in the Auckland region set to rise a further 1.2 million by 2050, 117 a second crossing is likely to be needed. The second crossing would be provided by means of a tunnel under the harbour. The $3.9-$5.3 billion additional harbour crossing project has been approved by the New Zealand Government and will be constructed in 2025. 118

Table 1: Span lengths

<table>
<thead>
<tr>
<th>Label</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span</td>
<td>176</td>
<td>244</td>
<td>177</td>
<td>124</td>
<td>114</td>
<td>103</td>
<td>80</td>
</tr>
</tbody>
</table>

Fig. 3.31 West Elevation, Span lengths of Auckland Harbour Bridge

Fig. 3.32 East Elevation, Detail sections of Auckland Harbour Bridge.
Structural Design

The Auckland Harbour Bridge is a steel truss structure with a total length of 1020 metres, designed by British engineers Freeman Fox and Partners. The total truss consists of a number of suspended and cantilever spans, supported by a steel truss below the deck, with the exception of the navigation span. The navigation span is 243 metres in length. The extension sections follow the same line and height of the truss with a 1:20 gradient. The road surface of the bridge is supported by the steel truss superstructure. The truss is a deck truss for its entire length, except for the main span which is a through truss with the traffic travelling through the structure. The truss throughout the whole structure is a subdivided warren truss. The steel truss is supported on 6 reinforced concrete piers which are founded on bedrock.

The bridge has 7 spans, A at the north end to G at the south end. The navigation span, B, is 243.8 metres with a 43.3 metre clearance at high water. There are in fact two bridges, A to C 597.4 metres long and D to F 422.2 metres long. There is a 1.7 metre long toothed expansion joint between them, clearly visible in the roadway, but no structural connection. The 12.8 metre wide roadway passes through the 14.7 metre wide spans A, B and C. The roadway is above the 9.9 metre wide spans D to F.

Deflection

The truss and bridge deck were pre-cambered by the amount of deflection expected under dead loading by adjusting the length of the truss members. This did not take into account the deflection under live loadings, so some deflection can be expected under heavy loading.

Services

This proposed parasitic project will connect to all services required and available under the road surface of the bridge. Additional waste water services will be installed to connect to Northcote Point sewerage and other connections.

Existing services inside the bridge structure

![GIS Image showing: Services available on and around the bridge.](image)

Fig. 3.34 Inside pier one

Fig. 3.35 Pinned connection under the clip-on structure
Site Geology

The harbour has bedrock of slate and sandstone at approximately 33 metres below sea level. The bridge site has up to 15 metres of sediment above the bedrock except for a few locations where the bedrock is exposed due to scouring. The bedrock provides a pile end capacity in the range of 6-16MPa.

Piers and foundations

The six piers were built using prefabricated steel caisson sunk to the harbour floor where they acted as foundations for the piers. The essential criteria for the piers was to withstand a severe earthquake by remaining fully fixed to the bedrock and allow pinned connections of the superstructure. The height of the piers ranges from 16.8 to 31.7 metres and they are constructed of high density reinforced concrete on the outside and low density material in the centre. Full width piers were used for visual appearance as well as allowing the large bearings required in the design. The longevity of these was critical to ensure the expected behaviour in an earthquake. High quality concrete used was needed to protect the structure from scouring due to the high tidal currents in the area. The varying ground strength allows the differing spans and pier depths. These all go at least 1.8 metres into the bedrock which limits the bearing pressure to 750KN/m² under normal loading and 1500KN/m² under combined earthquake and wind loading. The new proposed foundation for the development will be constructed by means of piles driven into the bedrock and connected to pile caps.

Sound Issues

Airborne Vibration

Traffic noise induces vibrations on and under the Bridge surface. These airborne vibrations occur at higher frequencies than soil-borne vibration and will have to be dealt with in the design. Traffic vibrations can be characterized by a source path-receiver scenario. Vibrations are transmitted through the Bridge structure and design solutions will have to be implemented to solve this problem on the chosen site. The proposed project would have to be insulated and soundproofed to the highest level. This will be similar to insulation being used in the construction of hotels at international airports. Dampers and rubber connectors will be installed at all connection points between the host and the parasitic structure.

Fig. 3.36 Traffic noise direction
This design originated from contextual and site influences. The use of marine life form and life-cycle processes, merged with cultural symbols were the main drivers set as a base to the development of the proposed structure. The site analysis informed the position, shape, access, orientation and structure of this proposal. The idea is that this semi-parasitic structure will be more independent of its host than the requirements or definition would be for pure parasitism: it will strive to form a symbiotic relationship with the host, and will make use of the services available under the bridge deck.

The horizontal inhabitation of the initial design has been developed to form the walkway and access route, while site conditions such as vibration, movement, sagging and hogging of the bridge, wind directions, solar considerations, sound control and the utilization of the best views in Auckland, forced the design upwards, into a vertical position, away from the noise and up towards the viewports to be created. The anchorage on top of the pier was one of the major considerations for the placement and position of the building. A part of the structure would be inserted and anchored inside the hollow pier to allow additional stability to the parasite as well as the host.

Development sketches
3.3.1. Initial Design

Alternative design # 1

Alternatives that were considered as part of the research were firstly the concept of “a bridge inside a bridge.” The design features lift access on the original footings used to anchor the bridge during construction. The programme consists of a hotel, restaurant, access lobby, reception, display room and offices for the bridge maintenance companies.

Fig. 3.37 Initial Programme, Alternative design# 1

Fig. 3.38 Elevation and Plan, Alternative #1
Alternative design # 2

A second concept stems from the shape and form of the green lipped mussel. This design accommodated a small hotel and restaurant referenced to the existing and historic lunch room only five metres above the proposed restaurant, which would exhibit a beautiful view of Auckland city and of the extreme sport bungy operation situated under the road deck at pier two.
Alternative design # 2

Fig. 3.41 Section and plan, Alternative #2

Fig. 3.42 Serial Vision images, alternative #2
Alternative design # 3

A third alternative showed typical parasitic architecture style clamping of a mussel shape to the pier, five levels in total height. This would however, compromise the safe operation of the host, and would add extra load and stress to the pier. It would affect the Bridge foundation and might compromise the operation and primary function of the Bridge.

Fig. 3.43 Elevations, Alternative #3
Fig. 3.44 Infrastructure infill and placing possibilities.
3.3.2. Developed Design

“Lautner intensified the dialogue between building and landscape, he focussed increasingly on connections – the sense of continuity accomplished through extending into the natural site, establishing a rhythm consonant with that in the natural context, and drawing in both outside space and the phenomena of light and sky.” Nicholas Olsberg on the Architecture of John Lautner.

In architecture we bring together separate entities. We combine materials, spaces and technology and join them together to create a structure that displays the concept in which the sum is greater than the parts, connected in symbiotic harmony, creating a sensible conversation.

John Lautner, an apprentice of Lloyd Wright, followed the quest to crystallize the patterns of elemental forces within the structure in shaping the building to reach out or radiate toward these forces. It created a dramatic conversation between space within and the space without. He created plastic, subtle and fluid containers, folding the outside world into them. A successful project will be based upon the way Lautner approached his designs, the quality of the connection of the parts and the way they are joined.

A goal set for this project will be to let the tectonic joints in the construction and in the spaces, show a reference to context, culture and nature’s forces on the bridge such as loads, material properties and in the construction process. The joining of this parasitic structure to the bridge, involves a common ground, the connection point, the physical meeting space under or above the bridge connected and joined at the existing pier. This will be the mediating element. The connection of the “journey” to the main structure can be observed as a bond where people mix, separate and interact. Typologies are brought together in this hybrid programme, considering traffic movement and human activities combined in a technology based space. It serves as the line to vehicular traffic, and will facilitate an adaptation of space for human habitation. The joining of the two elements will form a third hybrid space.

125 Ibid., 116, 117, 184.
Fig. 3.45 The optic-nerve, (walkway), connected to the eye, (views and programme) and brain (maintenance).
Initial Programmatic Influences

The programme is influenced predominantly by the access routes and the methods implemented in the process of maximizing the available views. Traffic noise forced the placement, and in some instances forced the elimination of space. Positioning of a waterfront style cafe at sea level is considered, catering for the needs of arriving guests and visitors by boat, ferry or water taxi to a double volume reception and retail component. Levels above would be classed as multifunctional and could be utilized or adapted to entertainment, exhibitions, functions and convention spaces, and could accommodate the maintenance engineers. Levels higher up and closer to the bridge deck that will experience some sound issues will be allocated for services and storage of supplies and surplus stock, to the hotel and restaurant.

The Gateway/Entrance

“Circle of Life to spiritual clarity.” 126

Stokes Point at Northcote Point would be the anchor point to enter the planned development. The walkway will maximize views of the city skyline and Waitemata Harbour to the west. This will be an experience in itself. The walkway would be entered via a security controlled area and lead to a connection point below the bridge deck to the hotel and restaurant lifts, passing another security point. There is an option for connecting to the “Sky Path” cycle and pedestrian development, planned for the near future. The hotel would be very exclusive and guests would be more likely to arrive by luxury private boat or ferry than via the cycle and walkway route, but it would be an option to draw visitors to the restaurant and bar area. The walkway could be seen as the optic nerve, linking the brain with all its functions to the eye that sees the proposed views in this project.

3.3.3. Form-Extraction

The technique of Deconstruction was applied to extract and generate forms from the superstructure of the bridge. The triangular shapes and voids were filled and moved to achieve an image that would relate to the golden and cultural triangle and play host to the planned walkway. This is a semiotic, analysis of the fragments of the bridge structure. It manipulates the structures surface and distorts and dislocates the elements. This is a purely formal exercise with little social significance: it literally dismantles the superstructure in order to simplify, abstract or find a system that could be applied to develop the search for form in this project. The result could be manipulated; therefore this would be used as a visual reference only and not researched in depth.

Fig. 3.46 Deconstruction of the superstructure.
The Shapes and forms that exist in the superstructure of the Auckland Harbour Bridge, have been extracted to inform the design of the building. The implementation of this method, similar to the Sierpinski triangular process, will ensure a connection to context and show a reference to the cultural triangle. The image shows a reference to the voids and solids extracted from the different parts of superstructure and the structural application.

Fig. 3.47 Shape extraction from the bridge superstructure
Fig. 3.48 Existing lines on the bridge structure, converted to shapes

Fig. 3.49 Reference to the "single twist" (see Fig. 3.18)
Architecture embraces what happens whenever human thought or action makes order and meaning of random space. As in related arts, architects pursue an underlying order within the seemingly chaotic systems of politics, technology, finance and form in order to shape a new model or development. This construct and form research will have the ability to affect human lives and the environment. The success of this design effort will be directly related to the comprehensive understanding of local and historical culture and contextual influences, connected to a space optimised structure.127

The highlighted lines that have been extracted and rotated have been manipulated to reference the cultural twist symbol (fig. 3.18) in an effort to connect structure and culture. The basic shape of the arch of the bridge between pier one and two, was simplified, combined and rotated in an effort to generate and illustrate the connection, or reference, to the symbol. In the final design this reference will be illustrated in the twist or rotation of the plan to negotiate wind conditions of the chosen site.

Fig. 3.50 Contextual Design influences

- Wind
- Water
- Structural rhythm
- Traffic vibration
- Sound
3.3.5. Design considerations and influences.

**Location** – The project will be located between pier one and Stokes Point, with the main body at pier one, with a possible second structure at pier two.

**Wind** – Wind loads will be dealt with in the structural design as well as in the facade treatment. Wind disrupters will be introduced to eliminate an airfoil effect. The design would strive to deflect and negotiate wind patterns from two opposing directions.

**Weight** - Material choice would be of utmost importance. The weight to strength ratio will be considered and it is predicted that hollow steel sections and components, lightweight concrete and double glazed smart glass would be the initial material choice. The walkway will be constructed in a lightweight composite material similar to that used in modern yacht construction.

**Maintenance** - The design will have to allow for regular maintenance access points as well as access to the existing bridge structure.

**Existing structure** - The design should not compromise the primary function or stability of the existing structure of the bridge.

**Movement** - The movement patterns of the bridge will be considered and dealt with. It is anticipated that only the approach or walkway would be in contact with the bridge and will be constructed to be able to move with the bridge. Light, colour and sound share the same wave patterns and the experience of harmonies and rhythms is shared by the eye and the ear. The music of the ear is the art which treats the harmony of sounds, the harmony of visible objects will then be called "the Music of the Eye". These sounds and myths will be experienced by the occupants of the proposed building. It should showcase the music of the eye. The essence of all vibration and rhythm is a sharing of diversities at recurrent time intervals. This also holds true for the tides of the ocean as for the human heartbeat. The sharing of diversities is evident in light, weight and sound as well as in the patterns of plant growth.
The vibration patterns of the Auckland Harbour Bridge will be applied as a positive experience on the journey inside the superstructure of the bridge, creating harmonies, sharing of light, colour and sound experienced by all senses, including the brain. It will create an experience for the occupants of this structure hanging above the ocean's ebb and flow, an imitation of the rhythm of inhaling and exhaling, the one action that keeps us alive! 128

The views - The views on offer and the new views created at height will be maximized.

Sound and Vibration - Sound and vibration will be dealt with in the form of rubber dampers at contact points and by means of appropriate sound insulation.

Prefabricated Construction - The project will aim to implement prefabricated construction to the maximum.

The Brief and Programme – The brief has been discussed and the programme will be dealt with in the next section.

Existing programmes on the Auckland Harbour Bridge.

The bridge superstructure is subject to constant maintenance. Movement and access of engineers will have to be considered as part of the existing programme in the final design outcome.

The existing lunchroom will be upgraded and made accessible on request for visitors. It is still used as a temporary meeting place for engineers working on the bridge.

The bungy operation and bridge walk guided tours, are in full operation and attract visitors who wish to experience the extreme sport of jumping off the Auckland Harbour Bridge or partake in a guided tour of the bridge.
Alternative design # 4

The Habitable Bridge Resurrected

Alternative design four displays a literal application of cultural symbols. The green lipped mussel shape, the fishbone structure, the fishhook, the twist, the helix DNA spiral in the design of the fire escape stair and in the walkway, all contributing to the design. The Myth of Maui is referenced in the base sitting on sea level in the shape of a stingray, believed to be the fish that Maui fished from the sea.¹²⁹

The Green Lipped Mussel, Fishhook and Fishbone as form generator.

See Appendix 2.

Fig. 3.54 The Plan view. Sea level based on the stingray.

Fig. 3.55 The North Elevation, and Fish Hook structure.
Fig. 3.56 The West Elevation with spiral, DNA imitation fire escape stair

Fig. 3.57 East elevation, showing reference to the "Twist".
Fig. 3.58 The view from North East, Glazed cladding that resembles mother of pearl

Fig. 3.59 The view from the North West
Fig. 3.60 View from the North West.

Fig. 3.61 Aerial view
Fig. 3.62 View from North East.
Fig. 3.63 Close-up view.
Fig. 3.64 The view as perceived from water level.
The entrance design is based on a triangular shaped threshold that would gradually lead and transform into the symbolic circle.

Fig. 3.65 Entry from Stokes Point

Fig. 3.66 Walkway Entry from Stokes Point
The initial design of the walkway was based on a circular shape and influenced by the DNA helix model.
The two images illustrate how the building will be perceived on bridge deck level in a vehicle.

Fig. 3.69 The view on the Bridge.

Fig. 3.70 Close up view on the Bridge.
“The ideal project does not exist, each time there is the opportunity to realize an approximation.”  

Paulo Mendez da Rocha

PART 4.

FINAL DESIGN EXECUTION

Architecture Follows Nature
Fig. 4.1 The development of Connections and Relationships.

Fig. 4.2 The systems.

Fig. 4.3 The fishbone structural development.
“He found a specific structural logic and architectural grammar to maximize – through vista, light, and the flow of space – the experience of its setting.”

Nicholas Olsberg on the Architecture of John Lautner.

Organs, Skeleton, Skin

The biological analogy was used by the Romantics to describe the spatial volumes of a building that functioned as the “organs”, the structural frame acted as the “skeleton” and the exterior walls represented the “skin” which also expressed the internal structure.

The final design will aim to find a balance between literal representation and architectural interpretation and will strive to illustrate the influences on a metaphysical level. The cultural symbols and marine life shapes that were researched should not overpower the design, but should be referenced on a level that will make the viewer aware of the origins without being able to identify every element. The building should tell the story of its growth from the context and show how site conditions contributed to the design. The “twist” was illustrated as an architectural gesture or ornamentation in the structural design of the fourth alternative, and was developed in this final design as a “Design Action”. This is shown in the plan that is twisted and rotated along the axis of the pier as host to form an aerodynamic shape that display the appropriate orientation to face prevailing South-Westerly winds and stormy weather from a North-Eastern direction. The final form still references the mussel shape; however, it gradually developed into a hybrid between the wing concept, and that of a sail on a yacht. The fishhook was simplified and moved from elevation to a less literal shape in the plan view, twisting and moving with the tides.

131 Cohen, Escher and Olsberg, *Between Earth and Heaven*, 100.
4.1. THE PROGRAMME

Selection of the programme post site analysis and literature review greatly aided in predicting outcomes caused by accessing the needs of a growing economy and city with a view to the extreme and extraordinary. The programme and design responded to the objectives of use and adaptation of unused space in infrastructure, creating new, valuable real estate from unused space. With all the programmes and relationships available, the site was explored to find the best suited option and methodology for the creation of programme spatial relationships. Navigation, circulation and visual experience were considered and positioned to accommodate existing access routes and waterway connections.

Fig. 4.4 The proposed programme.
Programmatic requirements.

- **Access Routes**: vehicle access from the motorway via Northcote Point, with parking available at Stokes Point as well as Northcote Point for visitors and hotel guests. Pier one sits on the ferry route for easy access by water, but will be regulated.

- **Access Points**: entrance and security considerations, undercover wind sheltered seating and boat parking.

- **Water level entry**, cafe setting and security screening to allow access to vertical circulation.

- **The creation of the walkway to establish a sensory experience**, the views, movement, vibrations and traffic noise, in an effort to become one with the bridge on the journey to the final destination.

- **Horizontal connection** to the main structure and connection to the future “Skywalk” cycle development.

- **Vertical connection** to the main structure.

- **Multifunctional spaces above the water level cafe** that may serve as offices or function rooms to accommodate special functions or bridge maintenance and other blue chip office space.

- **Reception areas** to accommodate security services.

- **The main restaurant areas** for fine dining, reception areas, kitchen facilities, administration areas, storage and cold storage areas and refuse area for rubbish. Internal vertical circulation and service areas for toilets will be required.

- **The main hotel space**, bedrooms and lounges, reception areas, services and maintenance, back of house areas positioned below the restaurant and road level, linen and other storage areas.

- **The sky bar on top**, spanning two levels with internal circulation, toilets, administration, cold storage and waste facilities.

- **The second building** to accommodate top quality residential suites. Accessible from sea level by ferry or water taxi.

- **A Plant room** positioned on the highest level to house services and water tanks, allowing for gravity feed to the rest of the building.
4.2. THE PARTS

- **Access points**: the entrance and walkway to be constructed in a composite and lightweight structure connected to the “skywalk” project as well as access provided for water level entry to the building.

- **Walkway**: fixing points will be supported from land and fixed to the superstructure to ensure movement with the bridge.

- **Cafe at sea level**: reference to Fisherman’s Wharf, Auckland’s oldest recorded Marine Restaurant, sporting lots of activity with a reception area and security control.

- **Restaurant** above road level: this will be a reference to lunchroom beneath road level at pier one. The concept of “see and be seen” will be applied in high end dining, providing views of the city and bridge below.

- A 5 star **Boutique Hotel**, reception at sea level, lounges and bedrooms, with top quality thermal and sound insulation on all hotel levels.

- The design will feature a top quality **Sky Bar** on the top levels.

4.3. Structure and Services

- **Structure**: steel pre-fabricated components that will ensure ease of assembly at 80 metres above sea level. Steel will be used to eliminate any runoff from alternative metals or materials to the bridge structure.

- **Floors**: will be precast, prefabricated, reinforced, lightweight concrete.

- The facade will consist of a sealed envelope with smart glass, solar collection driven. The prefabricated glazing panels will be gas filled for maximum sound and comfort insulation and fixed to the structural frame in separate sections.

- Both facades will be designed as double skinned. The balconies to the hotel bedrooms will be positioned in the space between the two facades. The recess will ensure solar protection in summer and will allow sufficient sunlight to the bedrooms in winter.

- **Heat pumps** will be the main source for heating and cooling driven by tidal energy harvesting, wind energy, solar and kinetic energy.

- **Interior**: Hotel rooms, toilets and washrooms to the different levels will be pre-fabricated. Any other interior walls will be constructed onsite and insulated to the highest standards.
• The core will house the lifts and fire escape stairs at both ends. It will serve as the seismic shear wall in precast reinforced concrete, to counteract seismic activities. Centrally positioned hollow steel columns will act as further stabilising and load bearing devices on either side of the main road deck.

• The columns will be anchored inside and on both sides of the pier and pass between the outside two lanes and the main road deck without connecting to the bridge.

• Services: Services will be housed inside certain sections of the hollow steel structure, horizontally inside a dropped ceiling and vertically in the void provided inside the core or the steel columns and in the void provided in the lift core.

• Rooms will be insulated to ensure the best room acoustics and thermal insulation, in line with that of the top international airport hotels. The insulation would be in Aerogel, the world’s lowest density solid, clocking in at 96% air. It supports up to 4000 times its own weight, can withstand a direct blast from 2 pounds of dynamite and is known to be the best insulator in existence.  

• The steel framed structure will accommodate fire sprinklers or have a water core to ensure fire safety. A fire sprinkler system as required by NZ Building Code will be provided for each floor.

• All details will adhere to fire safety standards and the building will be detailed to allow for fire separation between each floor.

• Fire escape stairs are provided on both facades of the building design.

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4.4. Energy and Water

The following methods will be employed to harvest energy:

- Tidal turbines under the platform at sea level entry level,
- Kinetic energy from the bridge deck, generated by moving traffic,
- Smart glass will ensure solar control and collection on North facade,
- Wind turbines will harvest wind driven energy, positioned inside the bridge superstructure.
- The idea would be to generate power and sell it back to the national grid rather than creating storage areas for this energy.
- Environmental considerations; the building will sport a sealed envelope above road level and heating and cooling will be supplied on upper levels. On the lower parts the envelope will be adaptable to make use of natural ventilation as it is less exposed to the elements than above the bridge. The cafe will be naturally ventilated and only heating will be supplied. The walkway will be naturally ventilated.
- Grey water will be supplied via reverse osmosis and clean tap water will be connected to Council services under the bridge running off the water mains at Stokes Point, 172 metres to the north.
- Waste water will be connected to the Council sewage system at Stokes point running under the bridge.
- Electricity and communication systems will be connected to the existing services running under the bridge deck and be upgraded to suit the requirements of the new development.
Fig. 4.5 Environmental Section (nts).
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1. CROSS BRACING STRUCTURE
2. GLAZED FACADE
3. 2ND GLAZED SKIN
4. LIGHTWEIGHT CONCRETE FLOORS
5. STEEL STRUCTURAL COLUMNS
6. FIRE ESCAPE STRUCTURAL SUPPORT
7. LIFT CORE STRUCTURE
8. FOUNDATION
4.5. Construction Process

- Design and Planning phase
- Construction of foundations and positioning of tidal turbines.
- Steel framed construction in prefabricated sections, positioned by barge crane
- Prefabricated floors positioned by barge crane on steel frame
- Hotel bedrooms, toilets and washrooms prefabricated. Each level placed in position by means of helicopter crane
- All glazed sections delivered and positioned at lower levels by barge crane, above road level by helicopter crane, assembled, fixed and fitted by altitude qualified construction workers

Construction

Marine Foundations - Sheet Pile & Cofferdams

Precision work will be required for the installation of sheet piles and the construction of cofferdams that will house the foundations and tidal turbines of the proposed building. Although these structures are often temporary, they will have to be built strong enough to withstand maximum pressure exerted by the ocean throughout the construction project and beyond. The scope of the work will include building three cofferdams, one for the foundation and piles of the building, one for each of the tidal generators, and one for decking which will require the installation and careful connection of interlocking sheet piles that will contain multiple driving templates. Working within the cofferdam, the area will be excavated to more than 8 metres below the seabed. The use of impact and vibratory hammers will drive 60mm diameter pipe into the dirt, mud and sea bed. The general contractor will pour concrete for construction of the building foundations.
Fig. 4.7 Wave diffraction and interference

Fig. 4.8 Two pebbles dropped in water

Fig. 4.9 Analysis of interference
Development of the Building Façade

The development of the two facades was based on movement and focuses on overlapping and transparency. The North facing facade illustrates the original fishbone structure developed into a shape that resembles and engage with the triangular shapes extracted from the bridge superstructure, growing from and showing a resemblance to the host structure. The principle of the power of limits was researched and applied further to the final development of this facade. The effect of two pebbles dropped into water some distance from each other, creating waves that create ellipses that grow into parabolic arches toward the infinite, were abstracted to inform this design. This pattern of waves, or interference, can also be created by vibration. The vibration sequences of the bridge superstructure are forced down to the water and transmitted through the piers. This will in theory, create overlapping wave and tidal patterns. This might not be visible to the human eye. It is however more likely that interference on wave patterns by the location of pier 1 and the north bound anchorage, will create the cross pattern used as the template as shown in fig. 4.7. The exterior skin will be constructed as a glass curtain wall with deep closed balconies to ensure solar control during all seasons.

The South facing facade displays a smooth horizontal band pattern, glazed and clad in a lightweight material derived from automobile and aeronautical influences on the design. Movement of air, water, watercraft, and traffic flow, informed the shift, shape and materiality on this façade, illustrated in smooth and curved horizontal strips that will reference traffic movement on the bridge. When travelling at speed, the horizontal elements in the design are emphasized, whilst the vertical becomes subservient.

134 Doczi, The Power of Limits, 139.
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The images illustrate site conditions as form generator. The shape will adapt to wind conditions by means of the implementation of aeronautical principles.

Fig. 4.20 Site conditions as form generator

Nautical and Aeronautical influences.
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The plan rotated on an axis around pier one, showing the “twist” symbol in action, rather than ornamented in the structure.

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The design is informed by site conditions and predominantly by wind patterns, wind loading and directions. Stormy weather from the North East and prevailing winds from the South West determined the shape and position of this structure. When dealing with wind and the open ocean, the sail comes to mind and how it harvests and negotiates the wind to maximize movement of the yacht. This design will do the opposite: it will deflect wind to minimize the wind load and the effect it will have on a mass exposed on open water mass.

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How will the building be perceived?

The fact that the site will continue its existence as a bridge implies that a substantial portion of people viewing the new structure will be inside a car at speed or in a moving boat at sea level. It will be perceived from varying speeds, proximity and vantage points and its appearance will be constantly changing by the movements of the observer. With this movement we might experience faster proportional changes than on foot, and the blurring and overlapping that might occur at speed could enhance the total image of this building, as if it is perceived under water, where the original shape derives from, and shapes are sometimes perceived as blurry and out of focus. This display experienced at speed will hopefully complement the landmark bridge by adding value to its iconic status.

The wing at the plinth of the building where it touches the ocean, show the development of the mussel in plan-view. The roof section displays movement, that of the wind and of the seabirds riding the air currents. The curved ramp that forms the base of this building provides wind shelter to both sides, depending on the wind direction. The ramp fulfils a dual purpose: horizontal circulation and seating area, as well as to serve as an undercover temporary parking area to accommodate the luxury boats of visitors. Permanent mooring would however not be possible because of the strong tidal movement.
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CONCLUSION
Results and Assessment

"I could realise there was a danger in too much abstraction." 136

Bruce Goff began to realize that things have no beginning or end really. We tune in on them even in a design or a problem of any kind. There is no place where you can say the problem really begins or really ends. When we decide to build a building, that is not the beginning of the problem, the problem started long before that, and after this structure is built the problem remains. There were the purists who were after abstract things, saying that architecture was not organic but synthetic, and that we combine things because we try to arrive at impersonal anonymous solutions because the problem always changes. 137 On completion of this paper, I would concur with Goff’s view: it is very important not to be too abstract too much; to find the correct balance, we need to focus on how our buildings perform socially, environmentally and economically over the long term.

One of the most important lessons learned from this research relates to the origin or starting point of the design. It will be wise not to start at what might seem to be the beginning but to project your thoughts and find inspiration in matters that existed even long before the existence of mankind: to start with Nature. Everything originates from Nature, as created by God. The solution is to find inspiration in natural things and the design process will show a harmonious balanced result. On assessment of the research it showed that the development of a project would always result in more than one acceptable solution. Another very important lesson learned was the fact that to gain something better, to improve a design, one has to let go of what you have at a certain point. This problem or research question might have been addressed, but it is only the start of the long term solution.

136 Welch, ed., Goff on Goff, 34.
137 Ibid., 33.
Human exposure to Nature has been drastically reduced. People often seek contact with Nature during their leisure time as Nature is pushed back from our daily functioning. We have a non-negligible positive affective relationship with natural entities. We are intrinsically fascinated by Nature, and it was the aim of this design to address this estrangement from Nature, showcased in an architectural solution.

This document originally developed from an interest in the habitable bridge concept as well as organic based architecture. We can overcome the estrangement from Nature by integrating nature-based forms in contemporary architecture on the basis that the presence of such shapes will positively contribute to human health. The integration of such architecture can form a compensation for the loss of natural form in the human living environment. The brain stimulates its integrated systems specialized in processing information about natural things. This information is expressed in different cultural and artistic creations and discourses. This paper pursues the idea that nature-based architecture can certainly, positively influence us on a creative and an emotional level: an individual could become less stressed and will encounter a positive aesthetic experience.  

Studies that have been done about the cognitive effects of Nature as a whole and water's amazing influence does not mean it displaces other concerted efforts to reach a mindful state; rather it adds to, enhances, and expands to our perception.

“People have a deep emotional connection to the sea. The Oceans inspire, thrill, and soothe us. Some think we owe our clever brains and the success they brought to our ancestors’ close link to the sea. But our relationship with the sea stretches back through time much further than this: all the way to the origins of life itself. We are creatures of the ocean.”  
Wallace Nichols claims that the fact that people relax near water, get creative near water and hold their most important ceremonies near water, illustrates a definite connection between human happiness and the ocean. It has been found that the cognitive and social capital of healthy waterways and their effect on humans is enormous. We have to step away from our stressed lives and into Nature to make a physiological shift. In nature, and near water, our brains and bodies change, a different brain network activates. We are more relaxed and the quality of our thought changes. This leads to feelings of connectedness and innovative thoughts. The effects of this research will hopefully be illustrated in the proposed water based project, an effort to make people happy and enjoy happy thoughts when visiting this project.

The method presented in this study was to generate a self-sustained, parasitic structure, able to adapt to its context by the creation and imitation of marine life forms. The results show it can be accepted as a basis for the design process of symbiotic forms, providing possibilities of architectural space development in and on a bridge structure, for further examination. The forms that were developed exhibited interest in the methods a designer can follow to fill space without changing the functionality of the host structure during construction and operation. The results support the idea of accommodation connected to a host structure in a parasitic manner. An exact structural analysis of the bridge and maximum load bearing calculations could be undertaken to test the strength of existing materials. The materiality of the structure, the strengths, loads and capacities was not defined as part of this investigation. The aim was the exploration and adaptation of unused space in a parasitic manner. The advanced structural loads and load bearing qualities will probably be more suited to the field of the engineer rather than the architectural field.

140  Ibid., 7.
FUTURE DIRECTIONS

This document has addressed the development of a self-sustainable, parasitic form, connected to the Auckland Harbour Bridge, well adapted to its context by the application of a historical model: the “Habitable Bridge” concept. The innovation of the research revolved on the biological nature-based concept of form development and representation resulting in a structure representative and growing from its context and site conditions. This building will adapt to the environmental conditions, providing a meaningful example of a symbiotic relationship between nature and architecture. The research and methodology followed the findings that stem from the precedents that have been used as a starting point and applied to the development in combination with ways to occupy unused space in infrastructure, and to extend it in a parasitic manner. The additional space created in the form of a restaurant and hotel offers new angles of approach to position accommodation and occupation with neutral modifications to the functionality and character of the existing infrastructure. The suggested method facilitates architects to form a mechanism for exploiting every possibility on offer in existing infrastructure. Future work will focus and examine the possibilities of a second structure at pier two. Similar to the first structure, it will be important to ensure that a second structure with different access requirements can be constructed without affecting the function, stability and character of the Auckland Harbour Bridge. A second building creates a visual balance, but two structures might compromise the safe operation of the bridge.

The estimation of the results showed that a clip-on building with self-supporting marine foundations should be the preferred construction method. This research might create a framework that can be applied to different bridge structures globally, with awareness of the modifications that will emerge at each individual identified site.
Could this research be applied to any other bridge structure?

Every bridge is unique, so the short answer would be no. However, some of the design development processes might be of some use to future parasitic, symbiotic and habitable bridge concepts. Lessons taken from the analysis of the habitable bridge precedents are based on application and exploitation of views on offer as well as views that will be created, highlighting historical features in iconic design. Material selection would be important to ensure ease of maintenance and harmony with existing materials of the host structure when considering any new structure connected to an iconic design. It is important to integrate the new design on the template of a historical model, to reference history and tradition, and to ensure a visually pleasing result. That is the key lesson.
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Why design a hotel and restaurant?

Tourism is a fundamental contributor to New Zealand’s economy and way of life.

**Key Facts.**

- Tourism is one of New Zealand’s biggest export industries, earning $9.8 billion or 16.1% of New Zealand’s foreign exchange earnings. (Year ended March 2013).
- Tourism directly and indirectly contributes almost 9% of gross domestic product for New Zealand.
- Tourism directly and indirectly employs nearly 9% of total employment in New Zealand - 172,100 full-time equivalent jobs.
- Tourism in New Zealand is a $65.5 million per day industry and delivers $28.8 million in foreign exchange to the economy each day of the year.
- Domestic tourism contributes another $38.9 million in economic activity every day.
- Total expenditure reached $23.9 billion for the year ended March 2013. 141
- The design will exhibit a historical connection to an existing lunchroom, originally built for construction workers and situated inside the superstructure, in the form of an upmarket restaurant. It will serve as a reference to, and provide a historical connection to the Fisherman’s Wharf, Auckland’s first marine restaurant. 142

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A 2.1 HABITABLE BRIDGES

What factors contributed to the disappearance of inhabited bridges?

Gradually habitable bridges were replaced by single use counterparts. The reasons can be put down to three factors: economic, aesthetic and philosophical. Changes in military strategy coupled with economic growth, expansion in commerce, and trade and growth of urban centres exerted pressures upon cities for the free flow of traffic on thoroughfares crossing the habitable bridges. Changing attitudes to nature brought about a change in perception of the bridge from that of a deterrent to hostile forces, to something to be contemplated for intellectual and emotional nourishment. This contributed greatly to the disappearance of habitable bridges, which became increasingly resented for their obstruction of vistas across waterways and urban landscapes. 143

What needs could be met by new inhabited bridges in the twenty first century?

Modern bridges serve only one purpose: to carry traffic. A modern approach should re-establish an organic link between separated urban entities to revalidate the vital notion of urban complexity. Diverse and complementary activities must be reconciled in one place, creating favourable spaces for social interaction and symbolically expressing a desire to unite a city's inhabitants converging in that link in between. We have lost the ability to generate the urban complexity illustrated historically by the inhabitable bridge typology; they created that urban complexity by superimposing several functions and concentrating them in one spot. Every bridge should be used to both financial and social advantage as a base on which to graft elements of urban life by surmounting obstacles that prevent the city forming a continuum: the bridge is to come alive! 144

144 Ibid., 33.
“The forces exerted with the internal column are felt as though they were acting within us... The column becomes a living form and its life becomes a metaphor for our own.”

Fig. A 2.1 Rangiatea Church, Otaki, New Zealand

145 Mumford, Form Follows Nature, 26-37, 30.
A 2.2 ORGANIC STRUCTURE

The organic tradition in the Scandinavian countries can be pinned down to the architects: Alvar Aalto, Eero Saarinen, Gunnar Asplund and Sverre Fehn. Saarinen’s technique was based on direct imitation of nature. Asplund, Aalto and Fehn developed an approach to architecture and nature through “immediate observations and spiritual appreciation.” 146

Aalto followed many strategies when dealing with nature. He often relied on the metaphor, or abstraction of nature, integration through consonance and strategic incorporation of materials to enhance exterior harmony with its surroundings. Sverre Fehn exploits the physical world, testing nature’s force. There is a proposition that our experience of space is mediated through the senses. We must strive to create architecture, mediated through the senses that will emphasise a physical and mental interaction between occupants and built spaces. This attempt will allow a more intimate connection between the body and architecture. 147

Symbolic structure usually recalls an idea, a quality or a condition. The Rangiatea Church Otaki, one of New Zealand’s oldest churches, presents a religious symbolic meaning attached to the exposed interior structure. The ridge - pole, sculpted from a single tree, symbolises the new faith in only one God. The ridge - pole is supported by three pillars, symbolising the Christian Trinity. From a cultural point of view, the ridge - beam is the centre of the roof that covers human habitation, it preserves human mind and spirit, the needs of the human body and sits in the collective human memory of place and of being in place. 148

146 Antionades, Poetics of Architecture, 246.
148 Charleson, Structure as Architecture, 189.
“Just when seeing a leaf of a plant, one deduces from it the whole plant; from the bone of an animal, the whole animal; so from seeing the cross-section one deduces the architectural members; and from the members, the whole monument.”

The biological analogy was used by the Romantics to describe the spatial volumes of a building that functioned as the “organs,” the structural frame acted as the “skeleton” and the exterior walls represented the “skin” which also expressed the internal structure. Viollet-le-Duc’s philosophy, based on “Gothic Realism”, urged the architect to follow the methods of medieval sculptors who studied plants and animals in order to understand how their forms expressed a function or submit themselves to the necessities of the organism and to apply the natural principles of creation. Viollet-le-Duc refers to this structural system in Dictionnaire Raïsone’ de l’Architecture Francaise: Exposed structure can enrich architecture when structural forms and details contribute meaning by virtue of their representational qualities, typifying a physical object.

150 Mumford, Form Follows Nature, 26-37, 27.
A preacher complained to Lloyd Wright that too many people came to see his building: the Unity Temple in Oak Park Illinois. The preacher wished more would come to hear the sermon. Wright told him the building was a sermon, you can’t help feeling it is a very special space, a religious space. The building seems ancient in one sense, but also very new, very alive and also very mysterious. Lloyd Wright pinned the success down to the order inside, he said it was the first time he was able to have the continuity, or the flow of space. That is what makes it the kind of space it is, religious. You don’t need a sign that says this is the Unity Church, you can sense it through the order of the design that goes through it. The order of design carries a consistency of language through all the related parts. It carries an order of feeling through it that dictates the forms and the structure in the space. To design a hotel based on this, would be an immense challenge, and the principles would certainly be applied in the proposed design. The challenge is to design a hotel without having to add a sign to it.

The imagination forms a phantasm (Aristotle), influenced by education, culture, life experiences and professional expertise of how meaning in architecture and in structure is perceived. Successful cities are often characterized by a strong identity based on unique cultural elements, such as Auckland, a key gateway for people, goods and ideas. Objects, and artefacts found in the natural world can be sources of design inspiration. Animals, birds, insects and marine life can be introduced to create fantasy, variety and surprise in architecture. The final design should build on and reference the lines and forms that exist in the Bridge as context, showing off other influences, marine life, site conditions and culture, converged in one design. The excitement of the building must belong to the position, form and structure. It must be dynamic in its stature, maximizing space and views and create a positive social tension. It must be able to tell a story!

153 Charleson, Structure as Architecture, 189, 200, 201.
A 2.3 The Golden Section: Crafts.

The Acoma Pot made by the Pueblo people more than a thousand years ago was created by a dinergic pattern-forming process in the form of the spiral outline and expresses the Indians’ unity with nature. The pot was created on three different levels:

Firstly, the dinergic work process of rotating and radiating the spiral outline. Secondly, the golden proportion relations of the shape and neighbours, that emphasizes the rhythmic harmony which unites all small and large elements of the design in dance-like energy. The third level consists of the decoration of the painted pattern in rectangular spirals. The three steps to create this pot could be applied to architecture in the processes relating to design, construction, context and decoration. The threefold dinergy of pattern, proportions and process will convey a strong sense of oneness between culture, infrastructure and Nature if applied correctly in this design for the Harbour Bridge.

154 Doczi, The Power of Limits, 22.
The Green Lipped mussel as form generator

Fig. A.2.4 Image: Generating the form of the North elevation

Fig. A.2.5 Generating the East elevation

Fig. A.2.6 Generating the plan
A 2.4 The Green lipped Mussel

The shapes and growth processes of Marine life, and, the Green Lipped Mussel, have been exploited, analysed, abstracted and developed in the form-making process. This shellfish is native to New Zealand, also known by Maori as Kūtai. The Green Lipped Mussel, *Perna Canaliculus*, is usually found below the intertidal zone on the hard surface of the basalt wall at Fisherman’s Wharf, Northcote Point. The mussels clamp on to the rocks, manmade structures and foundations in the context of the site and surrounding areas. The clamping of a group of mussels is purely to hold firm against tidal power. Because of the strong tidal currents, the substrate is kept clean and there is a rich low tidal and under-boulder fauna found in the area at Stokes Point and Northcote Point. The green lipped mussel attaches itself to a firm substrate by means of *byssal* threads or “beards”. The mussel shell consists of three layers: an inner iridescent layer of *nacre*, mother of pearl composed of *calcium carbonate* which is continuously secreted by the mantle: the middle layer of chalky white crystals of *calcium carbonate* in a protein matrix, and an outer pigmented layer resembling a skin, *periostacrum*. This outer layer is composed of a protein called *conchin*, and protects the prismatic middle layer from abrasion and dissolution by acids.155

Mussels are filter feeders. They draw water in through their *incurrent siphon*, then into the *branchial chamber* on the gills for *ciliary-mucus* feeding and release the waste water through the *excurrent siphon*. The shape, colour, life cycle and process, as well as the composition of the mussel in its three layers, will be a major source of inspiration to determine the basis of the design of this project. The layers can be referenced to inform the design layers in the interior and insulating system that will be the centre and soft protection to life inside the building. The mother of pearl second skin will be referenced in the facade design and the outer skin of the proposed building. The water filter and feeding system of the mussel will be referenced in a proposed reverse osmosis plant to de-salt sea water for use as grey water in the new structure. The building would be clamped around pier one, feeding off the sea, generating energy by means of tidal turbines in reference to *Perna Canaliculus*, visually and in its daily living and survival in nature.

Symbolic cultural objects referenced in the search of form in the structure.

**Fish Hook (Hei Matau)**
The symbol of prosperity, abundance, good health and power that illustrates respect for the sea and marine life. This symbol has been superimposed and developed to form the basic line in the search for a proposed structure.

![Image showing Structural reference to the Fish Hook](image1)

Fig. A 2.7 Image showing Structural reference to the Fish Hook

![Image showing the structure based on the fishbone concept](image2)

Fig. A 2.8 Showing the structure based on the fishbone concept
The Golden Section applied to the design

Alternative # 4

Machine and transport reference as form generator. The aerodynamic shape of the Lamborghini have been applied to inform an elevation.

Fig. A 2.9 Images showing the Golden section applied to the design.

Fig. A 2.10 Image showing the Lamborghini as form generator
Development Options for sea level entry.

This early sketch design shows a glazed “Fish Fin” covered entrance to the cafe that will function as a sea level porte-cochere to the retail and hotel entry. The entry level was researched and developed further through design in order to find the best option, more abstract and subtle, to compliment the project as a whole.

Fig. A 2.11 Development sketches for sea level entry
Development Options for sea level entry.

Alternative design options for the sea level arrival cafe, resembles the abstract shape of a sea shell. This imitation of marine life did not compliment the project as a whole. As a single construction at the base of the pier it would be acceptable, but aesthetically it let down the rest of the design. The water level entry programme design was developed further to a more desired outcome in a later alternative.
Seismic Resist technology

The North facade structure will form the required cross bracing structure and the proposed lightweight concrete floors will act as diaphragm connections to ensure seismic stability. The idea of applying post-tensioning technology to achieve moment resistant structural systems will be used in this project. Moment-resisting connections using post-tensioning concepts will be implemented in the steel construction and connections as well as to the lift core concrete shear walls. The self-centring and energy dissipating connection systems to steel structures will be initiated using post-tensioning concepts. This post-tensioned energy dissipating (PTED) connection system for steel frames incorporates post-tensioned high-strength bars that will provide a self-centring response along with energy dissipating bars that are able to develop stable inelastic axial deformations in both axial tension and compression. This connection is capable of achieving stiffness and strength characteristics comparable to a traditional welded moment-resisting connection. In addition, the connection can be designed to provide a sufficient amount of energy dissipation per cycle. The PTED system has a highly enhanced response to severe seismic loads, as it limits structural damage to sacrificial bars and assures a full re-centring of the structure at the end of the earthquake. 156 The lift core at either end with fire escape stairs will act as shear walls, acting as primary and secondary structure.

“In a strange way, architecture is really an unfinished thing, because even though the building is finished, it takes on a new life. It becomes part of a new dynamic: how people will occupy it, use it, think about it.” 157

Daniel Libeskind