

Architecture in Motion: Change We Can Believe In

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Abstract

This research project addresses a triple agenda of portability, adaptability and sustainability through the design of a multipurpose public events venue for Auckland city. Proposed events range from small community based markets to large exhibitions and concerts, all of which service and support the Auckland Summertime festival.

Extreme flexibility and adaptability, including significant change of shape and size, is the key programmatic requirement. The brief is further expanded to include portability; as the pavilion does not have a singular fixed location, but travels to diverse sites throughout the wider Auckland region. Portability also entails issues of ephemerality and transience in architecture. Lastly, the brief also postulates the green dimension; the pavilion is expected to perform in a highly efficient manner, as well as achieve a high degree of self-sufficiency.

The general approach to resolving this complex triple agenda is through prefabrication. The construction method is based on a structurally engineered timber panel building system, which incorporates principles of scaffolding for supporting structure.

The wider significance of the project lies in demonstrating that the traditional prejudice towards prefabricated systems as cheap, short-term and unsuitable public buildings is unjust. A prefab multi-use public pavilion is not only practical, safe and affordable - it can also inhabit and therefore enhance many locations, accommodate a very wide range of uses, and be resource-autonomous and environmentally friendly.

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1.0 Introduction

1.1 Project Outline

This project intends to explore prefabrication technology for the purpose of designing an ephemeral, portable, fully adaptable and sustainable public events venue.

Aims:

- To create a portable, adaptable building system in the form of an events pavilion for the purpose of hosting small to medium scale public cultural and entertainment events.
- The design versatility of the building system will create the opportunity for use within a range of architectural applications aside from purely public events venues.
- The design solution will have the ability to contract and expand depending on specific requirements at the time through the use of a standardised building system built with prefabrication construction techniques.
- The design will be a design 'in time' as much as it is a design 'in space'. The building will be able to respond to contingencies of use, as well as exigencies of the site.
- The utilisation of New Zealand-grown wood and associated engineering technologies will ensure relevance to New Zealand's natural identity and national stance on the importance of sustainability.
- The design solution will adopt certain self-supporting/self-sufficiency technologies in order to gain partial independence from 'grid' energy and also to reiterate the importance of sustainability within architecture.

1.1.1 Justification for Research

This project is born out of an identified need to investigate the possible realisation of sustainable prefabrication building technologies within the public architectural sector. The relevance of this project relates to the need for ongoing implementation of sustainable building methods in order to preserve and protect the natural environment in the face of future disruption in urban infrastructure. This project also seeks to respond to occupancy briefs and ownership patterns of public architecture, which are constantly changing and evolving due to the unpredictability of human occupation.

The proposed realization of civic architecture using sustainable prefabrication technologies relates to Auckland city's immediate requirement of a public events venue with portable, ephemeral and adaptable characteristics. The identified need for a venue of this nature has become obvious in recent times due to the steady increase of public events and festivals hosted by the city of Auckland over the summer months; most of which are hosted in inappropriate venues and locations. One such event of this nature, to be hosted in the near future; the 2011 Rugby World Cup "Party Central" demonstrates lack of appropriate venues in Auckland in the utmost. Although the scope of this project will fall outside the requirements for an event of this size, the need for an appropriate sustainable solution to other events such as "Music in Parks" and "Movies in Parks" is still apparent. The proposed adaptable, portable and ephemeral public events venue will provide service for several events of this nature in several locations across the wider Auckland area; in an exciting, original and sustainable manner.

The proposed use of prefabrication technologies as the chief construction method in partnership with local sustainable timber resources as the key material not only

relates to sustainability, but also all aspects of ephemerality, portability and adaptability. Prefabrication techniques ensure high levels of environmental friendliness through efficient material use due to factory quality control and modularity, as well as ease and speed of erection on site and therefore minimal environmental site disturbance. The use of standardised design techniques enables efficient transportation, ease of adaption through expansion and contraction of building form, and availability for multiple re-use on diverse sites with varying brief requirements. All points raised above will be discussed in greater detail at a later stage.

As the purpose of this project is to investigate and determine the possibility of implementing sustainable prefabrication techniques into mainstream architectural practice within the public sector, it is hoped that the results will serve the purpose of creating a more sustainable, resilient and flexible architectural cityscape. The proposed design solutions ability to repeatedly adapt to a diverse range of sites around greater Auckland will create public awareness in the economical and environmental value of prefabricated building techniques; techniques which are currently underused and under appreciated by the New Zealand building industry and majority of the general public. Through the use of ephemeral and portable characteristics in relation to buildings within the public sector, I propose to modify the public's view on what constitutes a public building in the sense of a cityscape. It is hoped that the proposed use of prefabrication techniques and studies into building adaptability will also lead to questioning what role permanence plays in defining a public building.

2.0 Review of Current State of Knowledge

2.1 Theoretical Background

2.1.1 Architecture in Motion

Portable buildings have been in use since humans first began to build primitive structures. Due to their transient nature, however, portable buildings have begun to be recognised as architecture comparatively recently. The first portable buildings, such as the “familiar traditional forms of tents, tipi and yurt all utilise sophisticated construction techniques”¹; techniques that are still heavily in use in today’s architecture. The beauty of the construction techniques associated with portable architecture is seen through their widespread ability to perform to both flexibility and adaptability agendas, attributes of which are becoming increasingly significant in modern day society. Technological, economic and political shifts across the world are considerably altering the way the built environment is shaped; architecture that can adapt and respond to these changes will prove to be essential in terms of environmental, economic and societal considerations.

The portable and adaptable architecture of the modern era represents a fundamental component of the global need for a forward-thinking design agenda. The requirement for portable buildings to respond to relatively extreme operational parameters creates the need for the technological development of high-spec innovative components. The use of these experimental and exploratory design and construction methods results in valuable technological development in the field of architectural portability and

¹Robert Kronenburg, *Portable Architecture: Design and Technology*, Berlin: Birkhäuser Basel, 2008

adaptability. Such development extends throughout the entire architectural and construction industry, as the various developments are incorporated into an industry-wide range of architectural applications. The share-and-share alike relationship between portable and permanent architecture ensures a constant forward thinking development of the architectural industry as a whole.

Portability and adaptability within architecture are simply functional requirements, alongside those of lighting, ventilation, security etc. All portable buildings, therefore, should be critiqued along the same lines, and judged by the same criteria as all other forms of architecture; for example fitness for purpose, user-friendliness, relationship with context, environmental friendliness, aesthetic value and so on. Regardless of the length of time the building occupies a particular site, the primary function shall remain the same as a similar permanent facility; all activities accommodated must be supported in the utmost. The way in which the building functions should not be compromised by its portable, adaptable nature; the occupants therefore should not have to suffer inferior standards simply due to the building's ephemeral, adaptable nature. All fine portable architecture should set out to create an identifiable sense of place in exactly the same way as a permanent building does. The buildings nature of ephemerality on a particular site, and the dramatic construction and deconstruction processes related to ephemeral, portable buildings adds a sense of excitement associated with events and performances; relating well with the purpose of this design project.

2.1.2 Prefabricated Architecture

Over recent years, there has been a resurgence in the use of prefabricated architecture in the residential building sector. In the public sector however, prefabricated architecture is seldom seen. This is possibly due to an ill-informed public perception of the construction technique. Prefabricated architecture has long been associated with the failed mass housing attempts of the post war reconstruction period. Because of this, up until recent years it has faced social rejection across the board of architectural services;

“Possibly the main problem with prefabrication has been that it has not had a chance to evolve sufficiently. It has virtually remained in its initial stages, even though technology now enables the construction of all kinds of high quality buildings at a reasonable price. The fundamental reason for this stagnation has been social rejection...people associated the concept of prefabricated buildings with communism, and the shortages of the communist regime; so rejecting the regime implied rejecting prefabricated buildings.”²

Recently however, prefabricated architecture has become relatively popular in the field of residential architecture as the public have become aware of the economic and sustainable benefits of this construction technique. In designing a public events pavilion, I wish to bring to light the advantages of such a technique in an effort to modify the public’s perception of prefabricated architecture.

It is hoped the unique and exciting adaptable qualities of the public events pavilion will bring attention to, and stimulate thought for the currently underappreciated design technique. By doing so, the benefits of prefabricated architecture can be felt both economically to clients, and environmentally for the planet.

² Sergi Costa, *New Prefab Architecture*, Barcelona: Equipo Loft Publications, 2008, p. 10.

2.2 Architectural Precedents

There are a number of valuable architectural precedents which display this design project's relevant characteristics of adaptability, portability, sustainability, economy and prefabrication. All precedents successfully display at least one of these characteristics, while some successfully display all five. The most valuable precedents are as follows:

Various Designs, 2008 Adaptable Architecture Gallery Competition. London, England

The *London 2008 Adaptable Architecture Gallery Competition*³ designs include aspects of adaptability, prefabrication, mobility and ephemerality. Competition entries were to follow a brief in which designs had to perform as a mobile architecture gallery, and also be able to float along the Thames and pick up visitors at several locations. The vessels had to be versatile and the exhibition space able to adapt itself to the movement of the river. The entries were to be capable of altering through their “temporary” presence the urban profile of the city, while at the same time being able to incorporate themselves into the miscellaneous context of modern-day London. These architectural precedents display the utmost relevance to my design project, as the ‘temporary’ presence felt in the context of an urban environment in terms of both adaptability and portability relate to the ephemeral nature of my proposed design solution within the urban context of Auckland city.

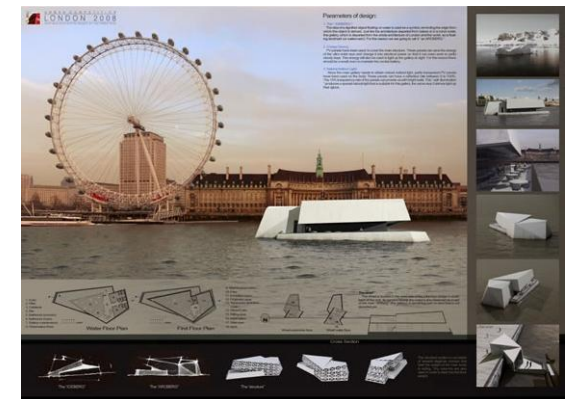


Figure 1- Various Designs, Adaptable Architecture Gallery Competition.

³“London 2008”, Arquitectum, accessed March 2010, <http://www.arquitectum.com/index.php>

The Prada Transformer, OMA. Seoul, South Korea

One such civic project which combines adaptability and prefabrication is *The Prada Transformer*⁴ or “*Anti-blob*” by the Office for Metropolitan Architecture (OMA). This pavilion allows different configurations for different uses (cinema, exhibition, art, fashion show), all of which are related to a new mix of disciplines, between art, fashion and architecture. The different configurations result by rotating the ‘object’ with a crane, as each face of this object is a plane with a given shape, specific for each use but also being used as a helper for the other uses. The function and purpose of this building relates well to my design proposal. The idea could be described as ‘avant-garde’ and is excitingly original. Four large cranes working in unison allow this building to transform and ‘adapt’.



Figure 2- The Prada Transformer

Taipei Performing Arts Centre, OMA. Taipei, Taiwan

Along the same lines, however less dramatically adaptable is another OMA project for the *Taipei Performing Arts Centre*⁵. This project is based on 3 theatres which are plugged into a central cube, allowing for flexibility as theatres can be used independently or combined. This new arrangement of stage and seating includes a public circulation that exposes parts of the backstage to the public. The overall purpose and function of the centre relates well to the design proposal, however, while this design solution is largely neither prefabricated nor portable, information on the workings of the interior flexible spaces will prove to be useful in the later stages of the design process.

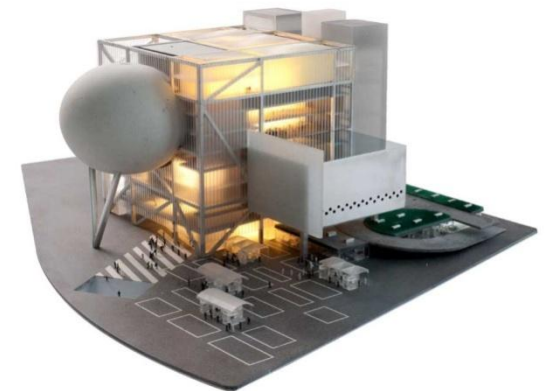


Figure 3- Taipei Performing Arts Centre

⁴“Prada Transformer”, Prada, accessed April 2010, <http://www.prada-transformer.com/>

⁵“Taipei Performing Arts Centre”, OMA, accessed April 2010, <http://www.oma.eu>

Mobile Art Pavilion for Chanel, Zaha Hadid. No Fixed Location

A hugely successful ephemeral, portable and semi-prefabricated example of civic architecture is Zaha Hadid's *Mobile Art Pavilion for Chanel*⁶. Inspired by one of Chanel's signature creations, the quilted bag, the pavilion follows the parametric distortion of a torus. In its purest geometric shape, the circular torus is the most fundamental diagram of an exhibition space. The organic shell of the Mobile Art Pavilion is created with a succession of reducing arched segments. As the Pavilion will travel over three continents, this segmentation also gives an appropriate system of partitioning – allowing the Pavilion to be easily transported in separate, manageable elements.

“The fascination of the Mobile Art Pavilion is the challenge of translating the intellectual and physical into the sensual – experimenting with completely unexpected and totally immersive environments... I see the Pavilion as a kind of a total artwork that continually reinvents itself as it moves from Asia, to the USA and Europe”⁷

The prefabricated, portable and ephemeral characteristics of this pavilion relate well to my design proposal. Further in-depth research into the technology associated with this pavilion will prove to be valuable.

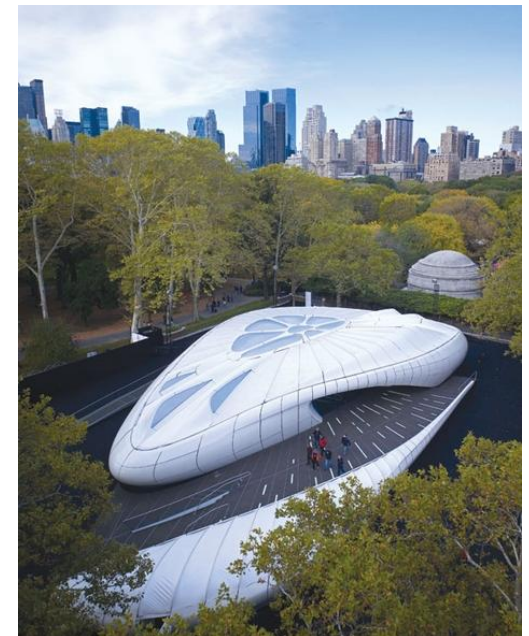
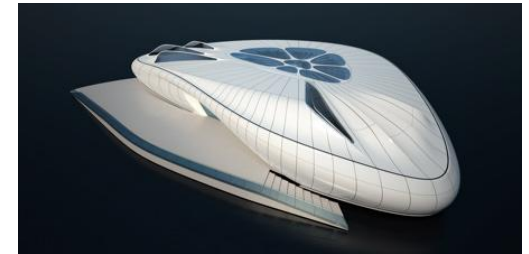


Figure 4- Chanel Mobile Art Pavilion

⁶“Chanel Mobile Art”, Chanel Mobile Art, accessed April 2010, www.chanel-mobileart.com

⁷ ibid

On Demand Housing Solution, Green Horizon. Durham, United States of America

An example of adaptable, mobile and prefabricated architecture in the field of residential construction is the Green Horizon *On Demand Housing Solution*⁸. The self-sustaining prefab home is an immediately deployable emergency shelter that can be configured to adapt to a remarkable range of situations. By focusing upon simple and sturdy construction, prefabricated modular parts, and green building strategies, Green Horizon has created a home that can sustain a family of four with a week's worth of food, electricity, and water without external support. Green Horizon's prefabs are constructed from 100% recycled or recyclable materials and feature a metal frame construction that allows for a nearly endless array of configurations. One of the prefab's hallmarks is the ease with which it can be deployed; they can be towed by truck, or carted by train, and even fit into a shipping container for travel by sea. In order to accomplish these feats the entire unit is capable of shrinking to a compact size in just under two minutes. The relevance of this residential design to this project can be seen in the use of prefabrication in both the wooden panels and steel framing system. Similar methods will be put into practice in this project. Moreover, the functioning design aspects of adaptability and mobility can be studied in an effort to help solve issues I may face in the design process.



Figure 5- On Demand Housing Solution

⁸“On Demand Housing Solution”, Green Horizon, accessed April 2010, <http://www.greenhorizonmfg.com/green-horizon-design.htm>

New Museum of Contemporary Art, SANAA. New York, United States of America

A stationary example of an architectural precedent that relates to flexibility and adaptability of interior spaces within civic architecture is the New Museum of Contemporary Art in New York by SANAA⁹. The 5,500m², seven-story composition of a stack of rectangular boxes shifted off axis in varying directions is a supreme example of architecture linked to the emerging theory of “Simplexity”¹⁰. Simplexity within architecture combines simple forms with complex function. The New Museum of Contemporary Art employs flexible open plan, column-free exhibition spaces, spaces which can be adapted and arranged to suit a variety of functions via use of temporary dividing walls. This building and the theory of ‘Simplexity’ are of high value to my design project, as the prefabricated nature of my construction proposal relates to the box type forms, and also the adaptable and flexible characteristics of the interior spaces relate to the requirements of my brief.



Figure 6- New Museum of Contemporary Art

Kubik, Blestra Berlin. Europe, No Fixed Location

The Kubik, designed by Berlin based firm Blestra Berlin is a portable public events venue linking architecture, light and music with a contemporary feel of sustainability through recycled material usage. The open air structures which tour Europe to sit ephemerally at major cities are constructed from hundreds of reclaimed, stacked and illuminated industrial water tanks. Not only does this precedent relate to the five important architectural characteristics stated above, but also reinforces the fact that while “the mobile entertainment



Figure 7- Kubik

⁹“New Museum of Contemporary Art”, Arcspace, accessed June 2010, http://www.arcspace.com/architects/sejima_nishizawa/new_museum/,

¹⁰Jeffrey Kluger, *Why Simple Things Become Complex (and How Complex Things Can Be Made Simple)*, New York: Hyperion, 2008.

business is rampant with waste”¹¹, a portable venue constructed of recycled materials will see huge savings in both materials and energy. This precedent, in relation to my project contrasts with the norm and proves that there is a sustainable and economically viable alternative to the wastefulness seen in the majority of the mobile entertainment industry.

Broad Pavilion, Broad. Shanghai World Expo, China.

The method of construction behind this precedent is valuable to a project of this character due to its ephemeral nature, working in combination with sustainable, prefabricated and economic characteristics. The Broad pavilion was one of 17 corporate pavilions at the 2010 Shanghai World Expo and was constructed in a remarkable 14 hour timeframe. Concerning sustainability; “The six-story energy-efficient structure was designed to use just 20 percent of the materials used by other pavilions of a comparable size. It also consumes just one-sixth of the energy of similar-sized pavilions due to a series of passive solar design techniques”.¹² The Broad Pavilion’s ability to be constructed in such a small space of time was due to the prefabrication of most of the building elements which were “produced in a single factory in less than a single week”¹³. The prefabrication techniques not only allow for reuse after the exposition, but also resulted in minimization of site waste. With construction waste accounting for “20 to 30 percent of urban refuse in modern cities”¹⁴, the pavilion used prefabricated materials brought directly from Broad’s factories to trim its waste to one percent.



Figure 8- Broad Pavilion

¹¹ “The Kubik”, Inhabitat, accessed June 2010, <http://inhabitat.com/2010/09/10/the-kubik-is-a-glowing-pre-fabulous-party-venue/>

¹² “Timelapse Construction Video of 2010 Shanghai World Expo Broad Pavilion”, Vimeo, accessed August 2010,

<http://www.vimeo.com/13727829>,

¹³ *ibid*

¹⁴ *ibid*

3.0 Methodology

3.1 Research Problem

Architectural research problem:

Can an adaptable, portable, sustainable, prefabricated architectural building system successfully respond to fluctuating briefs and diverse sites?

3.2 Research Objectives

1. Portability - To investigate and determine what role permanence plays in defining a public building, and what role ephemerality might play within the realm of public architecture.
2. Flexibility - To investigate and determine appropriate technologies associated with prefabrication and adaptability of building structures and components within architecture.
3. Sustainability - To investigate, determine and apply appropriate technologies / theories relating to aspects of architectural efficiency and sufficiency.
4. To undertake a design exploration through implementation of prefabrication technology in an attempt to produce a portable, flexible and sustainable architectural design solution that can respond to changes in environments and briefs through adaptation of form and structure.

3.3 Strategies Undertaken to Solve Research Problem

The research strategies undertaken in this project came in the form of two key research methods. These methods were undertaken as follows, in order of appearance:

Research for Design:

This method refers to all research undertaken into relevant information in regards to all aspects of the research project. This includes knowledge gained in subject matter associated with prefab construction, architectural adaptability concepts, sustainability principles, site environments, and relevant architectural and theoretical precedents. This knowledge base then resulted in the introduction of the second key research method; the formulation and initiation of an educated design process.

Research by Design:

This method was essentially design based research. Alternative design concepts and possible solutions were analysed in regards to the possible successful relationship with brief requirements and site parameters/conditions. Sketching and scaled 3D modelling of building form (both physically and digitally) enabled constant testing of design proposals as they would appear on site in reality. This method was used to selectively alter design proposals as to advantages and disadvantages; leading to a refined design solution that would be investigated and developed further in the final stage of design.

In an effort to further refine and develop the design solution, self-assessment was carried out on a regular basis. This self assessment resulted in the further refinement of

the design solution, as the critiquing of the overall process and development that had led to the proposed design resulted in the justification and purification of design decisions. This process was developed through a combination of sketching and 3D physical and digital modelling. A more detailed discussion of the research methods and final design outcome can be viewed in the *Project Development* section of this explanatory document.

4.0 Project Development

4.1 Formulation of the Design Brief

The process leading to the development of a design solution began with the formulation of a design brief based on the key requirements of providing a successfully functional public events venue for the people of Auckland. The general requirements that will guide in the formulation of the brief relate to the implementation of environmentally friendly design techniques through the use of appropriate prefabrication techniques in combination with suitable materials and technologies. Furthermore, it is hoped that design exploration into architectural characteristics of adaptability and flexibility within building form and function will enable the resulting design solution to accommodate many functional requirements in concert with varying brief requirements and diverse site locations.

The proposed major prospective client for the public events pavilion will be the Council Controlled Organisation(CCO) in charge of the Auckland waterfront redevelopment scheme, under guidance from the Auckland City Council. The Auckland City Council will incorporate the adaptable pavilion as part of the “It’s all happening in Auckland” festival which runs from November to April annually. This festival currently includes events such as ‘Music in Parks’ and ‘Movies in Parks’, as well as numerous other community based entertainment events. The design solution will incorporate such events in an attempt to attract and encourage the general public to attend such events, as well as encourage greater use and appreciation of the currently underutilized Auckland city waterfront.

A brief formulated to servethe above requirements will initiate a process leading to the development of an architectural design solution containing the following:

General Design Guidelines:

- The events pavilion will be required to host and accommodate several entertainment based facilities including spaces for live music, film screenings, live theatre and exhibition spaces. Spaces for food/drink sales and ablution areas will also be required as is mandatory at any public event/function space. It is expected that the pavilion should be designed to safely and successfully accommodate crowds of up to 1000 people (depending on specific brief requirements for each event).
- Appropriate outdoor spaces in the pavilion must be assigned for standing and seating viewing platforms.
- The events pavilion must have an efficient process of assembly/disassembly, and should be able to be constructed by a small to medium team of technicians with minimal use of machinery; as speed of construction is vital for an economical operating success.
- Building components must be appropriately designed/specified to enable efficient, economical and legal transportation between diverse sites by means of methods via land, sea or air.
- The building components providing the base and foundation structure for the public events pavilion must have suitable adaptable characteristics to enable construction to occur on diverse ground environments across the wider Auckland area.
- Spaces suitable for the erection of advertising banners and signs must be provided.

Specific Design Guidelines:

The specific design guidelines relate to the individual functioning of specific facilities within the events pavilion. Although facilities listed below would appear to occupy set spaces, it is hoped the proposed design solution will meet the adaptable requirements of the brief by containing flexible interior spaces which have the ability to adapt and host differing functions to meet the ever-changing needs of the client. Specific design guidelines are as follows:

- Theatre- The theatre will have seating space for at least 100 guests and encompass appropriate acoustics and lighting arrangements.
- Exhibition Space- The exhibition space will be required to host numerous forms of art in a suitably lit, open plan environment.
- Projection Room- The projection room will have seated viewing space for at least 100 guests.
- Outdoor Stage- The stage will be designed to function as a space for live music and other live performances. It shall be of appropriate size and must be arranged to face a standing/sitting area of which can accommodate a minimum of 200 guests.
- Cafe/Bar- The cafe will be required to accommodate at least 35 interior seating positions, and must be suitably equipped to cope with large numbers of guests.
- Restrooms- At least 20 male/female and 2 accessible restrooms must be provided.
- Viewing Platforms- Suitable seating/standing space must be allocated for viewing platforms- preferably raised.
- Plant- The plant and services area must be hidden from public view, and must be suitably specified in order for appropriate performance.

4.2. Methods of Transportation

The ephemeral nature of the proposed design solution means that transportation to and from the diverse range of sites must be an economical and efficient process. In order to guarantee success in terms of ephemerality, prefabrication techniques, along with multiple methods of transport (land, sea and air) had to be specified. The sites (discussed and analysed below), are all unique in terms of vehicular access. Some are accessible by all means of transport, for example Queens Wharf, whereas others, such as the Waiheke Island site are only accessible by sea or air.

In order to perform with utmost efficiency, most construction components of the pavilion will be transported in a 'flatpack' state. This is to ensure maximum haulage quantities per load. The use of prefab elements assists in method, and will also enable the use of industrial shipping containers; a method of extreme haulage versatility- as materials can be transported in safe, weather tight environments by all means of transportation. The building components unable to be transported in a 'flat-pack' state are services related components. For example the restroom module will be entirely assembled off site, and transported as a complete unit. To ensure transportation like this is both feasible and legal, the modules/service elements will be sized to meet transportation regulations such as those administered by the LTSA.

To enable efficient unloading/loading of construction elements to occur on site, sea and land based transportation machinery will be specified to be fitted with a Hiab crane. The crane will also then be able to aid in the construction of the events pavilion, which will therefore speed up construction processes resulting in time based economical benefits for the client.

4.3 Site Analysis

4.3.1 Waterfront Sites

As the Auckland City waterfront undergoes an extensive redevelopment over the coming years, I propose to specify a series of potential sites along the wider Auckland waterfront. Possible sites include Te Wero Island, Queens Wharf, Bledisloe Wharf and Wynward Quarter (after significant planned development). This series of sites suits the research intention due to the public nature and positioning in relation to the Auckland CBD; easy public access to sites is essential, as is the potential for future human activity. The Auckland City Council's redevelopment proposal for the Auckland waterfront reinforces this potential. These architectural and urban design redevelopment plans, as well as the predicted increase of population due to urban intensification and events such as the 2011 Rugby World Cup reinforce the value of the potential sites chosen. The mobile capabilities of the design solution may also allow sites to be specified further afield while still connected to the waterfront theme. Possible sites could include Waiheke Island and Devonport on Auckland's North Shore.

Due to the ephemeral nature of the proposed design solution, conducting a detailed site analysis on all possible sites is out of the question. However, I consider that one site in particular will have the most importance when proposing a "home-base" for the roving pavilion. I propose this site to be Queens Wharf.



Figure 9- Waterfront Sites

I propose Queens Wharf as the “home-base” for a number of reasons:

- **Central Location**-Queens Wharf is both centrally located to pedestrians from the CBD and also pedestrians who travel to the CBD (Britomart) by train, bus, ferry or car; *“Over 200,000 people visit the city centre every weekday, placing pressure on the 35ha of city centre public space. Half the city centre’s public space is located away from the places where most people work, visit or live (Grafton Cemetery, Myers Park and Victoria Park). Nearly half of the city centre’s workforce is located within a 10 minute walk of the waterfront, where there is a shortage of public space.”*¹⁵

An events pavilion centrally located will not only serve the citizens who travel frequently to the city centre, but will entice both locals and tourists alike to visit Auckland city’s waterfront; creating vitality, supporting the local community, and encouraging visitors to stay longer in the city. Increased visits will have significant economic benefits, particularly for retail and tourism services. This central location is also convenient for pavilion transportation to other waterfront sites; thus making journeys both shorter and safer.

- **Size**-As the “home-base” will be the showcase for the possibilities of the adaptable events pavilion, a site of reasonable size had to be chosen so that all facilities within the pavilion are appropriate sizes and functionally successful. Queens Wharf spans 400m from Quay Street and is approx 90m in width. One of the existing ‘sheds’ on the wharf will be removed (an existing Auckland City Council decision), allowing a

¹⁵“City Centre Waterfront Masterplan August 2009”, Auckland City Council, accessed March 2010, www.aucklandcity.govt.nz

massive 26000m² (approx) of possible development area. Obviously only a small section of the wharf (northern) will be used, however, if expansion is necessary, there is ample space available.

- **Recognized-**The Queens Wharf site has had a lot of media attention (both good and bad) in recent times due to several failed design competitions, failed Rugby World Cup proposals, national and regional government arguments, and very recently a final decision on a proposal for a temporary RWC “Party Central” structure, which has received both widespread praise and criticism. Due to this national and international media attention, and therefore public awareness and opinion, an events pavilion on this site would receive maximum interest from public based in New Zealand and internationally. This interest would therefore guarantee use and success (given that the pavilion is a quality design solution), and would prove to be a solid economic investment for the client; the Auckland City Council.

4.3.2 Landlocked Sites

Due to the event pavilion’s ability to be transported in a ‘flat-pack’ state within the confines of industrial shipping containers, all building elements can be safely and efficiently hauled by truck on the nation’s roads. This allows both urban and rural sites to be specified. Sites specified within wider Auckland city include the Auckland Domain (museum), Victoria Park, Mt Eden Domain (base), and the Mission Bay waterfront (grassed verge).

The reasoning behind the specification of these sites relates to ease of public access, public recognition and fitness for purpose. All sites are centrally located within their



Figure 10- Landlocked Site

own communities and therefore are effectively served by public transportation systems. In regards to fitness for purpose, all sites (excluding the Auckland Museum site in Auckland Domain) have been specified in order to serve as locations for the larger scale entertainment based public events (concerts) that this venue will host. The large grassed areas, ranging from approx 3600m² at Mt Eden Domain to the enormous approximate 35000m² at Victoria Park would provide greater user friendliness for this style of event due to ground comfort as opposed to the asphalt and tiled surfaces of the waterfront sites.

The only landlocked site specified without grass underfoot is the approx 2200m² area situated on the northern side of the Auckland Museum in Auckland Domain. I have specified this site due to its proximity with such a well known icon, the Auckland Museum, and propose the events venue to work alongside and support the Museum to host special public events/unique exhibitions.

4.3.3 Coastal Sites

Portability attributes of the building system allow pavilions to be transported to and erected on diverse and remote site locations. Possible sites of this nature include Piha Beach, Browns Island, Waiheke Island, Rangitoto Island and Great Barrier Island. The building elements in their flat-pack state could be transported via barge or helicopter. Pavilions erected on sites lacking vital infrastructure will need to generate their own energy through use of certain self-sufficiency technologies in order to function.



Figure 11- Coastal Site

4.4 Associated Research

4.4.1 Building and Construction Technologies

The technologies associated with designing and constructing an ephemeral, prefabricated, adaptable and portable public building are all directly linked to one another; many aspects of the technologies involved in one feature, are associated with-or are used to aid another feature. For example, an ephemeral building must have aspects of prefabrication in order for efficient construction/deconstruction, whilst a prefabricated building must be portable (either complete or in parts) to enable transportation from the site on which it was built. Also, in order for an adaptable building to be functionally successful, speedy construction/deconstruction of certain components is essential; hence the need for prefabrication. The main technologies associated with this design project are discussed as follows:

4.4.1.1 Timber

In order to further relate to New Zealand's national identity of the natural 'clean and green' image, I have chosen to specify the use of purely locally and sustainably grown New Zealand wood as the primary building material and construction element for this design project. The use of locally grown wood enables this design solution to perform to the highest levels of sustainability and economy; these aspects are of vital importance for the success of the design project.

In regards to sustainability, wood is the world's most sustainable raw building material.¹⁶ As a construction material, its credentials are unparalleled; as a totally renewable, reusable and recyclable material, wood's environmental impact throughout its entire lifecycle are very low. The low impact of wood see the natural material play a crucial role in mitigating climate change; so much so that building with wood actually extends the period that carbon dioxide (CO₂) remains captured from the atmosphere.

Therefore, the use of wood in place of other core building materials such as steel, concrete or plastics (which require non-renewable natural resources and large amounts of energy to produce)¹⁷ not only reduces CO₂ production, but also encourages the production of additional forests to keep up with the increasing demand. Consequently, the additional forests absorb larger amounts of carbon dioxide from the atmosphere, while producing increased amounts of oxygen. At time of manufacturing, the processing of wood-based products consumes less energy and produces fewer emissions than those of competing materials. Furthermore, unlike the waste products of man-made materials, a log of wood is utilised efficiently; in addition to the actual products, the production processes yield co-products which are valuable raw materials for other industrial uses. The timber products produced continue to store carbon throughout their entire lifespan; at the end of which the carbon dioxide released during incineration or decomposition equals that absorbed by the same wood volume in a growing forest. Wood is therefore proven to be an environmentally friendly renewable source of building material.

¹⁶ "Sustainable Construction", UK Timber Association, accessed November 2009, www.timber-frame.org

¹⁷ "NZ Wood- For a better world", NZ Wood, accessed November 2009, www.nzwood.co.nz

In terms of economy, the relationship New Zealand grown wood has with the New Zealand economy becomes apparent when considering the forms and functions of the timber in use; the characteristics of which I will now discuss.

New Zealand is known worldwide for its 'clean and green' image, an image which stands as the national identity for a nation surrounded by naturally unspoilt flora and fauna. Wood, locally grown and locally manufactured, is a plentiful resource; it is readily available almost everywhere, and it is for this reason that almost all costs associated with the production and manufacture of timber building materials are equal to, or lower than competing, less environmentally friendly materials. When used in combination with prefabrication and advanced timber engineering technologies, the use of wood enables costs to be cut across the board- through smaller required quantities, efficient production, efficient construction/deconstruction, ease of transport, and elimination of errors and inaccuracies; all of which will be discussed at a later stage.

The prefabrication and advanced timber engineering technologies mentioned above refer to solid wood construction technologies in the form of panels I have specified in the design solution. Solid wood panels are essentially "tilt up timber" or "pre-cast timber"¹⁸. Each panel is made up of several layers of timber, which are connected crosswise, making a panel that could be compared (structurally) to precast concrete. The panels can be made up to 20m x 4.8m, with thickness from 51 to 300mm. Essentially the size of panels is only limited by what can be safely transported.

¹⁸ "Wood Naturally Better", Wood Naturally Better, accessed June 2010, www.naturallybetter.com.au

Aside from the obvious environmental benefits of solid timber construction, there are a number of other advantages;

- **Efficient production**-As solid wood panels are prefabricated, they are produced with computerized accuracy under CNC router control in accordance with plans input into factory computer systems (tolerances are not more than +/- 1 mm)¹⁹. This CNC system also allows installation channels and services cutouts (plumbing/electrical) to be prefabricated to similar accuracies; therefore subcontractors are able to work extremely fast, as minimal on site work to structure is required, and assembly errors can be almost completely excluded. This efficient production of panels, in strict quality control environments, ensures costs are kept low through time saving in fabrication, contractor/sub-contractor labour and inaccuracy reduction.
- **Performance advantages**-Wood being wood, there are a number of performance advantages over competing, less environmentally friendly building materials; this is even more evident when concerning solid wood engineering. The wooden cores of solid wood panels are completely torsion resistant and have a high load-carrying capacity due to the crosswise construction of the timber components. This construction also enables the panels to become resistant to settling and shrinking. The superior physical characteristics of wood also offer increased temperature and sound insulating values as well as higher heat storage; for example, a brick-built building requires 43% more heating energy than

¹⁹ "Leno Panels- Engineered Wood", Finnforest, accessed August 2010, <http://www.ffebrochure.eu/UK/finnforest/Leno/>

the same building with the same insulation values built of solid wood.²⁰ As the design solution will be located on some waterfront sites within the sea-spray zone, the effect moisture will have on the building becomes a significant issue. Wood, unlike steel, (susceptible to rust in marine environments) is hygroscopic in nature and works to regulate internal moisture. In addition to this, due to the high degree of the drying within solid wood panels, the wood becomes resistant to attacks from moisture related problems such as fungus, as well as from similar attacks from insect pests. Panels treated with the appropriate level of preservative, properly clad and properly maintained, can “last in service for a hundred years or more”²¹.

- **Ease of transport-**Due to the simple prefabricated nature of solid wood panels, transportation, whether it be by land, sea or air is a simple and low cost affair. Panels can be transported ‘flat-pack’ and therefore via any number of means. The loading/unloading of panels (depending on size) is generally by means of Hiab crane, which attaches to panels via purpose ‘lifting eyes’.
- **Ease of construction/deconstruction-** Due to the ephemeral nature of the design solution, speedy construction/deconstruction is vital for both economic and functional success; the extremely precise prefabrication and simplicity of solid wood panels ensure there is no time consuming alignment, fitting or structural inaccuracies on the construction site. The speed at which solid wood panels can be erected was

²⁰“Reasons for Solid Wood Walls”, Massiv-Holz-Mauer, accessed August 2010, http://www.massivholzmauer.de/index.php?id=der_baustoff&L=1,

²¹“NZ Wood- For a better world”, NZ Wood, accessed June 2010, www.nzwood.co.nz

demonstrated in the world's tallest modern-timber residential building; *Murray Grove*²² by Waugh Thistleton Architects Ltd (Figure 12). The building stands at nine stories, the top eight being constructed entirely from solid wood panels; "Assembled using chordless drills, there were only 5 people on site, they worked only 3 days per week and each week another floor was added. The building was completed within 49 weeks."²³ As a testament to the popularity of timber construction, all 29 apartments were sold before construction had begun within 90 minutes.

4.4.1.2 Scaffolds

I believe the use of a system based on principles of steel scaffolding acting as the primary structure of the events pavilion is vital to achieve the adaptable, sustainable and ephemeral goals of this design proposal. Scaffolding, thought to have been in use since the 5th century BC in ancient Greece, is usually used as a temporary structure to support people and materials during the construction/repair of buildings. In my opinion, scaffolding can be so much more. What if a refined, more aesthetically pleasing form of scaffolding, instead of purely aiding in the construction process of the building, instead became a vital component of the building itself? The use of modular timber construction in combination with scaffolds would allow modules to simply be 'held in space' by the structural layout/composition of the scaffolding steel frame, thus allowing the timber modules to assume different layouts within the steel grid system. The speed of which scaffolding can be erected and modified perfectly suits a project of ephemerality and adaptability. In regards to environmental friendliness,



Figure 12- Murray Grove

²²"Murray Grove", Waugh Thistleton Architects, accessed November 2009, <http://www.waughthistleton.com/project.php?name=murray&img=9>

²³"NZ Wood- For a Better World", NZ Wood, accessed June 2010, www.nzwood.co.nz

through ease of modification and construction, the use of this material becomes relatively sustainable, as it can be reused countless times to adapt to both diverse sites and varying brief requirements.

In regards to transportation and loading/unloading, scaffolding again will prove valuable. The individual members of the scaffolding system can simply be stacked in assorted piles within shipping containers, or on the flat deck of the sea or land transport machinery. A team of technicians, or more appropriately the Hiab crane will unload the materials in a matter of minutes.

4.4.2 Sustainability and Resilience

4.4.2.1 Environmental Technologies

To guarantee that the events and performances hosted by the public events pavilion are run in a sustainable, energy efficient and economic manner, a series of environmental technologies, as well as planning procedures will be incorporated into the design and functioning of the proposed solution. The chief planning procedure relates to the issue of energy consumption and environmental responsibility, and is as follows;

The majority of the energy required to operate the public events pavilion will come via means of renewable energy resources, such as the sun and wind, through the application of the environmental technologies described below. Depending on brief requirements, the quantity of energy required, and therefore quantity of sustainable apparatus will vary from event to event. Should the situation arise due to unforeseen circumstances that demand for energy exceeds supply, a series of decisions must be made concerning a number of aspects relating to the overall functioning and success of the public

event. These aspects include such issues of; loss of economy due to closure, loss of public confidence due to cancellation/closure, environmental detriment through use of harmful machinery and incapability to protect public health and safety through power failure. In effort to guarantee these issues never eventuate, the following procedures, depending on each unique situation, will be undertaken;

- Cancellation of minor events in order to protect the proper functioning of the main/most popular events.
- Use of existing site infrastructure to provide vital 'on the grid' energy.
- Use of most environmentally friendly form of backup power generation (biofuel generator).

The environmental technologies specified to provide energy by means of renewable resources are as follows:

- **Wind turbines-** According to the Energy Efficiency and Conservation Authority (EECA), New Zealand has one of the best wind resources in the world giving us the opportunity to generate renewable electricity with no ongoing greenhouse gas emissions²⁴. Wind turbines (working in combination with solar power generation) appropriate for the adequate energy production required for the public events pavilion are on a relatively small scale and produce between 10 to 40 kilowatt-hours per day, in comparison the average New Zealand home requires around 25 kW/hours per

²⁴ "Energywise", Energy Efficiency and Conservation Authority, accessed August 2010, <http://www.energywise.govt.nz>

day²⁵. In an effort to produce sufficient energy for the events pavilion, multiple turbines such as the 'Whisper 200'²⁶ must be specified. The 'Whisper 200' wind turbine produces 200+kWh/month, and when paired with a small solar array should provide adequate energy production for the successful functioning of the public events venue.

- **Solar power-** The solar technology I have specified for the public events pavilion comes in the form of Building Integrated Photovoltaic Thermal (BIPVT). BIPVT panels refer to exciting new technology which merges PV and thermal systems, simultaneously providing both electric and thermal energy. Through this combination, the system also achieves significantly increased electrical performance in hot conditions, due to the thermal energy generation cooling the PV cells. In this way, more energy is generated per unit surface area when compared to separate photovoltaic panels and solar thermal collector's side-by-side.²⁷ Another bonus is that these photovoltaic systems are integrated with building roofs or facades. The beauty of such a technology allows for no limitation in design, as the panels can be transparent, coloured or even used as a projector screen; a valuable addition for the entertainment events hosted by this design solution.

²⁵“Genkit Absolute Power Generation”, Genkit, accessed August 2010, <http://www.genkit.biz/Products/Wind>

²⁶ibid

²⁷“Building Integrated Photovoltaic's”, Solenza Sustainable Energy, accessed August 2010, <http://www.solenza.co.nz/Solutions/bipvt.htm>

- **Solar hot water-** Hot water required for cooking/cleaning and ablution services will be heated through the use of solar water heating systems. Solar water heating uses the sun's rays to heat water which is then stored in an insulated water tank. Hot water systems will be installed on the roofs of service and ablution modules of the events pavilion. In the event of the sun being unable to heat the required amount of water, the system will be backed up and boosted by the energy created from the wind and solar panel installations.
- **Biofuel Generator-** In the rare event of power failure, emergency power in sites lacking infrastructure connections to the national power grid can be backed up through use of a biofuel generator. Biofuel generators operate on clean, renewable fuels such as vegetable oils, reducing dependence on traditional power sources that may contribute to pollution and the depletion of the earth's natural resources.²⁸

4.5 Design Development

4.5.1 Research for Design

The first stage of project development began with investigation into information relevant for the theoretical and architectural success of the design project. This information was based around 4 categories of equal importance, which included the following:

- Relevant architectural precedents
- Site location and analysis

²⁸“Biodiesel Generator”, Right House , accessed August 2010, <http://www.righthouse.co.nz/products/generation/biodiesel>

- Construction methods and materials
- Environmental technologies and sustainability

Relevant architectural precedents-

Architectural precedents for this design project, (the analysis of which can be viewed in the *Architectural Precedents* section of this explanatory document), ranged from mobile, barge based pavilions, to large scale stationary civic projects. The importance of such research became apparent when the tentative design brief was established, as analysis of the assorted precedents had revealed limitations and feasibility issues of my proposed design solution; issues primarily concerning scale and portability. As a result of research into relevant architectural precedents, the design brief began to evolve, forming a design project that would focus on beauty via means of pure simplicity, functionality and economy- rather than to set out to make an architectural statement through a design solution with minimal functionality and an overwhelming ‘wow factor’ similar to Zaha Hadid’s roving *Chanel Pavilion*, or the many modern designs by Frank Gehry.

Other relevant findings from research into architectural precedents related to the adaptable and flexible nature of cuboids. Precedents such as the *Taipei Performing Arts Centre* by OMA and the *New Museum of Modern Art* by SAANA demonstrate that simple but complex (“simplicity”) buildings are not only functionally flexible, but also aesthetically pleasing. It became apparent that the modular design approach would not only relate to the adaptable/flexible side of the design solution, but also relate to the ephemeral/portable aspects of the project; modules could house flexible functions, be easily and economically constructed through prefabrication, and also form adaptable compositions to enable

utilisation of diverse sites. Further discussion of modular design principles and their relevance to this design project can be viewed in the following three categories.

Site location and analysis-

The proposed design solution, with its unique ephemeral, portable characteristics, requires a number of sites in order to accomplish what is stated in the brief. For this reason, in-depth research had to be carried out into a number of sites around the wider Auckland area- each with their own unique environmental characteristics. Selection of sites was based upon a number of variables; ease of public access, building transportation, suitability for construction, environmental beauty and event exposure, (the analysis of variables for each site can be viewed in the *Site Analysis* section of this explanatory document). As sites were chosen, it became clear that the design solution would have to significantly adapt both aesthetically and functionally in order to perform successfully on sites with such varying degrees of infrastructure and environmental conditions; I am referring of course to the difference between sites such as Queens Wharf, in a busy urban setting, and Waiheke Island, a rural coastal site with a relaxed atmosphere.

Through site analysis, the issue of scale was again brought to light. Questions were raised as to how the design solution would successfully adapt in terms of function to sites of such varying size; for example the compact Te Wero Island site verses the large, open Queens Wharf site. A solution to this issue came through investigations relating to the portability aspect of the proposed design solution. In order to house different functions within simple forms, whilst remaining adaptable in terms of scale, functions would be housed in separate modules, which would then be arranged in varying compositions to respond to

contingencies of use, as well as exigencies of the specific site. This way, scale could be adapted to suit; modules could simply be added or removed in order to harmonise with differing site exigencies. Another issue raised through site analysis related to the environments of coastal based sites. The weathering impact of sand and/or sea-spray on various building elements would have a significant effect on the building materials chosen, and composition of the building modules. This issue would be investigated further in the *Construction methods and materials* section (see below) and also in the design based research undertaken at a later stage in the project development.

Construction methods and materials-

In order to perform successfully in terms of the portable, adaptable and sustainable aspects of the design brief, materials and construction methods had to be intensively researched and carefully selected to guarantee appropriate functionality on both inland and coastal sites. Firstly, research was undertaken into the sustainable aspects of various building materials, and their relationship with prefabrication technologies in regards to modular construction. Timber, both sustainable and easily prefabricated was the obvious choice (see section 4.4 of this explanatory document). The use of prefabricated timber elements would not only allow for simple and cost effective transportation, but also would ensure an efficient construction/deconstruction timeframe of timber modules and building composition; aspects of vital importance for an economical ephemeral design solution where time is money. The issue of the weathering impact of sand and/or sea-spray on various building elements (mentioned above) also had a significant impact on material selection. Through investigation, it was revealed that timber treated with the appropriate level of preservative, properly clad

and properly maintained, can “last in service for a hundred years or more”²⁹. Timber, unlike competing building products, would not be susceptible to rust or corrosion from the sometimes severe coastal environments.

In regards to the adaptable aspect of the design solution, my research into several architectural precedents had led me to question the role of scaffolding within building construction. Scaffolding, I had discovered, could not only aid in the construction of buildings, but also function as a primary structural building material. The use of modular timber construction in combination with scaffolds would allow modules to simply be ‘held in space’ by the structural layout/composition of the scaffolding steel frame, thus allowing the timber modules to assume different layouts within a steel grid system. The speed with which scaffolding can be erected and modified perfectly suits a project of ephemerality and adaptability. Through ease of modification and construction, the use of this material becomes fairly sustainable, as it can be reused countless times to adapt to both varying sites and briefs. In regards to transportation, scaffolding again will prove valuable. The individual members of the scaffolding system can simply be stacked in assorted piles, allowing for the efficient loading/unloading of the building material. However, the proposed use of scaffolding raised some significant issues as to the suitability of the material in this situation. Firstly, scaffolding, as a steel material would become susceptible to harmful weathering from coastal environments and secondly, the structural performance of the material in relation to various timber-to-steel connections, and diverse site environments and locations is questionable. Further research into the suitability of the use of scaffolds as a structural system will be undertaken at a later stage in the project development.

²⁹“NZ Wood- For a Better World”, NZ Wood, accessed June 2010, www.nzwood.co.nz

Environmental technologies and sustainability-

Aside from the proposed use of environmentally friendly timber and sustainable scaffolding systems, there were a number of sustainable building technologies that had to be intensively researched to determine appropriate use and specification in order for the design solution to perform at a high level of sustainability. Relevant environmental technologies discovered include the methods/products seen in section 4.4.2 of this explanatory document. Findings from this research provided valuable insight into the environmental technologies of modern architecture; from these findings I was able to select and prioritize certain technologies that would be able to function successfully on an ephemeral, adaptable building.

4.5.2 Research by Design

The first stage of research by design began with the nomination of module functions and appropriate corresponding dimensioning. Using 3D CAD modelling software, the Queens Wharf 'showpiece' site and surrounding CBD area was drawn and modelled to scale (Figure 13), allowing for accurate representation of the area. This way, when modules were placed on site, I had a fairly accurate depiction of how the modules would relate and/or harmonise with the surrounding environment in terms of scale and relationship to buildings in the site proximity. Within the 3D model, I then constructed a 5 x 5 meter grid across the entire site, enabling various compositional layouts of the modules to be trialled and then analysed according to the benefits and detriments of each composition. Benefits of various compositions included the creation of pleasant spaces, economical use of site contingencies and the harmonious relationship between cuboids in regards to both aesthetics and function. Detriments of other compositions included inappropriate juxtaposition of building modules

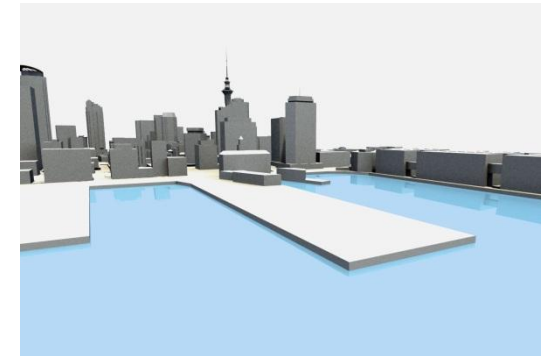
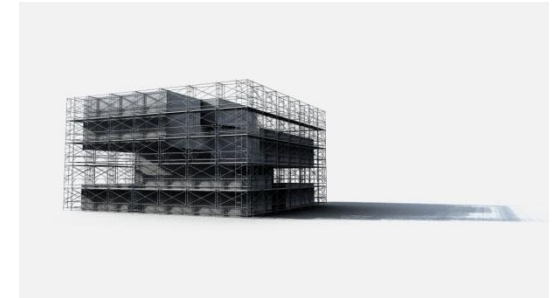


Figure 13- Waterfront Model

resulting in unpleasant external spaces and lack of functional layout in relation to possible pedestrian flow and surrounding site environments features and conditions.

After the creation of countless compositions, I began to realize the sheer scale of the proposed pavilion(s) was not feasible on a number of levels. Firstly, in relation to key aspects such as ephemerality, portability and economy, the number and size of the timber modules would result in a logistically challenging, lengthy and therefore costly construction and transport schedule. Secondly, in relation to differing site parameters, the sprawling type compositions of the first concepts would not be suitable for sites of smaller size. After these revelations, I began to approach the design from a different angle; I scrapped the idea of a sprawling type composition and instead began to design by 'thinking within the box'.

Thinking within the box involved designing by means of a strict rule based upon a governing exoskeleton type scaffolding frame in which the timber modules occupied various levels in various positions. The timber modules, confined to a 21 x 21 x 13 metre framed cuboid(Figure 14) could be readily adapted and arranged within the scaffolding framework to suit differing site parameters and brief requirements. The introduction of the scaffolding skeleton to confine the modules to a set overall ground coverage dimension would mean that the issue of sprawl on sites of varying sizes would be somewhat reduced. Also, by stacking and fitting the modules within a tight-knit group, other benefits are revealed. For example, providing essential services to modules becomes a safer and more cost-effective procedure, as services could be subtly confined to one area and would not have to sprawl across the site. Other benefits relate to the comfort of guests within the building; modules arranged in a tighter configuration means travelling from module to module would be more comfortable for guests- they could be undercover, and distances would be far less



Figures 14- Cuboid Concepts

than a single level, sprawling design. In terms of entertainment, a tighter configuration would provide a more 'party' atmosphere, and increase mingling within the crowds.

Several compositions in this format were trailed and again analysed according to the success and failures of the designs in relation to ephemerality, portability and adaptability factors. Once again, the issue of scale was brought to light. While the issue still related to feasibility issues regarding time and money, the main issue in this case related more to the brief itself. The general consensus was that the number of modules, and the size of the largest module was too great for a “small to medium scale public events venue” as was stated in the brief. The pavilion as it stood was trying to accomplish too many goals and incorporate too many functions, each of which had its own module. After further examination, the 900m² total floor area of the 8 modules did appear to be rather excessive, and it was discovered that one module could adapt and host many functions within itself; resulting in a more 'slimmed down' version of the overall pavilion.

After further research into the interior adaptability of singular modules, I began to design and model possible solutions based upon the “less is more” theories of Mies van der Rohe. I proposed a singular 13 x 13 x 9 meter module (Figure 15) in which the other smaller modules would appear to be housed, this way the four modules together would appear as one. The benefits of such a design would relate to the construction and portability aspects of the brief, as the size and therefore time and costs of erection would be less. Also, the method of construction would become much more streamlined due to the timber on timber solid connections; modules would butt up to and/or sit on other modules, rather than be held in space by scaffolding alone as was seen in the previous design attempts. In regards to the diverse sites that the pavilion proposes to occupy, the relatively small

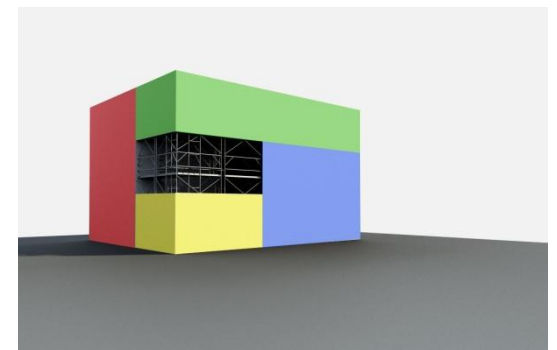
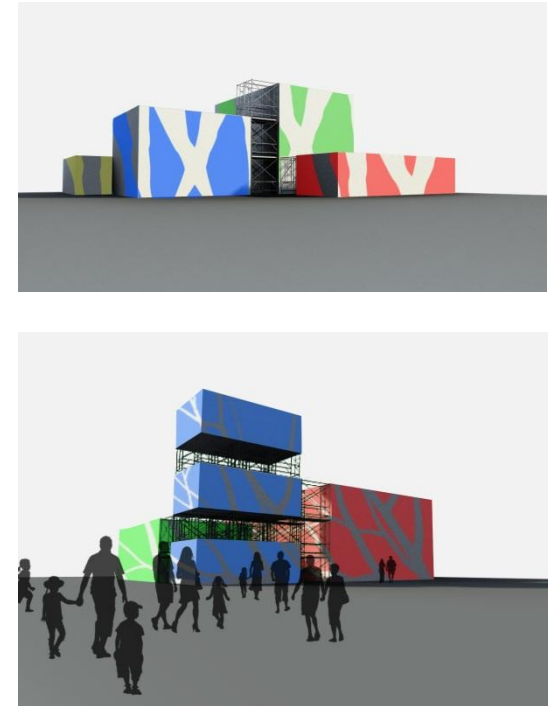


Figure 15- Cuboid Concept

169m² building footprint would suit even the smallest of sites, whilst still providing the functioning and services required through use of the 4 modules which include a 8 x 13 x 9m theatre/film screening module, a 5 x 13 x 3m exhibition module, a 5 x 8 x 6m cafe and a 5 x 8 x 3m restroom module.

On the surface, this design proposition seems relatively successful, and one that could be developed further into an interesting and valuable design solution. However, as I began to investigate further, the lack of adaptability options (key to the project's success) within the proposed design meant I was uncertain as to whether the singular cuboid form was appropriate for an adaptable public events centre. The inability of the singular cuboid to transform and adapt to varying surroundings and therefore varying brief requirements, whilst providing no adequate outdoor spaces lead me to discontinue the idea and return to the drawing board.

It was at this stage I discovered the value of the principles of the golden ratio and their relevance to a project of this nature. Continuing along with the belief that a 'slimmed down', multiple modular version of the pavilion (Figure 16) made better sense than the proposals aforementioned, I began to link the rectangular cuboid nature of the modules with the renewal of the perfect proportion theories of the modernists such as Mies van der Rohe and Le Corbusier. The result of this research was a proposition to create permanent harmony between building modules by basing all modular dimensions on the figures of the golden ration, for example; 1, 2, 3, 5, 8, 13, 21, 34 and so on. The outcome of this system of dimensioning would mean that whatever composition modules were arranged in, and however many of modules were involved; the outcome would always be appear to be proportionately beautiful.

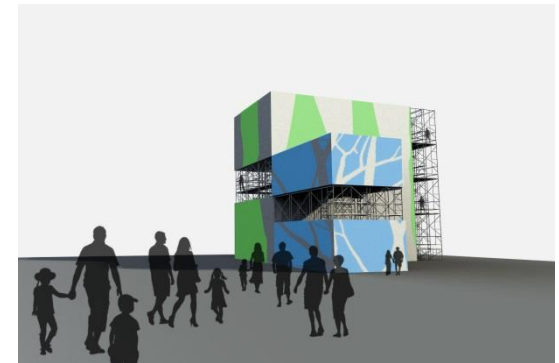


Figures 16- Golden Ratio Pavilions

Using the figures of the golden ratio, I then proposed to use 5 modules to make up the pavilion (Figure 17); the sizes of which include two 13 x 8 x 5m modules and three 8 x 5 x 3m modules. As separate modules of small/medium size, they can be tightly arranged to suit diverse sites, and can create a multi level pavilion up to a height of 13 metres; the benefits mimic the compact design proposals previously mentioned. In regards to the brief, I proposed the two largest modules host a theatre and exhibition space, while the smaller modules act as a cafe, restroom and staff/storage space. Raised spaces formed by module stacking I proposed to act as viewing platforms and areas for live performances.

Following the final interim critique and resulting number of discussions, it was decided that the proposed strict use of golden ratio proportions to determine all module sizes was too limiting in terms of both physical adaptation of building form and ability to house differing functions. In order to satisfy the brief, a method of greater adaptability and flexibility had to be designed. It was at this stage I began to focus on the design of a smaller 'one size fits all' panelised building system.

The panelised building system would not only guarantee a far greater ease and availability for adaptation, but would also mean prefabrication and transportation processes become simpler, more cost effective and more environmentally friendly through the reduction of waste materials. All wall panels that make up the events pavilion would be specified as one standard size; therefore guaranteeing efficiency and cost effectiveness throughout the entire process from prefabrication, transportation, construction and deconstruction. As well as being efficient and economical, the proposed standard panel size means the flexible nature of events briefs is no longer an issue, as internal and external forms can be adapted to suit any number of varying brief requirements. The standardised panel



Figures 17- Golden Ratio Pavilions

system seemed the most successful solution thus far, enabling me commence further in-depth investigation and therefore commencing the final stage of the design development; the refinement of the final design solution.

4.5.3 Design Solution

The majority of research into the design solution relates to technical aspects and refinement of the design, as the building system itself is by far the most important element, both in terms of structure and aesthetics.

The first in-depth technical research related to the design and construction method of the foundations and the structural solid timber wall panels (a general description of which can be found in section 4.4.1.1 of this explanatory document). Due to the ephemeral nature of the design solution, foundations for the events pavilion(s) must be an economic and efficient solution, but also result in minimal environmental site disturbance when removed. To ensure this occurs, I have specified the use of a screw pile foundation system, similar to those used on the temporary installations of the America's Cup Village in Auckland City, and also on the Cirque Du Soleil's Grand Chateau³⁰ which tours the world as a famous entertainment venue.

The structural solid timber wall panels, as proposed for this design project are to be sized 2.7m x 2m x 150mm. The 2.7m length provides an appropriate and conventional single level stud height whilst the 2m width is specified to enable greater ease of construction for labourers and a Hiab crane to safely handle single panels. I saw no reason to specify the use of the standardized plywood panel dimensions of 1.2m x 2.4m due to the fact that all

³⁰“Featured Project Testimonials”, Instant Screw Piling, accessed September 2010, <http://www.piling.com.au/testimonials/>

panels will be prefabricated off site to a single set of predetermined dimensions. The 150mm width of the wall panel is to ensure structural stability whilst incorporating an internal layer of thermal insulation. Connections between panels are designed to enable efficient and effective assembly and disassembly on site. Each panel will incorporate a 30mm x 75mm internal groove on all four sides, designed to fit a separate timber element, the 'key'. The 'key', a 150mm x 30mm x 2.7m LVL member, is simply inserted into the groove where the connection is required. The panels are then bolted through the 'key' member forming a solid timber connection (Figure 18).

The second phase of technical research related to the floor, ceiling and roof components. In effort to again standardise and simplify, all three components are essentially incorporated into one structural element; a prefabricated sandwich panel. The sandwich panel consists of 8 (4 boundary and 4 internal) structurally engineered laminated veneer lumber (LVL) beams sandwiched between two 30mm cross-bonded structural plywood panels (similar to the panel members that make up the 150mm wall panel). In order to mimic wall panel widths and simplify construction, all sandwich panels have a width of 2.15m; this is to allow for the thickness of the wall panel upon perpendicular placement. The overall thickness of the sandwich panel is sized according to the required span of the complete element. Based on an engineer's analysis, a ground floor element will require a total thickness of 230mm. A suspended flooring element spanning 4m will also have a thickness of 230mm, however as the span increases, so does the overall depth of the prefabricated element, for example at a maximum clear span of 9 metres, the overall depth of the element is 550mm. Roof elements are similar in nature however due to minimal live load, are able to span greater distances at the same depth as a flooring element. For example at a clear span

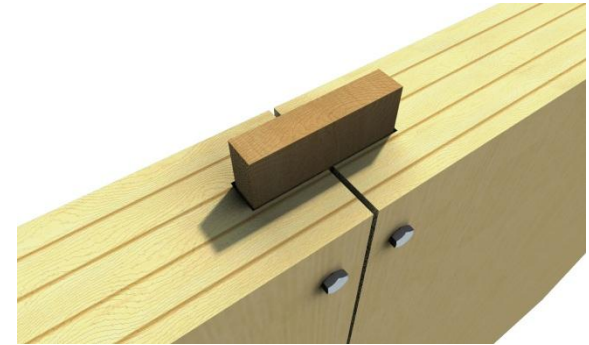


Figure 18- Panel to Panel Connection

of 8 meters, the overall depth is 230mm, whilst at a maximum clear span of 18 metres, the overall depth is still only 650mm. Cantilevered sections of the pavilion will require a sandwich panel with greater depth (depth is dependent on length of cantilever).

The beauty of such a simple, strong element is seen through its ability to span large distances without the need for support in the form of internal walls or columns. This enables large, unobstructed flexible spaces to be created; spaces of which are perfect for the ever-changing internal and external nature of this public events pavilion.

Connections to wall panels are based on the same principles as connections between wall panels. In each sandwich panel, whether it be a ground floor or suspended floor, 75mm x 30mm grooves are incorporated into the boundary beams in which LVL 'keys' are inserted. These 'keys' correspond with the grooves on the base of the wall panels and are simply inserted and then bolted in place (Figure 19).

Ceiling connections at intermediate floors (Figure 20) and at roof level involve steel angle brackets which are bolted to wall panels and beams within sandwich panels. Angle brackets will be sized to engineer's specifications.

Bracing for multi-level variations of the events pavilion is achieved through the structural integrity of the cross-bonded solid wood panels, however to ensure appropriate bracing is guaranteed, adjustable diagonal steel tension cables will anchor into floor/roof elements thus strengthening floor to floor level ties. In regards to waterproofing on the flat roof and outdoor decking levels, I have specified the use of Butynol. This product is impermeable to water and appropriate drainage even on flat surfaces has been proven and will be successfully achieved.



Figure 19- Floor Element to Wall Panel Connection



Figure 20- Intermediate Floor Connection

After questioning the placement of services and amenities in relation to the events and entertainment focused sections of the venue throughout the design process, I finally discovered an appropriate solution. As all public events require restrooms and associated facilities, I propose to incorporate all services and amenities into distinct modules. The modules, constructed using the same method as the venue itself will be prefabricated as a complete unit off-site, rather than requiring assembly on-site. The beauty of this proposition enables all services work relating to plumbing to be completed under strict quality control within a factory environment. As all events will require the use of these modules, time and money is saved throughout the transportation, assembly and disassembly processes, as no subcontractors will be required for the continuing re-installation and removal of these vital services.

Plant mechanics will be housed in a separate module. The mechanics include ventilation systems for heating/cooling, power generation in the form of a bio-fuel backup generator and small wind turbines. In relation to sustainability, the aim was to provide all forms of energy for the public events pavilion in a purely self-sufficient manner. However, due to site and timing constraints I began to realize that for the larger pavilions, this was not feasible in terms of both economy and functionality, as the pavilion designs would require large amounts environmental technologies, of which are both expensive and time consuming to install. The ephemeral nature, and proposed site occupancy's of the events pavilion also suggested reliance on 'grid' power. Having said that, I propose the pavilions to act as semi-self sufficient buildings through the installation of wind turbines, BIPVT panels and bio-fuel backup generators. The smaller pavilions on the other hand, such as market venues, require

minimal energy in order to function. These venues I propose to be largely self-sufficient, relying on the aforementioned technologies to produce energy.

The installation and placement of services, (such as lighting and ventilation) within the events function areas themselves relate to and work alongside the prefabricated wall and sandwich panel elements. Services are run horizontally and vertically within the prefabricated grooves in wall panels, whilst the sandwich panel design of the flooring and roofing system enables installation of services between internal beams.

As the chosen use of prefabricated structural timber elements largely governed the visual aesthetic of the events pavilion(s), I began to concentrate on the composition and layout of events venues which each served a particular purpose. After discussion with mentors, it was decided that I would produce 20 venue designs, each of which had a specific event function, or a number of functions. Six of the 20 venue designs (see Appendix A) would then be further developed into finalized design solutions, complete with floor plans, sections, 3D models and architectural construction detailing. The functions and site locations of the chosen 6 venue designs are as follows:

- Queens Wharf- Summer party central featuring live music, markets and hospitality.
- Queens Wharf- Films on the Waterfront.
- Te Wero Island- Conference / Lecture venue in support of the Auckland Boat Show.
- Auckland Domain (Museum)- BMW Art Cars exhibition support.
- Victoria Park- Open-air music festival.
- Mission Bay- Seaside market and live music.

As the all of the above events will be hosted by the city of Auckland during the summer months, all pavilions will have a large emphasis on open-air environments and indoor-outdoor flow. In order to create these environments with solid timber prefabricated construction I had to design a system of doors and windows that would mimic the structural and connection design of the solid wall panels(Figure 21).

In essence, the doors and windows (which are vertical bi-folds so as to increase horizontal movement space for foot traffic) are inserted into a 150mm frame of an original wall panel. This enables door and window panels to be placed on any facade, and at any level on an events pavilion, thus enabling total flexibility in placement in order to harmonise and functionally relate with surrounding site environments and parameters. The door panels will be a cross-bonded timber, as the panels will remain open during hours of operation dependant on weather conditions. Windows on the other hand will require a transparent panel; a strengthened scratch resistant Perspex panel or a toughened glasspanel will be substituted. Standard window/door glass in this instance is not appropriate due to the ephemeral, portable nature of the events pavilions.

In regards to vertical access to upper floor levels, I propose the use of another prefabricated element; the steel stair. Working alongside the proposed use of various scaffolding elements and techniques to provide vertical shaft structure, the stairs are bolted to flooring elements as complete units just as they have arrived on site. The stairs, in various U-shaped sizes either sit on their own, or wrap around the vertical shaft structure of the temporary elevator. The temporary elevator³¹, designed for disabled use, is a small 3 person

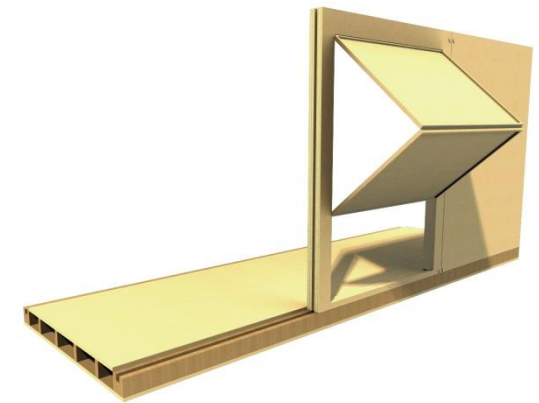


Figure 21- Door Panel

³¹ "Temporary Elevators", Metro Elevator, accessed August 2010, <http://www.metroelevator.com/champion-elevator-US900.htm>

prefabricated service liftcapable of being assembled in a short period of time. The structure of the elevator ties in with the structure of the building, whilst the foundation, a prefabricated steel element requires no poured concrete.

As I began to explore possible compositions for the various events venues, I also began to investigate the purely aesthetic internal and external features of the pavilion. Whilst the prefabricated elements dictate materials and form, other aesthetic additions such as colour, advertising banners, media screens and lighting will be implemented to provide a visual excitement boost to the simple, rigid forms of the pavilions. Colourisation and detailing will relate to each specific pavilion and the event of which is being hosted. This is also the case for advertisement banners, which will be hung on both the timber panels, and the exterior scaffolding structure. The environmental technologies in use such as turbines and BIPVT panels will also be visible, demonstrating the use and importance of such mechanics.

Internal spaces of the pavilions, due to construction methods and in relation to the simplified external scaffolding forms, will have a sophisticated, minimalist 'industrial' feel, with exposed timber surfaces and steel bracket elements visible to occupants; a reminder to the public perhaps that they are enjoying the surroundings and environment of a unique form of sustainable mobile architecture.

5.0 Conclusion- Critical Appraisal of Finished Work and its Theoretical Framework

In essence, I believe the final design solution is a successful and fitting response to the stated research problem and demonstrates that prefabrication as a construction philosophy, can deliver an excitingly original architectural design solution which successfully incorporates the set objectives of portability, adaptability and sustainability.

The chosen methodological approach of the project served as an ideal format for execution of the project. This approach was especially important when investigating the materials and technologies associated with prefabricated construction, since prefabrication was the general strategy in use. The design outcome demonstrates that not only is the system of construction feasible, but it also successfully incorporates the essential characteristics of the triple agenda of portability, adaptability and sustainability.

Aside from the functional benefits of the panelised building system, this design solution also satisfies the functional brief by displaying supreme functionality in terms of serving the primary function of providing venues for a diverse range of events. This is evident in the design of the 20 various events pavilions³², each of which serves a specific purpose on a specific site.

In order to produce buildings with supreme functionality as well as visually pleasant aesthetics, function and site parameters were balanced with the desire to produce architectural forms which pushed the boundaries of prefabricated construction within the public realm. The resulting pavilions I believe evidently succeed in doing so, and therefore

³² see examples in Appendix B

due to characteristics of ephemerality, successfully question the role permanence plays in defining a public building.

Aesthetically, the pragmatic imperatives of the prefabrication approach essentially dictated the simple cuboid shaped forms. This then naturally led to define both the external and internal visual appearance of the pavilions, of which are characterised by right angles, straight lines and level planes. The utmost beauty of this design solution is however seen in the diversity and variety the system offers as it inhabits a new site in a fresh state. Therefore, this design solution offers no perfect state of aesthetic beauty, and instead however guarantees an aesthetic beauty in a state of constant change.

A particularly important aspect of this aesthetic philosophy is the issue of simplicity. Simplicity, aside from its obvious functional and practical benefits, is a well recognised and widely accepted attribute of modern architecture. However, for overall building success, the simplicity of the design must be equally paired with its opposite; complexity. Therefore, the resulting design solution is a fusion of the both aesthetic simplicity and functional complexity. Probably the best way to describe this approach is by relating it to the emerging theory of “Simplexity”³³. Evidence of this emerging theory’s relevance to contemporary architectural practice can be seen in the work of SANAA (Sejima and Nishizawa and Associates), 2010 winners of the Pritzker prize.

This relates to one of the very early ideas of modernism, the idea of economy of means, honesty of expression and elimination of ornament. This of course is well known as Mies van der Rohe’s ‘less is more’ theory; a simple minimalist architectural design aesthetic. This paradox has been proven by this project to work, as the designed building

³³Jeffrey Kluger, *Why Simple Things Become Complex (and How Complex Things Can Be Made Simple)*, New York: Hyperion, 2008.

system has been able to accommodate a great variety of clients and sites through the production of specialised pavilions in each unique case.

The final aim for the project was to demonstrate the possibilities of prefabricated timber architecture outside of the residential architectural sector, and prove the construction method fit/adequate for the purpose of public buildings and events. The unique and exciting adaptable qualities of the public events pavilion successfully demonstrates the capacity for prefabricated timber architecture in the public domain. Arguably this construction method is superior to the status quo of today's public building industry, as it is not only able to satisfy the constantly changing brief requirements in the civic/cultural domain, but also adapt to and occupy sites of which are each uniquely constraining and environmentally diverse.

6.0 Annotated Bibliography

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Arcspace is an architecture and design magazine which features today's most creative projects as well as the most influential of the past. Arcspace works with the most influential architects around the world and provides weekly updates for readers. The Editor-in-Chief and founder of Arcspace Kirsten Kiser, is an architect and independent curator. Arcspace regularly sponsors major architecture exhibitions around Europe.

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Prefab presents a series of inventive homes and concepts that boldly demonstrate the possibilities of prefabricated construction. *Prefab* offers a glimpse into the history of prefabricated housing over the last century, and reveals a wealth of practical and attractive alternatives to the status quo. Prefab presents a series of innovative homes and space-saving concepts that show how far this building technique has come-and its possibilities for the future. Allison Arieff is a writer, senior editor of the architecture magazine Dwell. Bryan Burkhardt is the designer and co-author of *Airstream: The History of the Land Yacht and Trailer Travel: A Visual History of Mobile America*.

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Interactive Architecture explores a new architectural world where design pioneers are busy creating environments that not only facilitate interaction between people, but also actively participate in their own right. These spaces are able to reconfigure themselves in response to human stimuli in effort to change our worlds by addressing our ever-evolving individual, social, and environmental needs.

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Micro Architecture is written by architect and professor of architecture Richard Horden, a former partner of Norman Foster. Horden is the pioneer of small-scale structures constructed with some of the most advanced materials and techniques available. The book contains forty projects that draw on technologies from the nautical and aviation industries, as well as natural forms, to make small, mobile buildings that are not only highly functional but kind to the environment.

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Prefab Green is written by architect Michelle Kaufmann. Her firm, Michelle Kaufmann Designs (mkDesigns), blends sustainable home layouts, eco-friendly materials, and low-energy options to create a 'prepackaged' green solution to home design. In *Prefab Green*, Kaufmann shares her vision of creating thoughtful, sustainable design for everyone and

describes five eco-principles that are present in every design her firm creates: smart design, eco-materials, energy efficiency, water conservation, and healthy environment - and how each work together to create buildings that make an environmental difference.

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In this publication Jeffery Kluger attempts to describe the possible complementary relationship between complexity and simplicity; the theory of Simplexity. Kluger draws on cutting-edge theories to describe the basic workings of everyday objects and principles in accessible language, covering a wide variety of topics from design and viruses to economics and parenting.

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This book explores the whole genre of flexible architecture buildings that are intended to respond to evolving situations in their form, operation, or location. This publication crosses the boundaries between architecture, interior design, product design, and furniture design in effort to deal with the entire scope of the topic. The author Robert Kronenburg is an architect and professor at the University of Liverpool and is considered to be a worldwide expert on portable architecture.

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This publication by *In Detail* demonstrates the breadth and complexity of the issues involved in building simply, from functional and economic demands, through ecological and energy-related aspects, to design and construction requirements. The project section documents a comprehensive range of international examples, from simple wooden bridges, to pavilions, residential buildings, workshops, and warehouses. *Building Simply* provides valuable construction detailing information.

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This publication covers trade fair stands to museum concepts, describing that the successful transfer of information to a wide public audience relies on effective staging and appropriate architectural design. *Exhibitions and Displays* is a valuable practical guide to architectural detailing within the field of exhibition and display architecture.

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Wood Naturally Better is aimed to help everyone understand the natural advantages of wood and its positive contribution to reducing the effects of climate change. *Wood Naturally Better* is resourced by Forest and Wood Products Australia Ltd. The website contains information relating to designing, working and living with timber building products.

7.0 Appendices

7.1 Appendix A- Developed Venue Designs(Pg. 69 - 74)

7.2 Appendix B- Conceptual Examples Displaying Possible Variations(Pg. 75)



a summertimes market, featuring live music and a lookout tower, mission bay, auckland

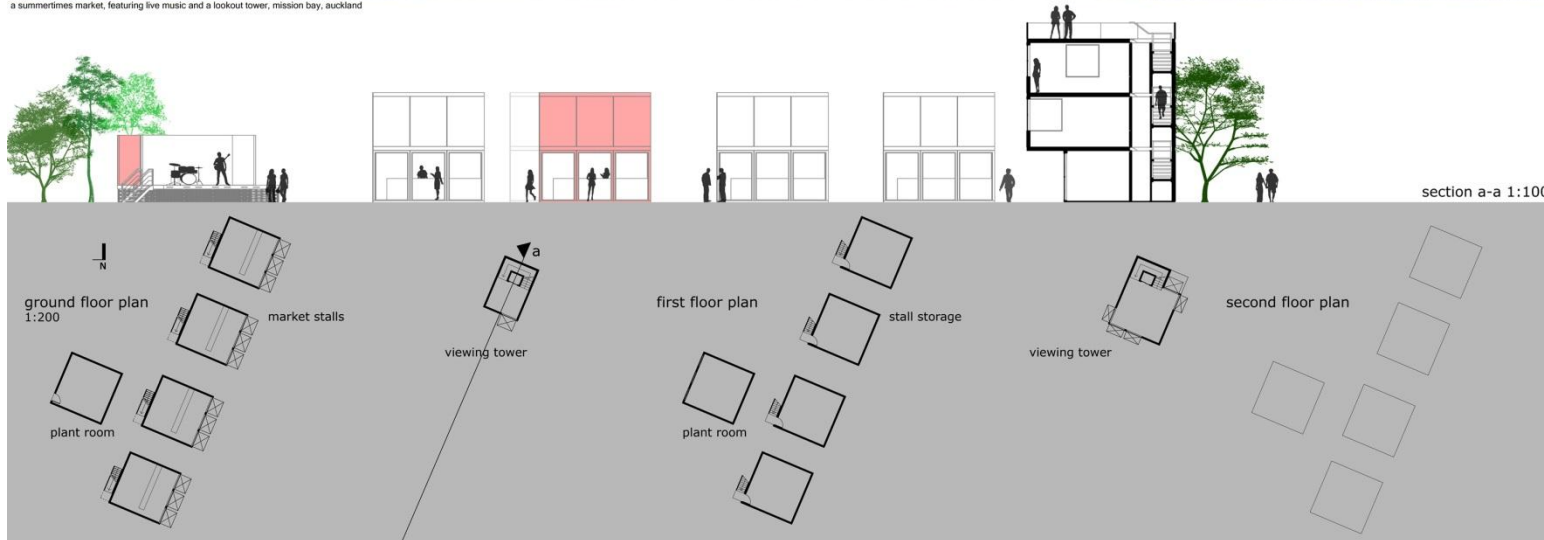
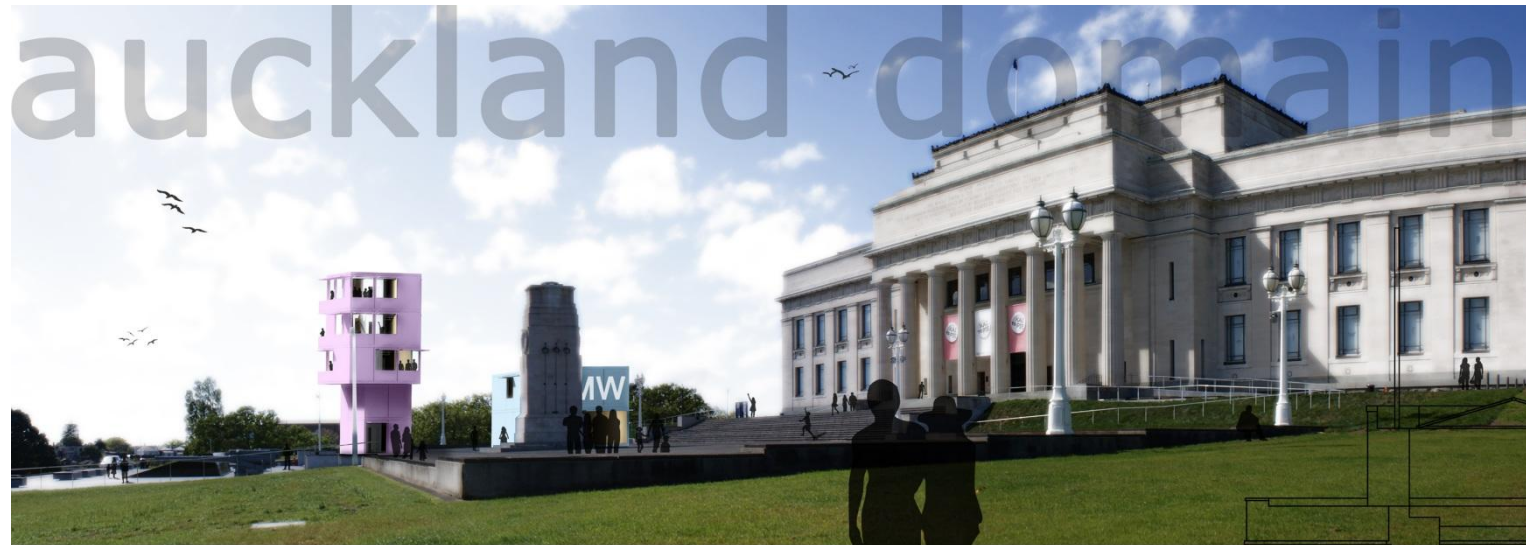


Figure 22 –Developed Design for Mission Bay



bmw art cars exhibition support pavilions featuring raised viewing areas and a lookout tower, auckland museum, auckland domain, auckland

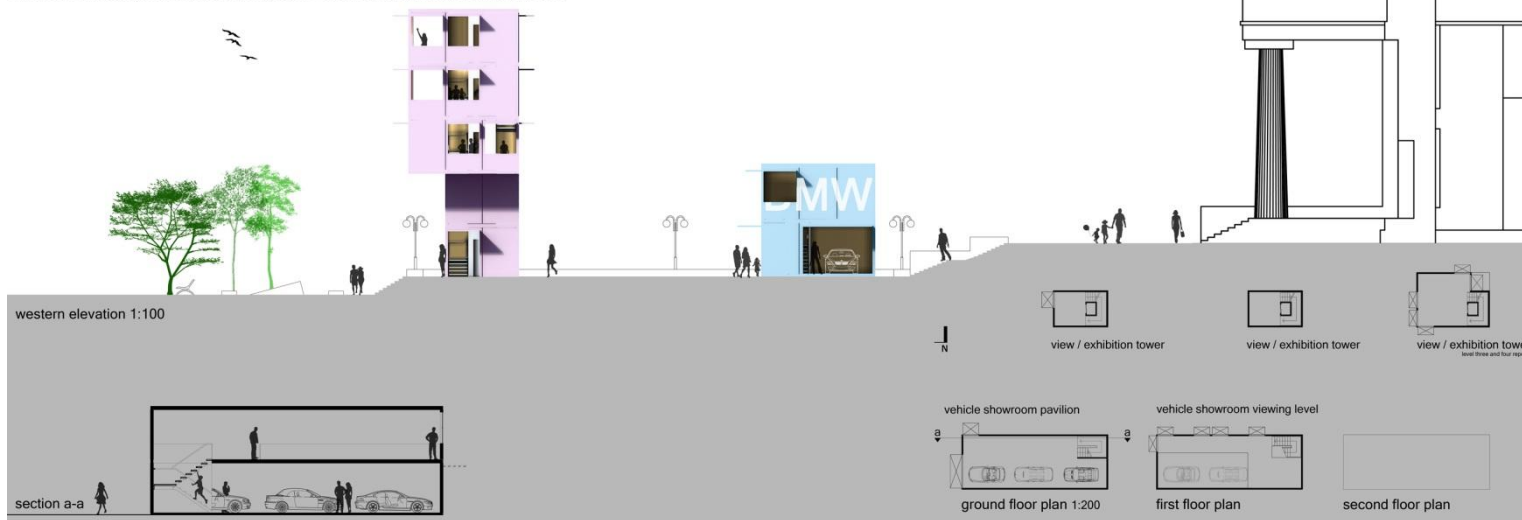


Figure 23 –Developed Design for Auckland Domain



a conference centre and cafe for the auckland international boat show, te wero island, viaduct harbour, auckland

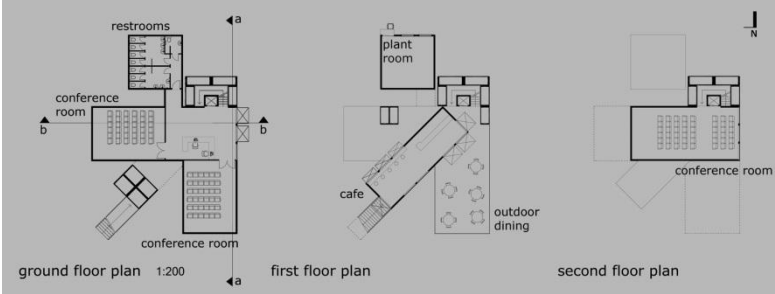
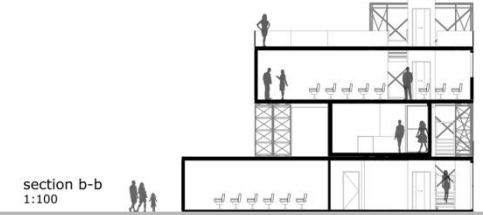
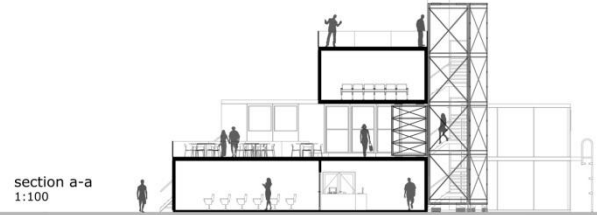
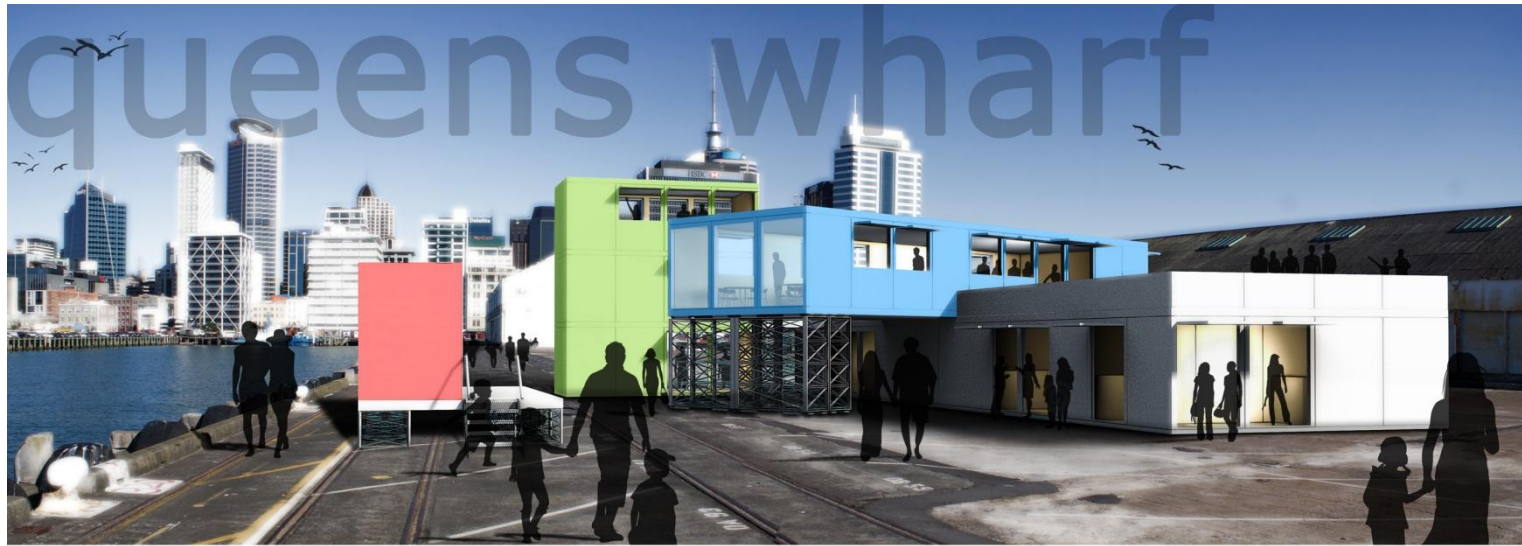


Figure 24 –Developed Design for Te Wero Island



a summertimes festival featuring live music, market stalls, a cafe and a lookout tower, queens wharf, auckland

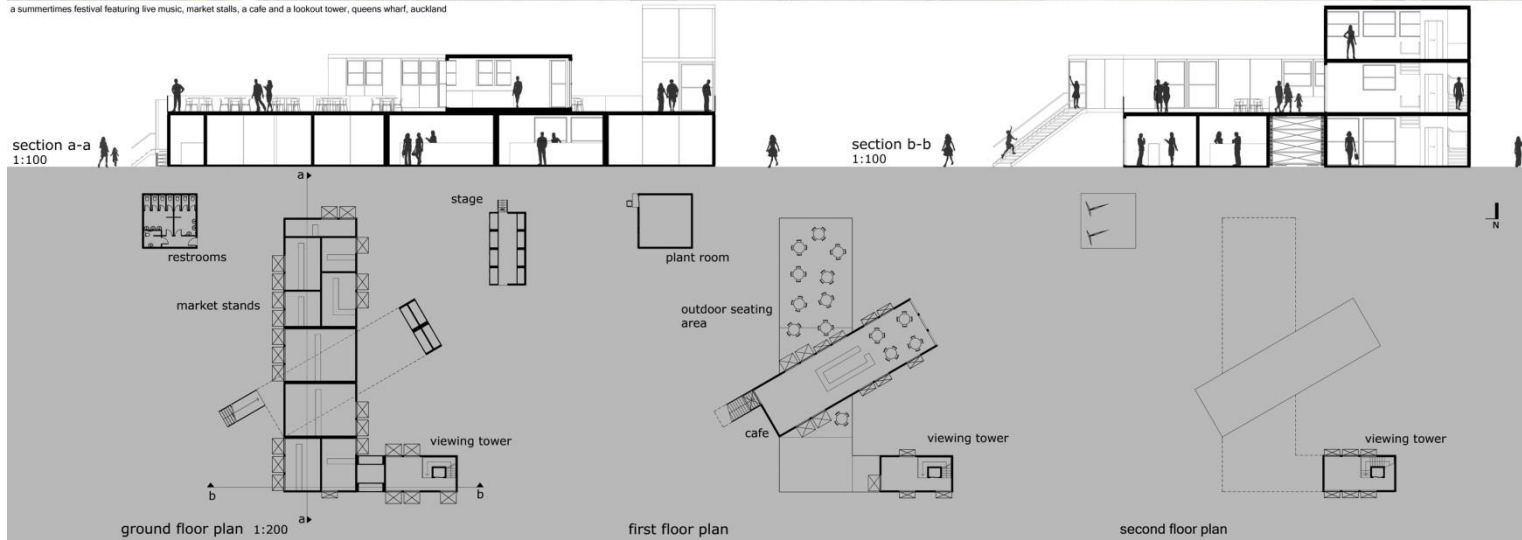


Figure 25 –Developed Design for Queens Wharf



a cinema, cafe and lookout tower, queens wharf, auckland

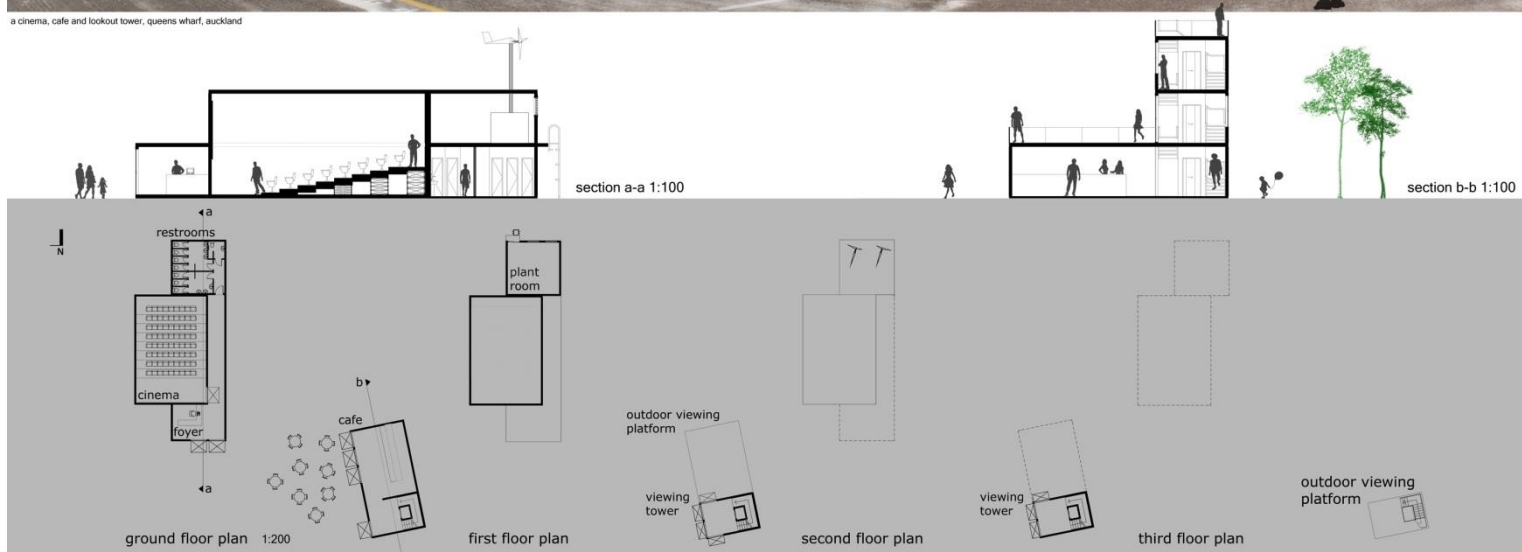


Figure 26 – Developed Design for Queens Wharf



an open air music festival in victoria park, auckland



Figure 27 – Developed Design for Victoria Park



Figure 28 – Possible Conceptual Variations