Design for smart transport: An integrated multi-modal transport interchange in central Christchurch

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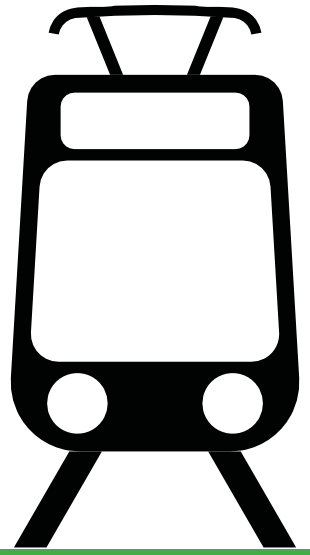
In memory of my dad

Abstract

Transportation, an essential component of modern life, is responsible for one of the biggest growth areas of our greenhouse gas emissions which causes problem for our environment and the economy. New Zealand cities face the same issues as many other cities in the globalised world. This thesis analyses the integration of all the public transport systems to encourage people to get out of the car and reduce the traffic volume within the city centre to develop with the aim of developing a sustainable city towards the future. Drivers in New Zealand believe commuter stress could be significantly reduced by improving public transport. The design calls for a new central transport interchange for all the public transport systems within Christchurch city to form a spectacular gateway to the city. The aim of the design is to create a unified urban structure in which diverse infrastructural and public elements merge together to form one building.

The outcome of this research identifies a strong future for a public transport interchange, but states that its physical and organisational form needs to be re-established. It finds that technology and architecture offer new opportunities useful for reinterpreting the typology. The thesis concludes that future public transport interchanges will become hybrids of activity, and places where the threads of urban life are joined together. The interchanges can become a major catalyst of urban regeneration- a focus for commerce and the flow of ideas as well as the movement of people.

Contents



Chapter 1
Introduction

1.1 Introduction to research

The invention of mechanical forms of transport at the dawn of the twentieth century established civilizations that shaped the modern city of today. Over the decades, the increased density of networks in modern-day towns are therefore the result of sweeping movement, which depicts how people move about the cities in many ways. People walk or ride bicycles; others catch public transportation- buses, trams or trains. Many people rely on carbon-based fuels to power the technology that moves them: they depend on their private cars for convenient choice. This thesis looks at the impact of this transport activity on one of New Zealand cities, using Christchurch as an example.

Due to the recent growth in bus patronage and the extensive damage to the current Bus Exchange following the February 22nd earthquake, Christchurch is in need of a new transport interchange. It is envisioned that the new Transport Interchange- a place where people transfer between modes of transport or between two services will be built on a single site that can act as an effective central bus interchange and other services, as well as easy access to central city businesses. Such a proposal will make public transport more easily accessible for the city dwellers, improves quality of life and protect the environment.

For this thesis, I will introduce a new mode of public transportation infrastructure in Christchurch city to showcase in the forefront of technological movement for a more sustainable city. I will conduct my study based in Christchurch's transportation moving networks. Such studies will include trains, buses, vehicles and pedestrians and observe the patterns to find the most "centralised" location for the main hub. It will not only be a place to commute, but also as a place to meet, a place to hang out and a place to experience space. The project will hope to generate interest from the government sector to fight global warming and climate change.

Christchurch needs to rebuild its infrastructure after the devastating earthquake that occurred on February 22nd 2011. Planning ahead to revitalize existing transport systems and introducing new modes is a step towards the "global leadership" in climate change, the environment, community engagement and clean technology that Christchurch city has to offer.

1.2 Associating transport and the city

Over the years, cities have been shaped by the way people arrive in and move around them. They have co-evolved with changing transport technologies. Different types of transport- walking paths, roads, tramlines, railways and airports- have moulded our cities in distinctive ways. While the station itself plays a major role, it cannot be taken account by a sole operator. A station is, because of its dual nature, a place that belongs to the city and to travel, bringing together different modes of transport that serves the city dwellers of today.

The nature of public transport makes it necessary for people to change transport modes throughout the journey. To aid the needs of passengers, one must provide efficient and easy to use public transport system to allow easy transfer between modes. One way to achieve this is a need for a central interchange point in the city. This makes it much easier to get around city by public transport as transfers should be more seamless, and it should also improve transit times. The challenge is to transform these places of travel that are stations, into places that not only “functional”, but which are also authentic public spaces. The creation of these new spaces, while also serve the public as a hub of exchanges, should portrayed an image of the city it serves, an expression of its identity, that there be greater fluidity between the city’s public spaces and modes of transport.

1.3 Aesthetics of Technology

Throughout architectural history, architects keep challenging the very question of what defines beauty in terms of architecture, and its relationship with form and aesthetics. Architectural aesthetic values can relate to classical lines, proportions, dynamic shapes, elegance, or natural beauty as learned from nature, underlying concepts may also include imaginable form, a sense of place, and interpretation of available technology. The latter implies the aesthetic effects that can be achieved are dependent on the technology that is available and that can be adapted to architectural design. This characteristic of new architecture often demonstrate the influence of technical progress but sometimes, partly or fully, cannot be derived from technology and are consequences of purely architectural considerations.

The modernists and post-modernists ideas of architecture were not personal philosophical or aesthetic pursuits by individualists; rather it had to consider everyday needs of people and using technology to give a liveable environment. Thus, the question is not if aesthetic values do or should play a role in architectural technology. Instead, the question to be dealt with in this proposal is how aesthetic values inform technology and how they compete or harmonize with other values that can be adapted to architectural design. Therefore traditional 'station' spaces may no longer be appropriate, as travel extends beyond the program's apparent complexity.

The modern interchange is a hybrid that accommodates new transportation technologies and seeks to provide a simple solution for a space that is understandable and pleasant to frequent. The ability to handle large numbers of transferring passengers, to process complex movement patterns while also producing buildings of quality, comfort and architectural distinction, is the challenge ahead.

1.4 Problem statement

1.4.1 Travel trends in New Zealand

Mobility is an important part of everyday life. The complex and growing networks make up modern cities contributes to leisure activities on one side, work on the other and habitat on a third side. Many people travel in many different ways, and the way we travel affects the environment and society at large. Modes of travel in New Zealand cities are changing, although not in ways that are favourable for environmental sustainability, or for good public health. The New Zealand Household Travel Surveys have recently conducted a survey on national patterns of travel. In fact, the data collected illustrates just how car dependent this country is. 81 percent of total travel time was spent as a passenger or driver in a private motor vehicle, 12 percent was spent on foot, and about 1 percent travelling by bicycle (Woodward & Lindsay, 2010). This is in sharp contrast to the profile in many European countries, where active transport (walking and cycling) has much greater share of all travel.

Statistics New Zealand (2007) also conducted a survey focusing on the main means of travel to work. The results show similar patterns as to The Household Travel Survey for all travel as well as travel to work. Between the 1996 and 2006 Censuses, an increasing proportion of people used a car to travel to work. The survey showed Wellington has higher usage of public transport as compared to Auckland, and only one percent of people travelling to work in Christchurch from surrounding districts used public transport. The information collected is becoming more relevant as the environmental consequences of motor vehicle use became increasingly important over the late 20th and early 21st centuries. Motor cars were the main means of travel to work, with approximately two thirds of the employed population listing this as their main means of travel to work on census day 2006. Between 1996 and 2006, the use of cars increased slightly, while walking, jogging, and cycling declined. This means that urban travel patterns need to change. The ever increasing dependence on private motor vehicles is a major contributor to carbon emissions, which leads to environmental problems and health related issues.

1.4.2 Christchurch: The City of Cars

Other than the bus system, private cars have remained the dominant form of transport in Christchurch. It is estimated that about 44% of New Zealand's carbon dioxide emissions come from private cars. It is accounted as one of the biggest growth areas of our greenhouse gas emissions which causes problem for our environment and the economy (Ministry of Economic Development, 2010). Only 1 percent of people travelling to work in Christchurch from surrounding districts used public transport (Goodyear & Ralphs, 2007). A 2006 census day survey done by Statistics New Zealand shows that there are still increasing number of people travelled by car to work (over 1 million people) as opposed to other alternative transport (Statistics New Zealand, 2007).

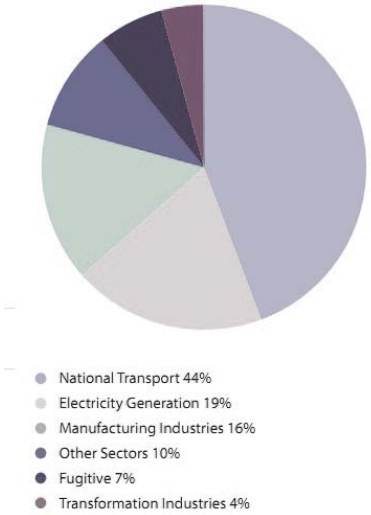


Figure 1.1: Graph shows that 44% of New Zealand's carbon dioxide contributed mostly from national transport. (Source: Ministry of Economic Development, 2010)

Figure 1.2: Shell Brougham Street, like most service stations, experienced huge demand for fuel. Picture taken after earthquake struck. (Source: Photoshots, 2011)

1.5 Christchurch earthquake

On February 22nd 2011, Christchurch was hit by a 6.3 magnitude earthquake that causes a significant damage to the city's infrastructure. The latest report from Cera published on 28 September 2011 listed some of the costly damage caused by the seismic activity:

- 500,000 tons of silt from liquefaction has been removed from the city and suburban areas.
- 600 kilometers of roads were damaged and 20 of these roads are still closed
- 300 kilometers of sewer pipes need to be replaced.
- 600 power cable faults have been repaired.
- 546 buildings have been demolished and the sites cleared in preparation for the rebuild.

It is hoped that 40% of damaged buildings five storeys or higher will be demolished by September 2012. Demolition of all damaged CBD buildings with less than five storeys should be completed by February 2012.

Figure 1.3 (below): This picture was captured by a tourist the moment the quake hit. Taken from the Port Hills overlooking Christchurch. (Source: The little red gallery, 2011)

The public transport infrastructure also has been compromised with bus patronage declining by approximately fifty per cent since the February earthquake, and Evironment Canterbury (ECan) believe that up to thirty percent of this decline is attributable to the lack of “through routing” of buses, forcing people to take multiple bus trips across city. The current Bus Exchange on Lichfield Street has suffered damage in the earthquake and is currently unavailable due to the severe damage to the common areas shared with adjoining buildings, although the structural damage to the exchange itself is not major. The city council has since then replaced a temporary bus exchange, called Central Station, in Lichfield Street that was opened on 25th of October 2011 (Christchurch City Council, 2011). The station is the first piece of infrastructure built in the central city since the February’s quake. It consist of basic platforms and shelters, an information kiosk, waiting rooms and toilets, and real time display information. The station will be used for up to two years. (Refer to figure 1.4)

Figure 1.4: The opening of Christchurch temporary bus interchange, dubbed ‘Central Station’, was built to improve the level of service for passengers and to support the recovery of the central city after the earthquake. (Source: Author’s own image)

1.6 Rethinking Christchurch's public transport

Since then, there seems to be a lot of mention in the media and various social networks about the role of public transport in the rebuilt Christchurch, including particular support for the establishment of a light rail system. In addition, public feedback through Share an Idea expo held by the Christchurch City Council, the community wanted an integrated and affordable public transport, as well as pedestrian friendly city centre and separated cycle lanes to create a safe and efficient cycling network. Furthermore, people wants to create a new network, focused more on the needs of walking and cycling, while offering resident's choice to use modern, efficient public transport services that is now lacking in Christchurch city.

One of the significant problems with Christchurch's public transport is that it is almost entirely a bus system. There is no real 'backbone' to the city's system that allows quick services along a dedicated corridor which normal bus services feed onto/from. According to the article in the press, only 15 per cent of Christchurch residents surveyed used buses regularly, compared with 35 per cent of Wellingtonians and 25 per cent of Aucklanders. Even though Christchurch's public transport system rated highest in New Zealand for accessibility, frequency, reliability and affordability in a survey for the Ministry of Social Development and 12 councils throughout the country. What perceived to be the problem is the city's network's reliability, primarily the lack of connectivity between other transport services. This has changed people's perception of using the public transport in Christchurch, and instead people have chosen their private cars for more convenience. The city carries no significant commuter traffic, and the rail services were progressively cancelled in the 1960's and 1970's due to the underuse of people travelling long distance. Bringing back a basic rail system will hope to deal with some of the transport problems in and around Christchurch. It could then be incrementally upgraded and expanded as the rebuild work is carried out around the city, and the potential to extend rail into the CBD as the main hub, and/or connect it to tram tracks in the CBD. The key would be the rail system feeding into the bus network at strategic points. It would therefore be a great idea to roll out more bus lanes, as roads and communities are repaired. The environment effects of transport mode choices are complex, hence, challenging the social norms between private and public transportation needs to be considered. Speed and independence ("leave any time I want, get anywhere I want") are important determinants of transport mode choice. Other relevant factors are comfort, costs, social safety, physical safety,

health, environmental friendliness, and luggage capacity. These are the factors that need to be considered especially when travelling long distance.

1.7 Potential growth in the suburban areas

Statistics New Zealand figures show that Christchurch's commuter belt is one of the fastest growing in New Zealand. Canterbury towns send hundreds of workers into Christchurch every day, with Rolleston having the highest commuter growth rate in the country. Nearly half the working populations of the Waimakariri and Selwyn districts commute to Christchurch. The number of people commuting to Christchurch from the Selwyn District has increased from 4800 in 1996 to 7800 in 2006 (Statistics New Zealand, 2007). The number of Waimakariri people commuting to Christchurch has risen from 6580 in 1996 to 8930 in 2006. Potential growth in the near future for areas that are not badly affected by the earthquake such as that of Waimakariri and Selwyn, might have people migrating to the city for work during the rebuild and eventually settling there. Christchurch's rapidly growing commuter belt places strain on arterial roads and is difficult to serve with bus routes, and hence most commuters travel by private car rather than public transport. This resulted only 1 per cent for commuters travelling to Christchurch from outside the city by bus (Gates, 2009). Part of the problems is due to the sparsely populated catchment area that will need to cover a lot of road if served by public transport, and it is very uneconomic to operate if the demand does not meet the growth. However, the number of passenger trips has grown 4 per cent on the previous year and is expected to reach 25 million by 2014, which means public transport for commuter towns could be funded with a targeted rate in the future. Transport links between Rangiora, Woodend, Pegasus, Rolleston, Prebbleton and Lincoln are also going to be given priority.

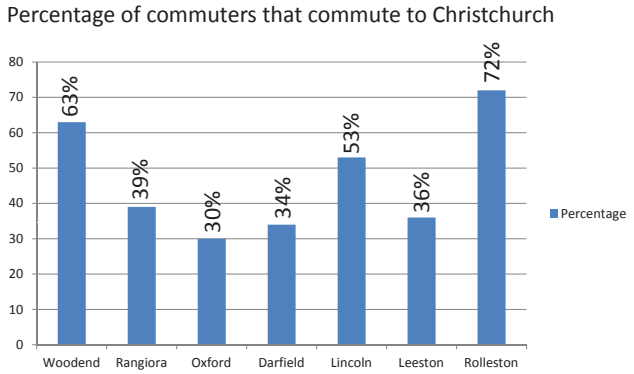


Figure 1.5: Graph showing percentage of commuters from suburban areas commuting to Christchurch. Drawing by author. (Source: Statistics New Zealand)

1.8 Aim and objective

In this project, I will investigate of how Christchurch city can become greener by introducing integrated public transportation system in order to reduce the number of people using their cars, and cut carbon emissions. A variety of transport including buses, shuttles, trams, future light rail system, taxis, cycles and walking are all to be integrated under one roof. Thus I intend to design a transport interchange in the urban context and aim at creating spaces that are authentic, while also applying the ideas of technological aesthetics within the architectural design process. The main intention of the research is to develop a model for an inner city interchange which is responsive to urban context, and designing truly public spaces, places that are alive, while completely integrating the new spatial factor constituted by movement and speed.

1.9 Research approach:

The aim of this research is to establish a centralised location for a multi-modal transport interchange and proposes an architecture that constitute as part of the rebuild action plan following the Christchurch earthquake to create a modern and sustainable city for the 21st century. The thesis is divided into five chapters.

Chapter 2: Literature Review
This chapter provides a review of literature which draws together the relevant theoretical texts concerning automobile dependency in cities around the world and its sustainable implementations. This chapter also uses literature to establish the relationship between transport technology and its impact on designing a modern transport interchange. The criteria for this building type associating with its users and the urban form of a city is also discussed.

Chapter 3: Review of current Practice
This chapter is a review of five case studies divided into two parts. Each of these examples is well integrated into the urban context and provides a model of different concepts discussed in the literature. The first two case

studies looked into cities; Copenhagen and Perth, and how each city is heading towards developing sustainable transport modes. Then it is followed by three case studies: Britomart transport centre in Auckland, Arnhem central station in Arnhem, and King's Cross Station extension in London. The three case studies represent the architectural response in developing sustainable transport in a city.

Chapter 4: Design Case Study
The fourth chapter is a design study that tests the findings of previous chapters in a detailed design solution. This chapter questions the future of transport interchange might be like by ways of designing and experimenting; using mobility and technology as the primary means to represent this.

Chapter 5: Discussion and conclusions
The final chapter discusses how the research has met the intention of developing a model for a central transport interchange which is responsive to urban context and reflects the issues of sustainability in a modern city. Furthermore, areas for future research are also presented.

Chapter 2
Literature review

2.1 Introduction

Cities around the world are increasingly developing strategies on how to create a more sustainable city to achieve sustainable development goals for the improvement of urban quality and life. Sustainable development includes improving aesthetics, mobility, the environment, and energy systems. Such strategies reflect the challenges face by New Zealand's regional and local councils to strengten urban sustainabilty. Christchurch City Council adopted its first Sustainable Energy Strategy for Christchurch 2008–18 in September 2007. The strategy aims to project a city that shows responsible leadership using the best sustainable energy practices and does its part in the global effort to reduce greenhouse gas emissions. This chapter discusses the literature on technology influenced transport in cities and how it can be made compatible with one of the sustainable development goals. These challenges are not unique to Christchurch; however, Christchurch has a unique opportunity to redesign the system and the supporting architecture. The resurging interest in the transport interchange and the need to achieve sustainable development through better design and management of transport infrastructure. It is concerned with people, with performance, with building and urban spaces, and with architectural delight.

Figure 2.1: Christchurch City Council new civic building, rated as the greenest building in New Zealand, reflects Council's commitment to creating a sustainable future for the community and the region.

2.2 Mobility and the interchange

Interchange is about processing passengers between modes of mobility; the process is people-centred and consists of moving users from one transport source to another (Edwards, 2011). However, good transport architecture celebrates the mundane process of circulation and movement by creating uplifting spaces that, through their scale, volume and clarity, 'reduce stress and anxiety among the travelling public'. (Ibid) Harbour (2006) also supports this view by suggesting ways of creating good transport architecture that fully exploits aspects of design to make way-finding clear and to make the process of dealing with users obvious. Providing a pleasant journey for travellers will affect on how people view public transportation. Unless transport interchanges provide clarity of use and raise the spirit, they will not be able to achieve the switch from car use to public transport, no matter how well designed the new trains or buses may be.

As we move into the twenty-first century, more and more people are travelling more frequently, and farther distances than ever. Seventy two percent of New Zealanders live in urban areas at the time of the 2006 census. (Statistic New Zealand, 2007). Our cities now sprawl over the green belts set up in the nineteenth century and spread into the suburbs. As we work with this inevitable urban sprawl issue, the need to adapt to how we travel can contribute to a more sustainable urban future

Internationally there has been much debate on urban sustainability focusing on the main component of the relationship between urban form and transport (Buchanan, et al., 2006). One of the main arguments has centred on the issue of sustainable city size and shape of cities: should the city be allowed to become dispersed, or should cities become more compact? The benefits of a compact city with higher densities with less car use favours over dispersed city discourse due to increasing environmental and social problems. These benefits primarily function around urban processes that concentrate development, reduce the need to travel and result in a reduced environmental impact. Conversely, several negative points have also been argued that can result from urban consolidation; these are based around overcrowding, loss of urban quality and increased congestion and pollution (as cited in Buchanan, et al., 2006, p. 342). Roncayolo (1998) argues that the impact of urban form is no longer appears to be closely linked to growth, but to changes in lifestyle or in the way space is dealt with.

Mobility seems to be the principal characteristic of the urban phenomenon, but it remains unaffected by economic and demographic variations. Emerging issues span the environmental, social and economic range, from climate change to rising energy prices, the health issues associated with lack of exercise, and keeping our cities economically competitive. The evidence of increased car travel and deteriorate of air quality standards in New Zealand suggests that high car use is critical to the situation (Longley, 2010). The car is seen as increasingly unenvironmental and also to some people antisocial. So in spite of greater affluence and more flexible lifestyles, the shift from private cars to public buses, trains and trams is a characteristic of the early years of the twenty-first century.

2.3 Developing sustainable transportation

As a city develops, people desire higher personal mobility. One way to achieve this is through a high reliance on motorisation. This has to be supported by massive investment on the construction of expressways and the road network, an expanding automobile industry, and the heavy consumption of non-renewable energy. A second way to achieve higher personal mobility is through the development of the urban public transit system. In most cases, infrastructure investment decisions by New Zealand's local and central government has been about the funding (or relative lack of it) for essential public transport projects. Professor Peter Newman, who is best known for and popularised the term 'automobile dependence', sees this primarily as an issue of environmental sustainability due to the consumption of non-renewable resources and production of greenhouse gases responsible for global warming. Newman and Kenworthy (1999) investigate how a city goes about achieving an integrated approach to all aspects of sustainability, and one of the key factors discussed is the transportation. They suggest ways and techniques to overcome automobile dependence by traffic calming and providing quality transit, cycling and walking policies. They strongly discourage urban sprawl, but rather seek to create multimodal centres with mixed, dense land uses that reduce the need to travel and that are linked to good transit. In 'Transport: Reducing automobile dependence', Newman (1996) based his detailed study of cities around the world on automobile dependence, and using graphs and statistic tables compared the impact of automobile use has between cities. This paper also shows how such cities do not need to depend on high levels of private automobile use and describes how automobile dependence has been reduced in many of the most successful cities. The author uses many examples of cities that have reduced automobile dependence through innovations in public transit and controls on automobile use.

Mees (2000) also agrees the rise of private car use poses a challenge to public transport. Conversely he pointed out the positives about the public transport as alternative to cars, and continued by saying walking and cycling are the only truly sustainable transport modes. According to Mees (2011) at the 'Smart Transport Conference' presentation in Wellington, New Zealand's transport funding is currently at 20-1 roads to public transport ratio and needs to move to a 70-1 ratio in ten years. He argues that where the funding goes towards public transport people have used it. Mees pointed out that Switzerland as a prime example of good public transport and compares

the cities that have similar population density to New Zealand. He suggests integration between trams (main routes into the city) and buses (which feed into the tram routes at key locations), in which he calls a 'network effect'. He believes this is what council should be aiming for in the future rebuild of Christchurch.

Visionary urban designer Jan Gehl also looked into Christchurch as part of his study about quality of urban space. In *Public Space Public Life Study,* Gehl (2009) undertook study of central Christchurch commissioned by Christchurch City Council in 2009. The study considered how people used Christchurch's Central City spaces and streets, assessed the quality of the spaces in the Central City, where people walked and how public spaces could better sustain public life and create a better sense of community. One of the four key challenges Gehl discusses is that Christchurch is a traffic dominated city, which contributes to the unpleasant environment for pedestrians and cyclist. He suggests central city to be giving pedestrians and cyclists a priority in dedicated streets, moving buses away from CBD and dedicating bus lanes to ensure the frequency and reliability of the bus service. Gehl also encourages a development of a centralised transport interchange on the periphery of the city centre for effective fast transfers. Mees (2011) also supports this concept and discourages the council's proposal to deviate bus services around the central city. Christchurch has great potential to become a vibrant and liveable city. Now the future rebuild is underway, opportunity has risen to develop a truly sustainable city.

Although Christchurch may seem to be moving forward in achieving sustainable goals, even before the earthquake, it is only through the eyes of tourists visiting the city that have true sense of what Christchurch has to offer. From Christchurch International Airport that utilises carbon neutral programme, to taking a bio-diesel bus to the city centre with historic tree-lined boulevards and streets, and seeing many historic buildings have been well kept. As a tourist, you see quite a range of sustainable ways of moving around the city centre, a free inner city bus that uses a low-emission vehicle, tram, Green Cabs and recently introduced bicycle sharing systems (Moore, 2010). But it is also through the contribution from citizens and the community at large on how we view mobility, how we develop sustainable transport and understanding more sustainable urban form solutions is vital for our health and wellbeing, and for our future.

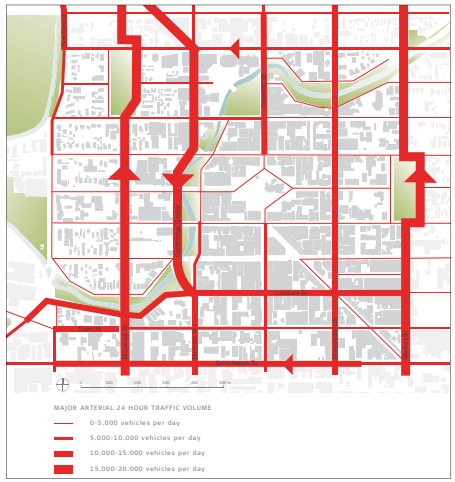


Figure 2.2: Jan Gehl study of traffic movement for his Public Life Public Study in Christchurch. (Source: Public Life Public Study, 2008)

2.4 Towards a modern transport interchange

A transport interchange is a place of connection, public presence and movement. Researchers have suggested the interchange is the architectural expression of functionalism and movement acted out in interweaving patterns of interior space, light and technology (Edwards, 2011). Technological change in the transport industry is driven by three forces; the need to improve efficiency, especially in energy consumption and people moving capacity; the need to exploit new markets in mass people movement; and the need to improve customer comfort level (Ibid). Hence, the modern interchange is a hybrid that accommodates new transportation technologies and emerged in response to new social and economic dynamics.

Designing a project for a multimodal hub has become ever more complex. As well as involving questions related to transport technologies and the city's development, considerations must be given to people's needs. To be successful, the interchange must be a place of connection, of transfer and of social interaction. Historically, transport infrastructure was the domain of engineers, with little attention given to aesthetics or to people. Although engineering considerations have a greater influence on the design of transit stations than on most other buildings, good architectural design is essential. The structure that accommodates these travel movements needs to serve interchange mobility well, both functionally and aesthetically. Architects are now appointed alongside engineers in order to bring order and beauty to the interface between transport infrastructure and the city (Griffin, 2004). The concepts and design details controlled by architecture will always determine passenger convenience and comfort, developing ridership and public acceptance. Leading architects are thinking forward with sustainable design approaches at the interchange.

A key concern is the changing function of interchanges in terms of their role as new urban magnets in the emerging imperative of 'sustainable development'. (Edwards 2008) From the traditional singular transport building types in the past decades to integrated public transport infrastructure brought together into a single building, is now becoming the norm particularly in metropolitan areas. As a consequence the interchange has an important contribution to make in achieving urban sustainability and good social welfare (Scott, 2003). Edwards (2008) indicates several ways of achieving sustainable transportation:

- Reducing the need to travel by land-use integration
- Making public transport as desireable and convenient as private transport
- Increasing urban densities to sustain public transport
- Changing modes of transport from cars to public transport, cycling and walking
- Improving the image of public transport
- Changing transport stops into interchanges
- Turning transport interchanges into business, community and sustainability hubs.

The development of transport interchanges into multifunctional facilities would imply that the interchanges should be places rather than spaces. Duthilleul (1998) suggests that this new place of transport- a hub of exchanges- also be a major public space. This means that it should contain all sorts of urban retail facilities and services. Edwards (2008) discusses transport buildings seeking to provide dignity and hospitality for travellers. Dignity for Edwards is reflected in the large columned spaces that constitute booking halls and the wide malls that channel passage; hospitality in the many shops and cafes that are constructed within transport buildings. Architecturally the invasion of commerce and retail into interchanges has often been at considerable aesthetic cost that will help to boost economy.

2.5 Design influences on transport architecture

In the early 20th Century an artistic and social movement of Futurism was born. It was originated in Italy by an Italian writer Filippo Tommaso Marinetti, later joined with artists, painters and other practitioners alike. The Futurists admired speed, technology, youth and violence, the car, the airplane and the industrial city. In the article written by Futurist architect Antonio Sant' Elia, 'Manifesto of Futurist Architecture', which was published in 1914, he expressed ideas of modernity in his writing (Braham, 2007). He rejects ornament and decorative motives on all classical architecture; maintaining that Futurist architecture should only contain its original arrangement of raw or bare or violently coloured materials. He also suggests that Futurist architecture is not one of linear rearrangement. He avoids perpendicular and horizontal lines or cubic and pyramid forms that are static. Instead, the uses of oblique and elliptic lines are dynamic, and by their very nature possess an emotive power a thousand times stronger than perpendiculars and horizontals. Sant' Elia also argues that the use of massive and bulkiness of materials are the principal cause of grotesque appearance of 'fashionable' buildings; and that Futurist architecture should be of simplicity and to employ lightness. One of the examples the author pointed out was the need for more railway stations in the Futurist city, and feels there is no need for cathedrals or palaces because he considers those architectures as monumental, heavy and static.

Figure 2.3: Giacomo Balla's painting of abstract speed + sound (1914). Much of futurists' works are inspired by speed, technology and cars. (Source: About.com, 2009)

Sant' Elia's views on Futurist architecture extend to what should be of constructing it with all the resources of technology and science, and that it should be new to suit unique conditions of modern life is certainly true to its statement. Part of the architect's job is the ability to understand ahead of the time and seeing into the future. The project should incorporate the available resource of today's technology into the building design. Sant' Elia's statement is just as relevant today, with the world's most prominent architects today such as Lord Norman Foster, Santiago Calatrava, Zaha Hadid, incorporating elements of high-tech industry and new technology into building designs. Technology speeds up the progress of time.

According to Girardet, "Today we don't really live in civilisation but in a mobilisation- of natural resources, people and products. The world's major transport systems start and end in cities. They are the nodes from which mobility emanates, along roads, railway lines, aircraft routes and telephone wires." (Girardet, 2008) The author states

the fact in his book that since the beginning of the industrial revolution, carbon dioxide in the atmosphere has increased by some 30 percent, from 280 to 373 parts per million, and average temperatures on Earth have risen by 0.7° Centigrade. While Sant' Elia proclaimed that the architecture must find inspiration in the elements of the utterly new mechanical world as opposed to nature, writing and designing at the time of the industrial revolution, recent consideration for the environmental impacts demands a reinterpretation of modern futurism.

2.6 Transport Technology and the sublime

It is inevitable that we live in a fast paced world where the technology of transportation keeps evolving and is helping us to get from one place to another. Technological innovation linked with faster and more efficient transport systems in cities have shaped the contemporary globalisation. This process implies a space-time convergence where a greater amount of space can be exchanged in lesser amount of time. Here, I want to point out two ideas of the sublime; space and time (Nesbitt, 1995). This section refers to the sublime that is related to the technological movement of our time. How place, scale, and networks are used as metaphors for the spatiality of globalization suggests that space/time still matters.

The metaphors for space/time has come to mean that, while space is collapsing and time is speeding up in absolute terms, under globalization, time is becoming relatively more critical than space. Indeed, speed has become a central metaphor for what is distinctive about contemporary globalization. Thrift discussed the emergence of a "structure of feeling," a culture of mobility emphasizing speed, light, and power (Thrift, 1996). Rodrigue, Comtois and Slack (2006) acknowledges that technological advancement and economic development are the driving forces behind the geography of transportation. Technology permitted improvements in transport speed, capacity and efficiency, allowing individuals and corporations to take advantage of this improved mobility. As people work with this transport legacy, adapting to new challenges, emerging issues span the environment, social and economic range. The early twenty-first century is an era of car and truck dependency, which tends to constrain the development of alternative modes of transportation. But as oil production is expected to peak by 2009-10 and then decline, energy prices are expect to soar, triggering the most important technological transition in transportation since the automobile (Rodrigue, Comtois et al. 2006).

The relationships between the environment and the transport industry are strong. With the rapid expansion of the world economy, concerns over the environment impacts of transportation are increasing. Sustainable development applied to transport systems requires the promotion of linkages between environmental protection, economic efficiency and social progress. Under the environmental dimension the objective goal is to understand the environmental issues which need to be addressed by all aspects of the transport industry. They include air

and water quality, noise level and public health. Under the economic dimension the objective is that the transport industry can support economic development. Transport must be cost-effective and capable of addressing changing demands. Under social dimension, the objective is to upgrade the standards and quality of life.

2.7 Summary

We live in a world of constant change, and global population growth will eventually leads to increasing mobility rates. The literature has discussed the importance of environmental impacts relating to the transport industry. The nature of urban development in New Zealand is a major contributor to carbon emissions. The shift away from automobile dependence to alternative modes of sustainable transport systems would bring multiple benefits such as fuel savings and increased energy resilience, air quality improvements and improved health outcomes. The support for compact and attractive development around public transport nodes encourages walking and cycling activities, making the city more liveable and increase quality of life.

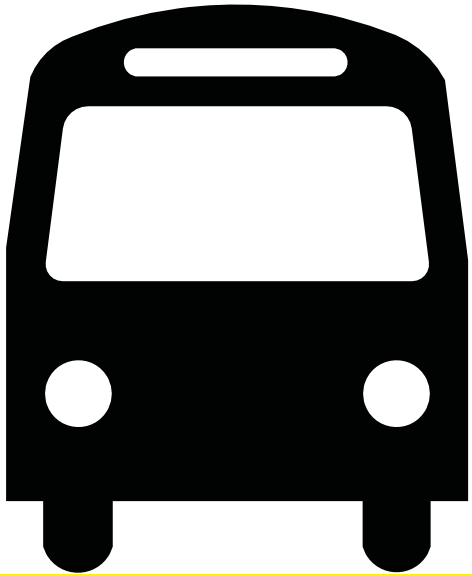
The design of a modern transport interchange moves away from the traditional singular transport building types to integrating multi-modal transport and multifunctional facilities into a single building. Interior spaces should be filled with natural lights creating uplifting spaces while making way-finding easy. The literature discusses what defines a modern transport interchange that includes technology, circulation, functions and aesthetics while thinking forward with sustainable design approaches.

The term Futurism is very relevant to the current research, which explores the ideas into developing a model for designing a transport interchange. Futurism admired contemporary concepts of the future including speed and technology. This concept has implications for the design of spaces within the interchange that is relating to circulation of movements and the available technology of modern life. Furthermore, reinterpreting ideas of Futurism coincides with the content of 21st century sustainable inspirations, which is a major challenge for transport industry facing today.

Architects today are thinking forward in designing buildings with minimal impact to the environment where incorporating the available resources of today's technology. Architects lead all development of concepts, building form, layout, and building functions to ensure the convenience and comfort for the users.

The lack of literature related to centralised transport interchange design on the city centre within New Zealand

provides an opportunity to research this topic. Exploring a new building type also provides the opportunity to explore the internal layout and circulation to encourage social interaction and construction of knowledge.



Chapter 3

Review of current practice

3.1 Introduction

In the introduction, I have discussed the problems/issues that Christchurch is facing. In a wake of the earthquake occurred on February 22nd, Christchurch city council and the community are looking ahead to improve the existing infrastructure or to replace with new. The current Bus Exchange has suffered damaged in the earthquake, and the temporary bus station (central station) was opened to the public on 25th of October 2011 to provide public transport infrastructure in Christchurch city. As plans are put into action and the rebuilding gets underway, Christchurch has the opportunity of becoming a modern and green city for the 21st Century. According to the Mayor Bob Parker, *"the Central City Plan identifies projects and initiatives to be implemented during the next 10 to 20 years which will make Christchurch one of the most exciting, modern and liveable cities in the world".* (Christchurch City Council, 2011)

This chapter explores the phenomenon of the public transport infrastructure in the two cities chosen and subsequently illustrating examples of transport interchange regarding current practice. By comparing Christchurch city centre with other city centres we can get an idea of size, distances and urban grain and insight into the public life in relation to other cities of comparable size. The two cities selected are Perth and Copenhagen, even though understandably two cities have differences in the history and character. Copenhagen is a medieval city with the characteristics that implies, while Perth is a younger city with some similar problems to Christchurch. Christchurch has large blocks in comparison with Copenhagen city centre, and Perth has similar sized blocks in a rectangular grid. The second part of the section refers to the architectural response in relation to public transport infrastructure. They are buildings that explore energy efficiency, people needs, urban spaces, architectural aesthetics and technological implications. As a result they respond to the need to achieve sustainable development through better design and management of transport infrastructure. Finally the conclusion is made identifying the positives from the precedents and the knowledge gained, which will lead to the design solution.

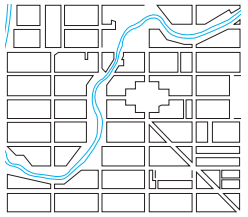


Figure 3.1:
CHRISTCHURCH *(Source: Gehl, 2009)*
- 1,740.00 m²
- Approx. 2,000 residents in the city centre (2008)
- 12 residents per hectare
- (382,000 residents in the metropolitan area)

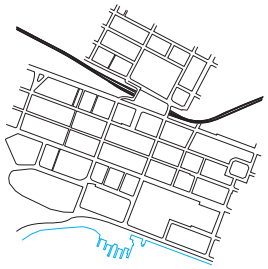


Figure 3.2:
PERTH *(Source: Gehl, 2009)*
- 1,200.00 m²
- Approx. 1,000 residents in the city centre (2006)
- 8 residents per hectare
- (1.4 million residents in the metropolitan area)

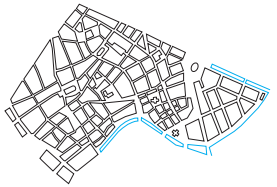


Figure 3.3:
COPENHAGEN *(Source: Gehl, 2009)*
- 1,150.00 m²
- 7,600 residents in the city centre (2005)
- 66 residents per hectare
- (1.2 million residents in the metropolitan area)

Figure 3.4: Central Perth Station, providing residents public transport modal choice as a way to overcome automobile dependence in a city. (Source: Newman & Kenworthy, 1999)

Table 4.19. Perth's Strategies for Overcoming Automobile Dependence

Traffic Calming	*Favoring Alternate Modes*	*Economic Penalties*	*Non-auto-dependent Land Uses*
Central city area becoming progressively more traffic-calmed and pedestrianized, though much remains to be done.	High investment in upgraded and extended electric rail through the 1980s.	Fuel tax, but used entirely for roads.	Recent extensive new central city housing projects, including revitalization of old industrial land for resident/mixed-use development.
Traffic calming or local area traffic management practiced on ad hoc basis throughout the region.	Commitment to further extend rail system.		Beginnings of urban-village-style development around rail stations through sinking of line at one station and large redevelopment project.
Some good examples in many local centers.	New bus service initiatives to improve cross-city travel (circle route), plus upgraded bus stops and information systems.		A focus on land use planning to discourage automobile dependence in regional centers.
Forty-kilometer-per-hour zones around schools.	A good off-road network of cycleways, especially for recreation, and increasing attention to direct, on-road routes for commuting and other trips.		Development of community code to encourage urban villages in any new urban development.
	Some favoring of pedestrian, cycle, and transit access at regional centers over last five years.		

3.2 City case study:
PERTH, Australia

In November 2008, Christchurch City commissioned world renowned Danish urban designer Jan Gehl to undertake a Public Spaces Public Life Study of central Christchurch (Gehl, 2010b). In the proposal study, Gehl used other cities for comparison and act as the frame of reference in his study. Perth was one of the Australian cities he has chosen in relation of comparable size to Christchurch city centre and faces some similar problems. The rapid growth of Perth over the decades' means suburbs were being built without access to rail services, and left over to bus service that rarely came more than hourly at off-peak times. Hence the Australian suburban lifestyle rapidly became highly automobile-dependent. But over the years, transport planners and the communities are pushing towards public transport resulted in the Rapid Transit System that consists of rail service and features trains that are linked by bus services interchanging passengers directly on to the stations. This saw an increase of 40 per cent patronage using the public transit with rail-bus over bus-only in the corridor. The improvement of public transit system also saw an increase of 25 per cent of the patrons on the northern rail line gave up using their cars (Newman, 1996). This proves that the new service has been successful that people are willing to give up their cars even in an automobile-dependent city if they are given a good option and efficient form of service. The city has demonstrated in the way communities and planners think about the city as ways of developing a sustainable city through improve transit, begin demonstrating alternative, land-use development around transit, and traffic calming in the central city area to encourage more pedestrians. Jan Gehl also referred to Perth as "The Reconquered City", which during the past three to four decades; the city has striven to achieve a better balance between traffic, market and meeting place issues. Development of a centralised transport interchange will not only improve the city's public transport system and overcome automobile dependence, but also providing a lively and vibrant public space that will increase the number of people living in, using and caring for the city.

Table 3.1: Perth's strategy for overcoming automobile dependence. (Source: Newman & Kenworthy, 1999)

3.3 City case study:
COPENHAGEN, Denmark

The city of Copenhagen is one of the best examples of recent urban transformation. In addition to major initiatives on public transport and cycling, perhaps the most striking change there has been in the inner city. Over a period of 40 years, a total of 100,000 square metres of the inner city that had been devoted to motorized transport was converted to traffic-free space for pedestrians. The surfaces of streets and squares have been replaced with beautiful natural materials, and street lighting and furniture have been refined as well. The entire city centre now has a character and an atmosphere that invite people to walk and to spend time there. It has transformed the experience of Copenhagen for local people as well as visitors. The result has been not only a reduction in the traffic but growth in the vitality of the city area. Social and recreational activity has tripled in Copenhagen's major streets. In fact 80 per cent of the movement through the city centre is foot traffic (Gehl, 2010). Copenhagen's Strøget car-free zone, the longest pedestrian shopping area in Europe, is primarily the result of Jan Gehl's work. Gehl's strong vision also supports cycling in the urban centres. He often uses Copenhagen as the best examples of cycling in the city. Copenhagen has earned a reputation as one of the most bicycle-friendly city in the world, due to the fact that the entire city is served by an effective and convenient system of bike paths, separated by curbs from sidewalks and driving lanes. They even have their own signal systems, making it considerably safer to cycle around the city. This resulted in the change of patterns of how people commute in the city. Bicycle traffic doubled in the period from 1995 to 2005, and in 2008 statistics showed that 37 per cent of personal transport to and from work and educational institutions was by bicycle (Gehl, 2010).

Copenhagen is just one of many cities in which urban policy initiatives have raised urban quality. Traffic, noise and pollution have been reduced; foot traffic and bicycle traffic have been reinforced. Public life has blossomed on the streets and squares of the city in a way not seen 20 or 30 years ago, certainly not in the form it has today.

Figure 3.5: Copenhagen is regarded as one of the most bicycle-friendly city in the world, due to the fact that the entire city is served by an effective and convenient system of bike paths. By 2008, bicyclists account for 37% of commutes to and from work and education. (Source: Gehl, 2010)

Figure 3.6: Nyhavn converted to a pedestrian street in 1980. (Source: Gehl, 2010)

Project facts
Location: Quay Street, Auckland city, New Zealand
Client: Auckland city council
Design: Mario Madayag Architects, JASMAX Architects

3.4 Architectural case study: BRITOMART - Auckland, New Zealand

The following case study explores the interchange as a gateway to integrated travel modes when people are given choice. Britomart transport centre in Auckland was the architectural response by a winning international design competition from Californian architect Mario Madayag in collaboration with Greg Boyden of Jasmax in New Zealand and Peter Walker & Partners in San Francisco. The project seeks to bring trains back into downtown Auckland city for the first time in over 70 years, and the need to provide the diverse transportation to its citizens.

Figure 3.7: Surface bus interchange (Source: Britomart, 2011)

Figure 3.8: The "glass box", entrance plaza to Britomart transport centre (Source: Urban design case studies, 2010)

Figure 3.9: Rail station interior (Source: Auckland transport, 2011)

Over the years, Auckland transport system has been centred around freeways for much longer than other comparable cities, and this is one of the major reasons for the extremely low usage of public transport. But the residents throughout the region are clearly aware traffic congestion and transportation are the most important issues facing the city. It was the region's growing need for a transport hub that drove Council to announce the Britomart Development design competition in early 2000. The project incorporates a public transport interchange for trains, buses and ferries and restoration of historic Chief Post Office. At the same time, this was an opportunity to create a gateway to the CBD and provide a series of welcoming public spaces.

The fundamental purpose of the Britomart is to offer people modal choice by enabling an easy interchange between rail, road and sea (proximity to ferry terminal). The design of the station allows easy modification of the platform and track configuration to accommodate any mode of public transport.

The historic Chief Post Office building has been refurbished and now serves as the pedestrian entry to the station. It contains 236 m² of retail space (excluding the ticket counter, information counter and an ATM). The eight retail spaces were readily leased and are occupied by a variety of businesses including a convenience store, florist and café.

The opening of the Britomart transport interchange has stimulated patronage on the rail network across the region. Rail patronage has risen about 30% across the region since the station opened. A June 2004 Britomart patronage survey recorded 6,864 rail passengers per day with a steady increase since the station opened. The Beach Road Station before its closure had about 3,500 passengers per day (Ministry for the Environment, 2005).

3.5 Architectural case study:
ARNHEM CENTRAL - Arnhem, the Netherlands

Project facts

Location: Station area, Arnhem, the Netherlands
Client: Municipality of Arnhem
Design: UNStudio

The following case study considers the interchange as a place of connection, public presence and movement. The architecture of Ben Van Berkel and Caroline Bos of UNStudio set an example for their design of Arnhem central station in Arnhem, the Netherlands.

Arnhem Central is a large urban plan development composed of diverse elements which amassed constitute a vibrant transport hub. The existing station is being redeveloped to an imaginative plan. Here a new shop-lined pedestrian link with the town centre will connect with a bus and trolley-bus terminus, situated beside the station. Below this will be parking for cars and cycles with new offices above. Due to the scale and complexity of the project, the architects uses two models as methodological approach in order to achive a fluent and coherent terminal landscape with minimal obstruction to passenger flow. Both emerged from the combination of time, movement, space and structure. Time-based studies at the beginning of the project constitute the understanding of different types of activities during different time of the day. They address relationships that is vital to developmental potential, such as programme and distance, public access and attraction. The analysis of the types of movement on location includes the directions of the various trajectories, their prominence in relation to other forms of transportation on the site, duration, links to different programmes and interconnections. The design of the master plan is therefore based on the pedestrian movement studies that became the cornerstone of the proposal. Van Berkel uses the Klein bottle as the design concept for technical/spatial organisation, which connects the different levels of the station area in a hermetic way. The Klein bottle stays continuos throughout the spatial transformation that it undergoes from a surface to a hole and back again. As the ultimate outcome of shared, motion-based relations, the Klein bottle is an infrastructural element both pragmatically and diagrammatically (Van Berkel, 1999).

The second type has been in operation for a number of years in the practice of UNStudio. It consists of deep and long shafts that connect the underground layers of the parking garage to the terminal and to the high-rise office towers. These shafts are V-shaped in order to form the structural backbone of various programmes with their

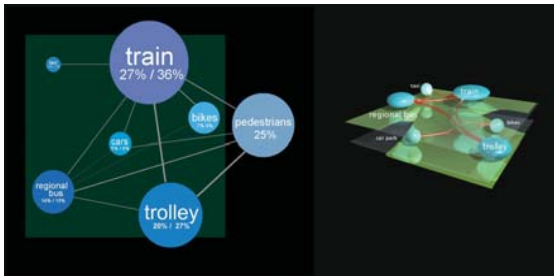


Figure 3.10: Programmatic studies during the early stage of the design process. (Source: UNStudio, 2011)

Figure 3.11: UNStudio uses the Klein bottle as the design concept for technical/spatial organisation. (Source: UNStudio, 2011)

Figure 3.12: Aerial view of the station's area. (Source: UNStudio, 2011)

Figure 3.13: Walkway leading towards the entrance of the transfer hall. (Source: UNStudio, 2011)

Figure 3.14: Rail station interior. (Source: UNStudio, 2011)

different restrictions. In the parking garage the V's are materialised as a concrete structure of high corridors with slanting walls, resulting in an oblique, permeable space which lets in daylight and is filled with programme and circulation.

As these two models indicate, UNStudio introduced column-free spaces that allow easy interactions and bringing in new qualities to types of spaces that we need to invest with new urban experience.

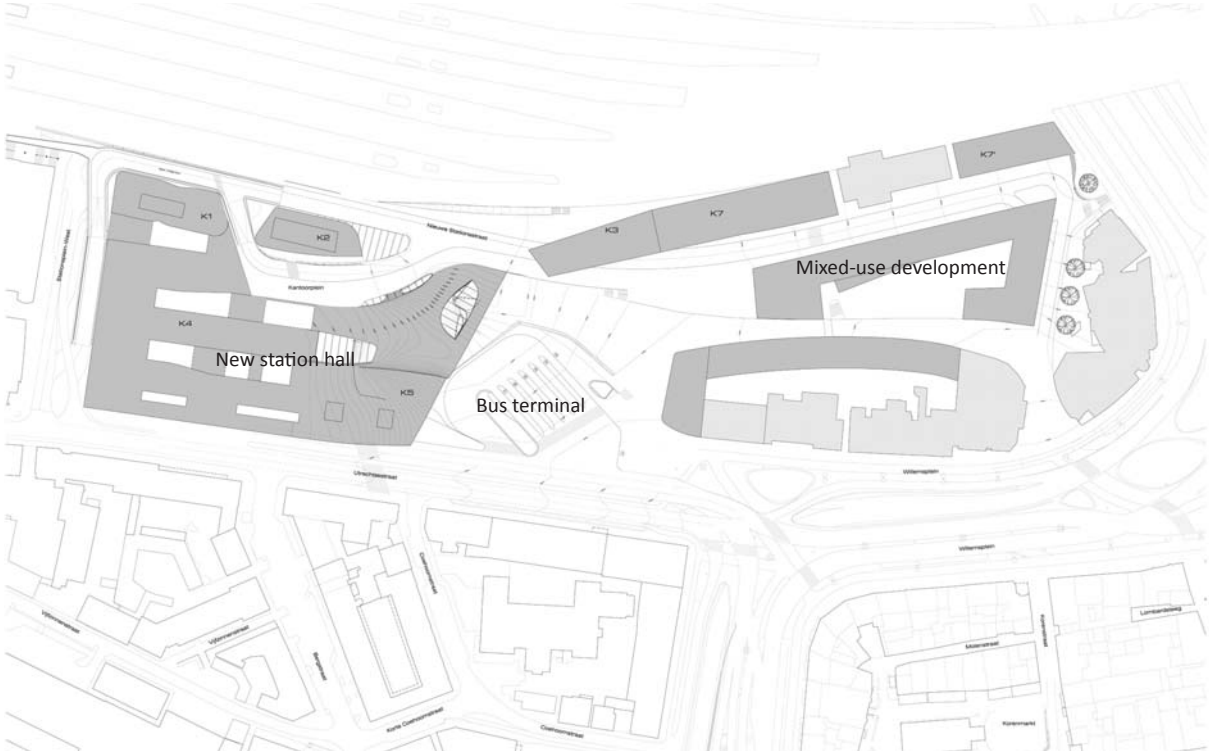


Figure 3.15: Master-plan area of the entire Arnhem Central. (Source: UNStudio, 2011)

3.6 Architectural case study:
KING'S CROSS STATION - London, U.K.

Project facts

Location: Camden, London, U.K.
Client: Network Rail
Design: John McAslan + Partners

The following case study is a recent major works to King's Cross station in the city of London, United Kingdom. The project has been selected because it is a recent project that implies the architectural aesthetics and unifying structures bringing in the quality of spaces within the interchange.

As lead architects and master-planners, John McAslan + Partners' transformation of King's Cross Station fused together the three very different styles of architecture: reuse, restoration and new build. The train shed and range buildings have been adapted and re-used, the station's protected heritage façade dating back from 1852 has been very precisely restored, and a new, highly expressive Western Concourse has been designed as a centerpiece and heart of the development. The new vaulted, semi-circular concourse to the west of the existing station creates a new entrance to the station through the south end of the structure and at mezzanine level on the northern end of the Western Concourse. The concourse, engineered by Arup, rises some 20m and spans the full 150m-length of the existing heritage building, has become Europe's largest single-span station structure, comprising of 16 steel tree form columns that radiate from an expressive, tapered central funnel. The programme consists of the new London Underground northern ticketing hall, and with retail elements at mezzanine level, the concourse will transform passenger facilities, whilst also enhancing links to the London Underground, and bus, taxi and train connections at St Pancras. The concourse is set to become an architectural gateway to the King's Cross Central mixed-use developments, a key approach to the eastern entrance of St Pancras International.

The relationship between old and new will raise King's Cross position to that of a modern transport super hub. When the works to the station are complete and it opens to the public in March 2012, the transformed station and its memorable new Western Concourse will take on the role of a new, iconic architectural gateway to the city in time for the 2012 London Olympics.

Figure 3.16: Single span steel structure rises from tapered central funnel. (Source: Archdaily, 2011)

Figure 3.17: Cut away view of the King's Cross station's new development area showing the fluid interconnection between old and new. (Source: Edward, 2010)

Figure 3.18: Rendered image of the Western Concourse interior view showcasing an impressive volume of space. (Source: Archdaily, 2011)

3.7 Summary

Two of the case studies presented showcase ideas of more effective public transportation systems from two different cities, while also concerning the redesigning of urban environment to make it more sympathetic to the needs of people and more human in dimension. But what is the architectural response in relation to the public transport in a city? The planning and design of the interchanges is complex. Their design should reflect civic aspirations whilst meeting transport needs. They succeed by recognising what travelers need in terms of information and comfort and what cities really want in terms of image projection, as has been achieved at Britomart in Auckland. With the need to project a good image to the public, rail operators now recognise the importance of imaginative station design. The design of Arnhem Central by UNStudio creates architectural expression of functionalism and movement acted out in interweaving patterns of interior space, light and technology. Their design is based primarily upon the geometries of movement, with large fluid spaces for social and economic exchange. But the design of the western concourse in London's King's Cross Station gave the dramatic effect in the interior space, through the architect's task of ordering space, structure, daylight and mobility in a coherent fashion. Transport buildings have long since been a gateway to travel, but the twenty-first century transport interchange is more than just providing mobility to people, but also a gateway to experience urban areas and a gateway to sustainable development.

Chapter 4

Design Case Study

DESIGN CASE STUDY 4

4.1 Introduction

This chapter expands upon the studies using the precedents made in chapter 3 to act as a guide to possibilities for integrated public transport in a New Zealand city. In particular identifying different modes of transport that can be used, taking account of reducing car 'dependancy' and improving the quality of life in cities today while providing a better transport choice for a sustainable future. The pollution levels and traffic problems due to the city's transport planning centred around freeways, contributed to the extremely low usage of public transport. Reviewing the reasons behind the current policy impasse proves to be way too complicated to resolve in such a short time, especially where issues of politics and personalities are involved. Wellington has the highest usage of public transport and is considered to have the best public transport infrastructure in the country. This guided the identification of an appropriate location for an inner-city public transport interchange in Christchurch. Since the opening of the bus exchange in 2000, Christchurch saw an increasing bus patronage leading to a need for a larger transport interchange in the central city. However, public transport poses a new challenge to the rebuild of Christchurch city after the February earthquake. The selection of site was conducted in the months following the earthquake considering a permanent site for the future interchange. Once a site had been selected based on the assessments of the surrounding context, the site layout and operations, it then outlines the ensuing design exploration and experimentation undertaken for an inner-city interchange. A brief and programme was developed identifying the key facilities required in a typical transport interchange considering circulation of spaces as a key concept.

The chapter is divided into sections starting with site context analysis where it forms a major decision on the chosen site in particular to existing transport networks. Followed by site specific design brief and finally the design is presented through the exploration of the relationship between transport, city form, urban image and technology.

4.2 Site Assessment

Christchurch is located on the east coast of New Zealand's South Island and in June 2010 was home to 376,700 people (CCC Draft Central City Plan, 2011), making it the second largest city in New Zealand. Many heritage buildings were lost due to the recent series of earthquakes, but the distinctive street patterns of Christchurch will remain unchange, which was laid out in a grid pattern, interrupted only by the curvilinear alignment of the Avon River, and the two diagonals High Street and Victoria Street. Christchurch's street grid was laid out by Edward Jollie in 1850 and is an essential part of Christchurch's identity and character. It is part of the 'core architetcure' of the city. At the very centre of the city was a 'Square' intended as a grand centre for the city and the site of the proposed cathedral and grammar school.

The city has grown concentrically around the original city grid forming a radial city structure, with expansion of the city's public transportation network heading additional various transport hubs around the city service the surrounding areas. (Fig 4.2)

Figure 4.1: Aerial photograph of Christchurch. (Source: Google earth)

4.3 Christchurch region

In the 2006 census by Statistic New Zealand, the major commuting hub in Christchurch was Cathedral Square, and therefore the site selection initially involved identifying an area in Christchurch central city. (Refer to figure 4.2) which shows regional transportation hubs for each mode of transport) Connectivity of the site was the first and foremost consideration taken into account. As the square is the geographical centre and heart of the city making it a prominent site to have all forms of public transport cluster into a central site.

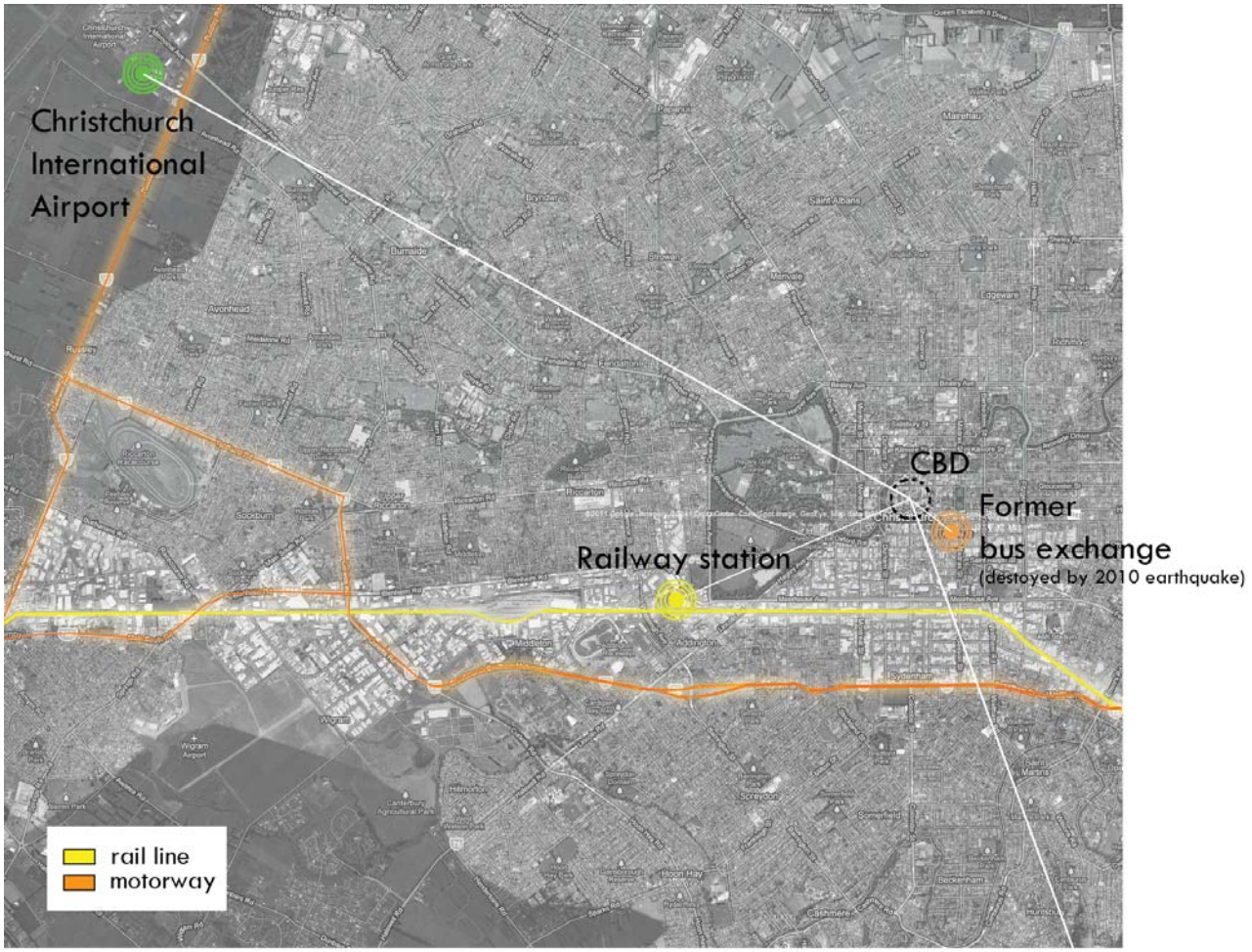


Figure 4.2: Christchurch regianal transport hubs by type

Lyttelton Port

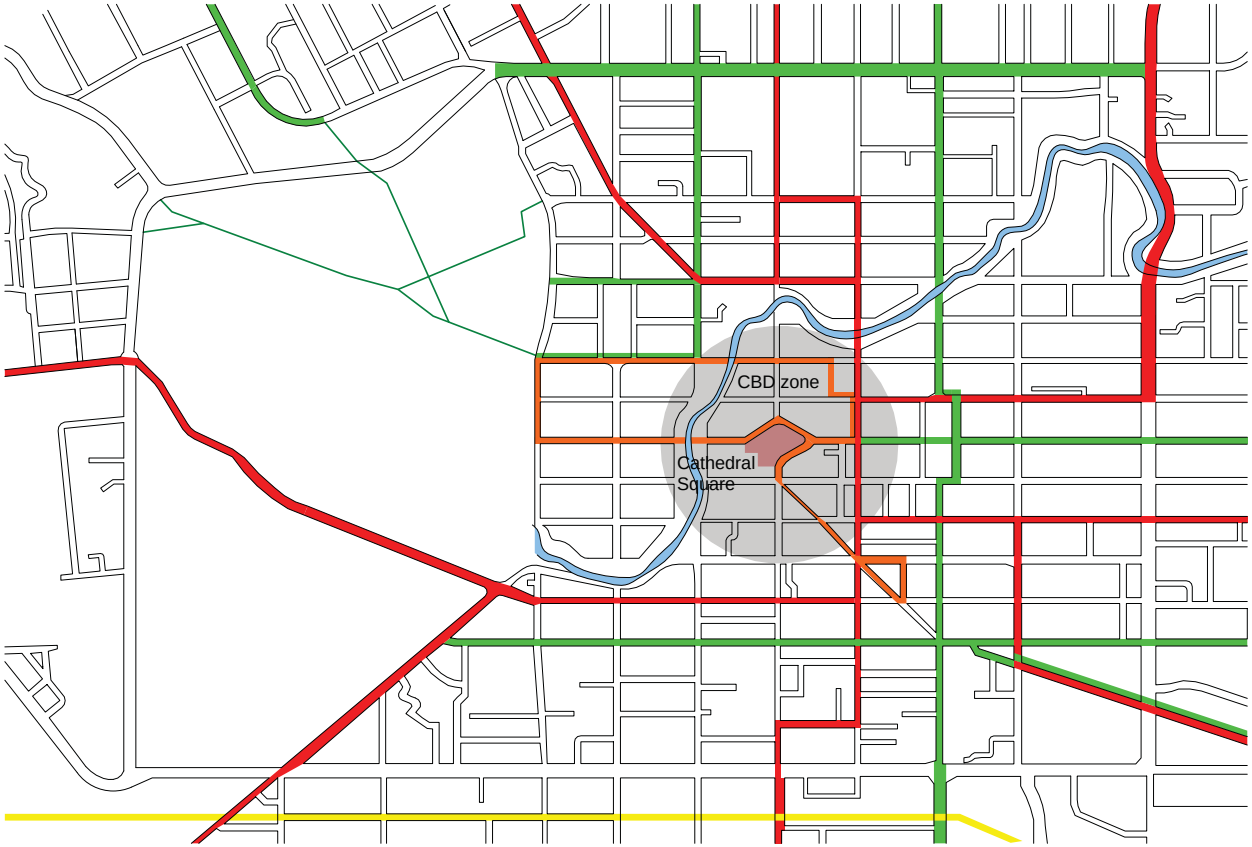


Figure 4.3: Public transport network

4.4 Site selection criteria:

- Proximity of the Cathedral Square where the major public life are located.

- Proximity of open green space (for bike network)

- Best possible access for buses.

- Existing transport network in the area

- Safe and easy access for passengers.

- Ability to allow flexible operations and access by passengers.

- Provide support for the Central City.

- To rebuild on a future vacant site as the result of the earthquake damaged buildings.

Source: Christchurch City Council, 2011.

4.5 Christchurch today

The earthquake which occurred on the 22nd of February was a devastating event for the city and the country. Many historic buildings and landmarks will either be destroyed, modified or cut-back due to excessive damage. However, Christchurch is eager to leap back. The government (local and central) seems intent on rebuilding Christchurch and getting it back on its feet as soon as possible. There are currently total of 1227 buildings have been approved for demolition to date, including 933 under Canterbury Earthquake Recovery Authority (CERA, 2011). The massive rebuilding effort is not just an opportunity to rebuild Christchurch, but also to rethink the urban form of the city. Examples of other cities around the world where good ideas have made them better cities to live, work, play and visit, can apply to Christchurch. Promoting ideas such as building a compact city to reduce car use, developing an innovative public transport system, including rail and better infrastructure for cycling, and creating more public spaces and develop a more sustainable city are examples. How the city is developing the transport infrastructure support is one of the keys to building a sustainable city. As the rebuilding effort is well underway, the city should build more sustainable transport modes, where quality public transport moves masses of people efficiently between key points, easy to cycle and walk and where our first thought is a city for people, not for cars.

Christchurch has a long way to go towards developing sustainable goals, particularly when it comes to funding, but the support from the council and the published Draft Central City Plan from Christchurch City Council shows a commitment that the city is moving forward to become a truly world leading and sustainable city.

Figure 4.4: Demolition figure ground (Buildings set to be demolished shown in red)

4.6 Design considerations

4.6.1 Christchurch grid system

Christchurch's winding Avon River and grid street pattern should play vital roles in the earthquake-hit city's future. The city's grid street pattern should be preserved in the rebuilt city centre because it is a strong piece of the city's history and the core architecture of the city.

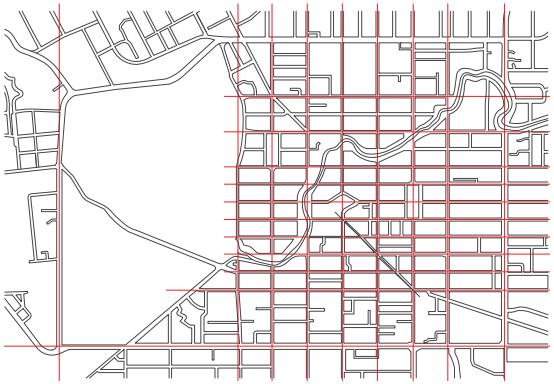


Figure 4.5: Christchurch grid

4.6.2 Character map

A number of streets and places have been identified within the Central City as critical to Christchurch retaining and enhancing its special character to attract business and visitors. Respecting the character of these streets and places will create long-term benefits for the areas they support and support the development of precincts which bring economic benefits to the city (Source: Draft Central City Plan, 2011).

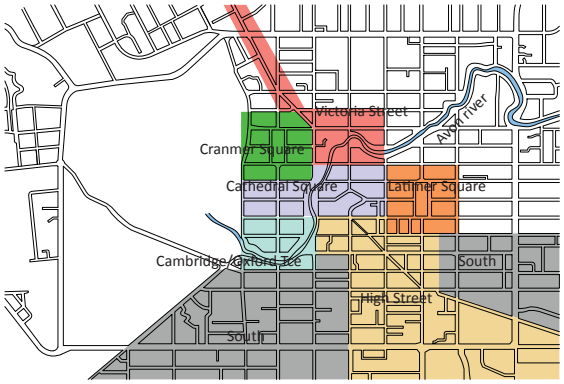


Figure 4.6: Character map. Drawing by author. (Source: CCC plan, 2011)

4.6.3 Building height

In a study from Public Space Public Life (2010) by Jan Gehl, he suggested the central city zone in the city plan allows buildings to be built too high. This creates people walking or staying nearby to be uncomfortable due to the wind effect on the ground area. Hence, in a rebuilding effort, the council is identifying the minimum and maximum building heights in the city plan (refer figure below). The heights of some key streets and places will be lower to provide for increased sunlight to create better public spaces, and recognise the character and sensitivity of these edges, as well as respecting the surrounding heritage buildings.

Figure 4.7: Maximum building heights across the city (Source: CCC plan, 2011)

4.7 Site specific

The most important part of the site selection process is to identify different modes of transport passes through a single site within the inner city to create an opportunity for passenger to transfer between services effectively. The discussion to demolish undamaged buildings to make way for a new transport interchange will be unncessary and insentitive. So when targeting a possible site it was important to take into consideration of the damaged buildings as the result of the earthquakes for a future vacant site. (Fig. 4.8) Access to local amenities is particularly important to the interchange as to increase opportunities for active and passive activity on streets and in public spaces in the central city. A search of this area was carried out to identify possible sites that could resulted an integrated, multi modal public transport merge together under one roof.

Figure 4.8: Photograph was taken on the day after the earthquake showing amount of damaged buildings in the surrounding context. (Source: Koordinates)

Figure 4.9: Site photo looking from Gloucester Street, the site was vacant following the September earthquake. (Source: Picasa web album, 2011)

Figure 4.10: Site photo looking from Worcester Street. (Source: Picasa web album, 2011)

4.8 Transport interchange site

The search lead to the area around Cathedral Square, which was appropriate as it is an area of diverse activity and major public life within the heart of the city. It is proposed the interchange be located along Manchester street bounded by two orthogonal streets, Gloucester street and Worcester street, which runs off the Christchurch Square in an East - West direction. Following the February earthquake, few buildings were badly damaged on this site. Wave House (Old Winnie Bagoes), the Pharmacy, Iconic, Lonsdale House (Pedros Restaurant), and most notably Former City Council Civic Offices were among the list of buildings set to be demolished. As a result sites in this area could create opportunity for a new interchange. Christchurch City Council has recently published a draft Central City Plan outlined how the central city will be redeveloped and rebuilt following the February earthquake. The proposed site was considered from the city council as one of the viable sites for a street station in the plan. The area will have major transport system running through the site including buses, cyclists, slow core street and re-routing of the historic tram line (refer to figure 4.27). The goal is to create a compact CBD and more transport choice within the city, which will be a good addtion to the rebuild of Christchurch city.

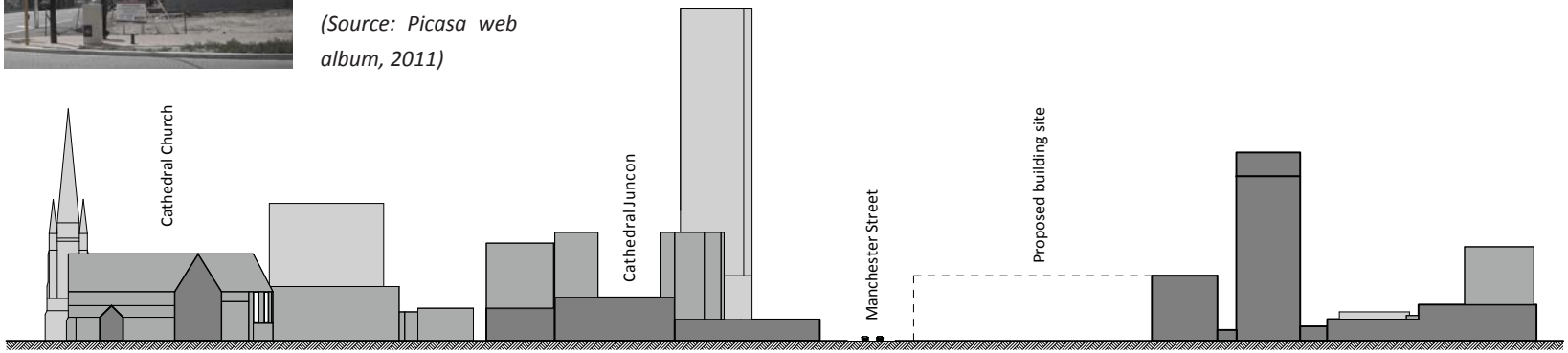


Figure 4.11: Sectional drawing of the site showing relationship with the surrounding urban context

4.9 Draft Central City Plan

Christchurch City Council produced a draft Central City Plan describing the key changes the city will make to help create this new future. One of the key agendas discussed is the need to improve the city's transport infrastructure. It is proposed that buses are to run around the perimeter of the inner-city streets rather than going through them. In this encirclement, as well as on the approach to the core, buses will pass through a number of "super stops" and "street stations". Looking at the indicative map, three or four super stops are planned around the core with at least another six on the approaches. As discussed with a strategic planner from the Environmental Canterbury (ECan), Simon Milner suggests the reason behind this is due to the radial bus operation coming from four suburban corners into the CBD zone, an accessibility concept rather than a single transfer.

The move from a central transport interchange to having three "street stations" distributed around the core of the city presents some challenges. For example, if this is the solution for Christchurch's transport network, then all buses running into or through the central city will need to run around the loop and through all street stations and three or four super stops. If one of the street stations is off the loop, how would this be achieved is questionable. It could also be time consuming for the many through bus routes that Christchurch has if they went right around, making them less convenient. Having a central interchange allows quick and easy transfers, which are essential to any modern public transport system. One of the street stations on the corner of Manchester Street and Gloucester Street (shown red in figure 4.12) is where the intended site to be in my proposed central transport interchange.

The Plan

Figure 4.12: Christchurch city council has recently published in the central city draft plan documenting the potential for the city's future of transportatio. (Source: CCC, 2011)

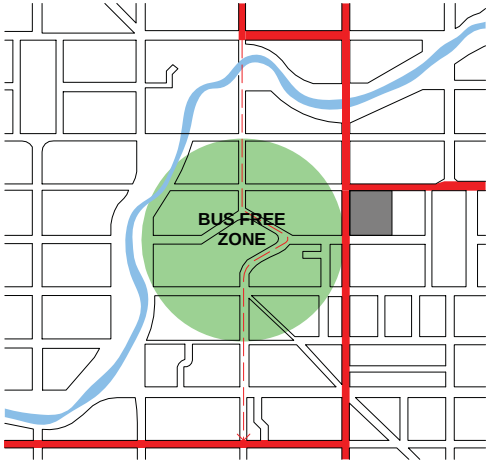


Figure 4.13: Moving buses away from major public space

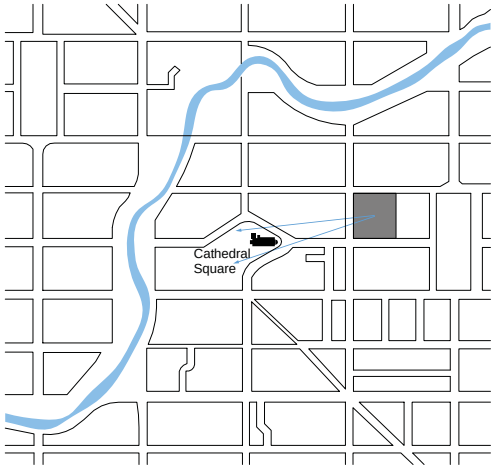


Figure 4.14: Connection to Cathedral Square

4.10 Design brief: Pedestrian friendly CBD

After thorough urban context analysis which forms the major decision on the placement of the chosen site, it then follows by site specific design brief and to conduct a further site analysis which together guide the deign process.

4.10.1 Bus free zone

Moving buses away from major public spaces

Currently there are estimated of about 200 buses running through the crentral city, which causes nuisance with pedestrians crossing in particular Cathedral Square. The plan is to re-route bus network coming from North of Colombo to Gloucester Street and Manchester Street. This creates opportunity for greater quality of life in the public square and connecting the bus network through the proposed site.

4.10.2 Connect to Cathedral Square

Having a major public space in proximity to the proposed site is an advantage because it creates a vibrant atmosphere not just on the site itself but also the surrounding areas. Hence, connection from the proposed site to the Cathedral Square is an important aspect that needs to be considered.

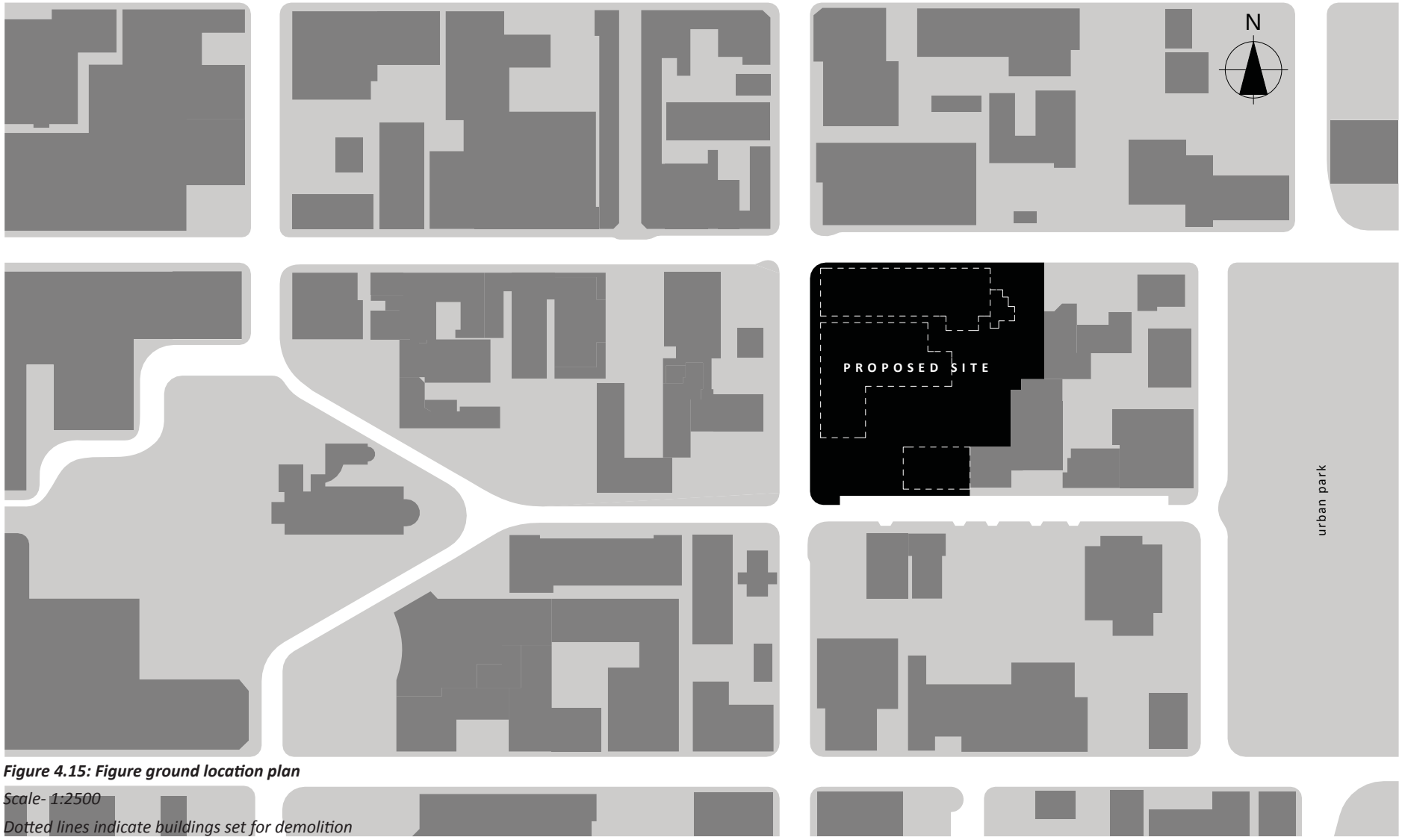
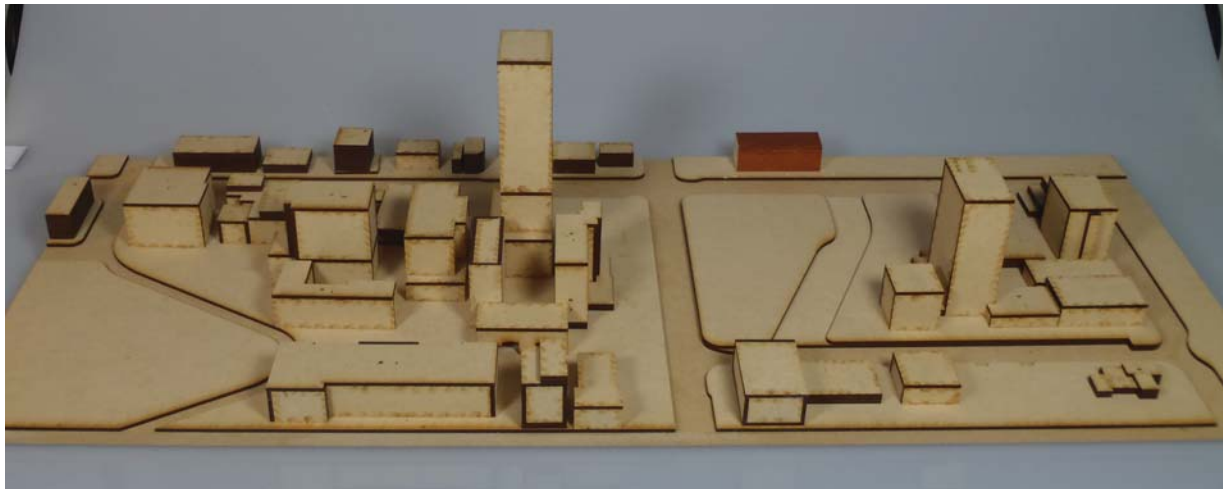
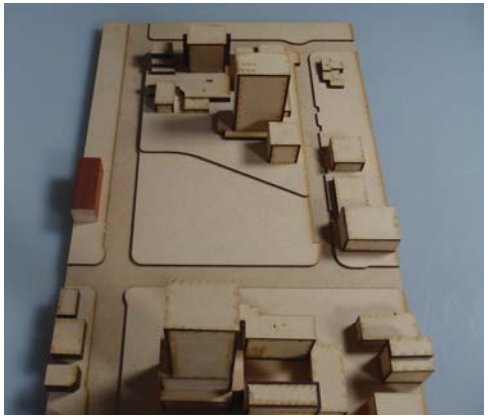


Figure 4.15: Figure ground location plan

Scale- 1:2500

Dotted lines indicate buildings set for demolition

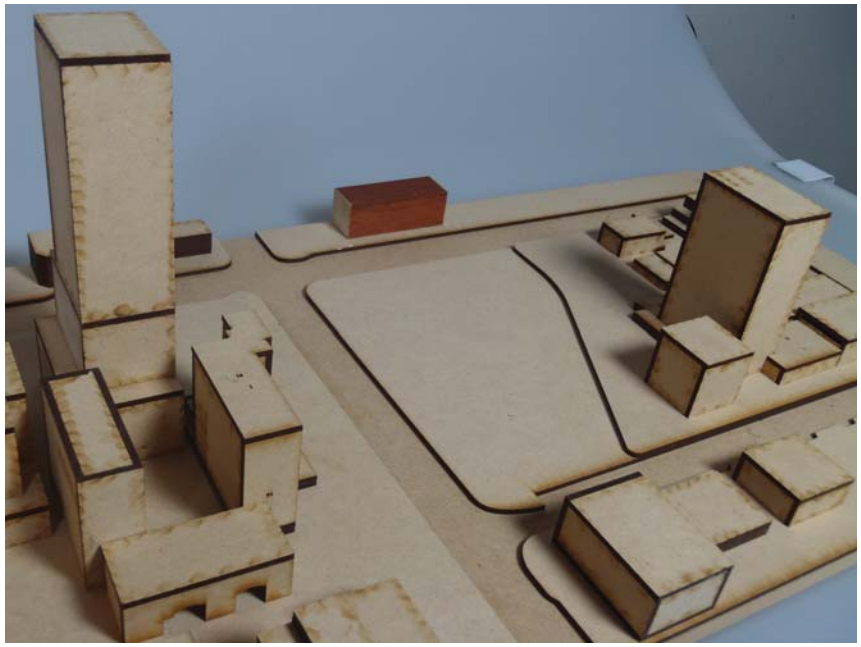




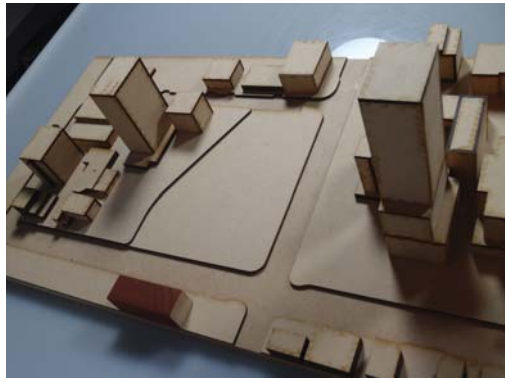
Figures 4.16-4.18: Physical model to show the understanding of the surrounding context. The main technique that was used for this physical model was by a laser cutting machine, provided by Victoria University School of Architecture and Design.

4.11 Physical model

During the design process, it is important to understand the surrounding context of the proposed site. Hence, the physical model was made to show how the site is related to the surrounding buildings. Through the understanding of this physical experiment, the evidence suggested that existing buildings exceeded new height proposed by Christchurch City Council. The most dominant skyline is the residential and hotel tower within the Cathedral Junction complex standing at the height of 92 metres, which claims to be the tallest building in the South Island. The height of the new proposed building is not to match the surrounding buildings, but the relationship to the urban form is important during the design process decision. It is intended that the height of the new building to be as low as possible, i.e. two storeys maximum, due to the new regulations and creates a contrast to the surrounding buildings.



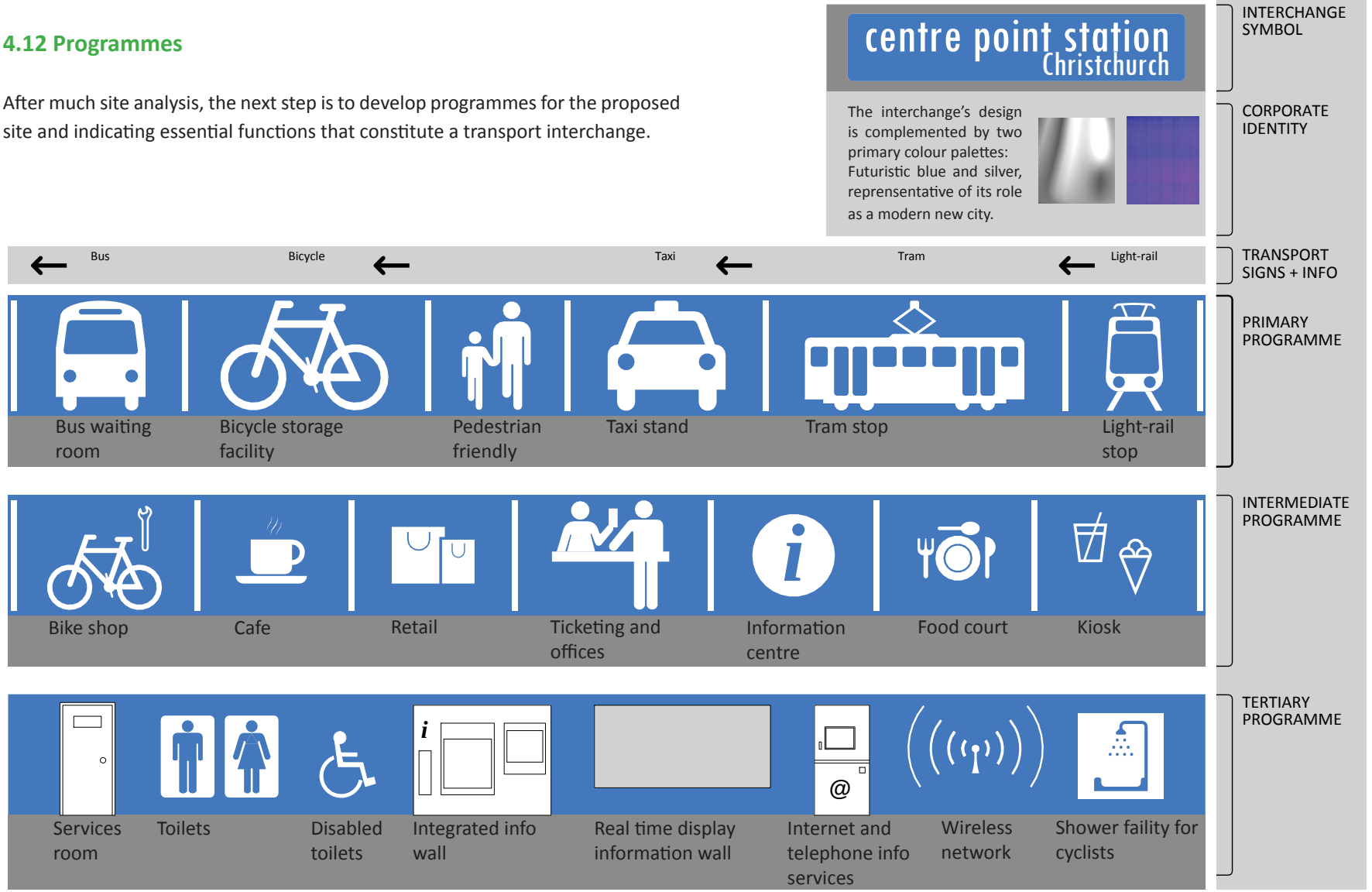
Figures 4.19: Physical model looking down at the proposed site.



Figures 4.20: Aerial view of proposed site.

4.12 Programmes

After much site analysis, the next step is to develop programmes for the proposed site and indicating essential functions that constitute a transport interchange.



4.12.1 Detailed programmes

After indentifying the essential programmes on site, some details relating to the programmes will need to be calculated in order to design the required space or number of people catered.

LEARNING FROM FORMER BUS EXCHANGE

8,600,000

APPROX. BUS PASSENGERS PER YEAR

1,850

BUSES PER DAY (1,050 OFF-STREET)

PEAK CAPACITY FROM MAIN PLATFORM

48

BUSES PER HOUR

18

AVERAGE LOADING OF PASSENGERS PER BUS

(Source: Connexion, 2010)

WAITING AREAS

BUS TAXIS TRAM LIGHT-RAIL

0.7 PER m²

NZBC OCCUPANT DENSITY
(AIRPORTS - WAITING AREAS, CHECK IN)

864

18 PER BUS
X
48 BUSES PER HOUR

PASSENGERS PER HOUR @ PEAK

864 ÷ 0.7

1,234m

SPACE REQUIRED

(Source: New Zealand Building Code, 2011)

BICYCLE STORAGE FACILTY
NO. OF BIKE RACKS / STORAGE

5%

PEAK OCCUPANTS

864

18 PER BUS
X
48 BUSES PER HOUR

PASSENGERS PER HOUR @ PEAK

864 x 0.05

43

BIKE RACKS / STORAGE REQUIRED

(Source: Victoria Transport Policy Institute, 2010)

CAFE

0.8 PER m²

NZBC OCCUPANT DENSITY
(DINING, BEVERAGE & CAFETERIA SPACES)

50m²

AVERAGE CAFE SIZE

50 x 0.8

SERVE

40

PEOPLE @ PEAK

(Source: New Zealand Building Code, 2011)

4.13 The architecture of interchanges

"The more a space accomodates diverse functions, the more numerous the flows of people, the infras-trcutures and the modes of transport that intersect there, the more its architecture needs to be simple. In order to meet the sometimes contradictory needs of the multiple actors in a place such as a station at the end of this century, the project must be legible and unifying. Supported by structures whose rhythm and geometry have been rigously defined, the buildings are- sometimes as far deep underground- bathed in abundant natural light, source of well-being and of humanity."

(Cristina Di Stefano of AREP, 1998)

The following sections of the chapter discusses, through design process with images and text, the key ideas that form the basis of the architectural project- namely circulation, the articulation of form, order of geometry, clarity of function, structural simplicity and luminosity.

4.14: Circulation: Creating routes which are fluid and legible

When designing a transport interchange it is important to establish efficient public transport systems and provide passenger ease of transfers between different modes without conflicting one and other. It is not enough to have the various forms of transport converge at a single point in order for the connection of a interchange's points of access to be arranged functionally and harmoniously. An analysis of the flow of travelers has to be carried out simultaneously with a spatial analysis: it is then possible to arrange the progression from one means of transport to another and mark reference points, thus encouraging fluidity and comfort.

In the design of the interchange, the large central space in the centre of the building allows for easy circulation from one end to the other without the disruption. The arrangement of the spaces leading up to the first floor have simultaneous views of the buses and the town. It is thus possible to have a "preview" of the route that leads from one form of transport to another, via the different services that are provided.

4.15: Testing ideas configuration

4.15.1: Analysis of flow between various modes of transportation: **BUS**

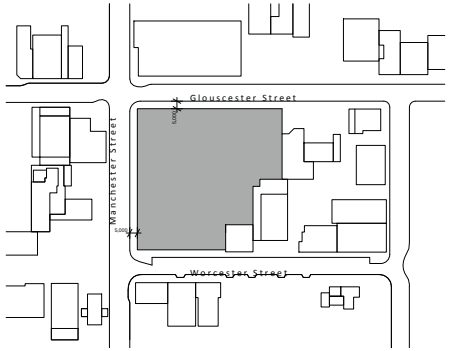


Figure 4.21: Site plan showing proposed building.
Area shaded indicates building footprint and minimum 4.5m set-back from town planning.

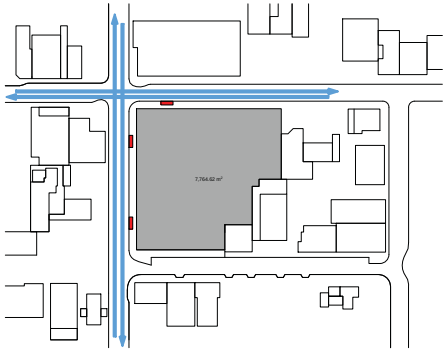


Figure 4.22: Arrows showing main flow of buses in both directions and red boxes indicates possible bus shelter placement.

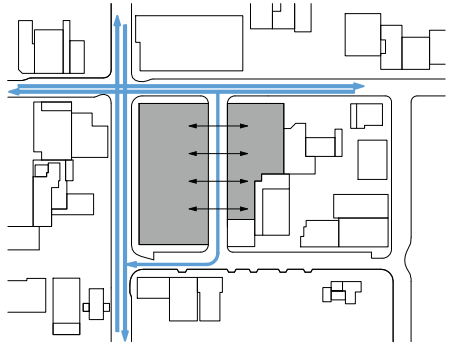


Figure 4.23: The idea of introducing buses into the building will enliven the spaces within as well as easy access for the travellers. The design also took consideration for people to provide cover where it allows people to be moved about freely inside the interchange.

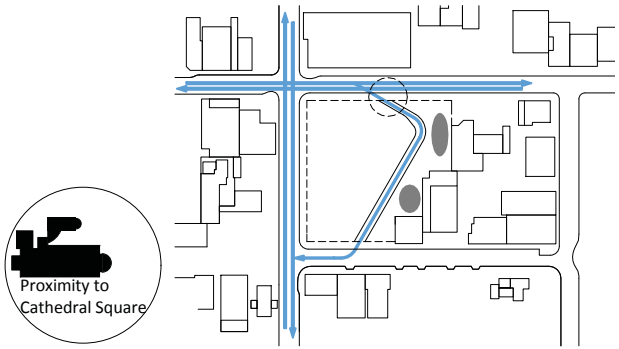


Figure 4.24: The angled bus lane follows the same concept with the building form where the idea of pulling people into the Cathedral Square is important during the design process. However, after much discussion with the E-Can staff, the suggestion came towards the northbound access of 90 degree turn facing Gloucester Street is too tight for the twin rear-axled buses, so it needs to changed. The grey shaded area suggests some possible programmes without comprimising the angular design.

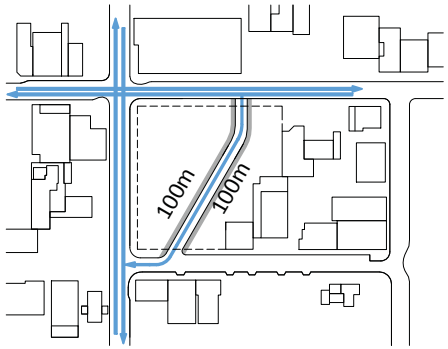


Figure 4.25: The suggestion also came through with the E-can staff that the design would work as a two 100m platform operation, with the outside lane of the southbound and northbound reserved for buses pulling onto/off platforms.

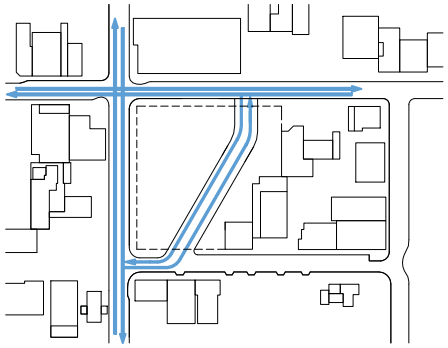


Figure 4.26: Due to the possible rising bus patronage in the future, the decision leads to introducing more buses running northbound and southbound directions, hence four bus lanes are required to accomodate large capacities of passengers.

4.15.2: Analysis of flow between various modes of transportation:

TRAM & LIGHT-RAIL

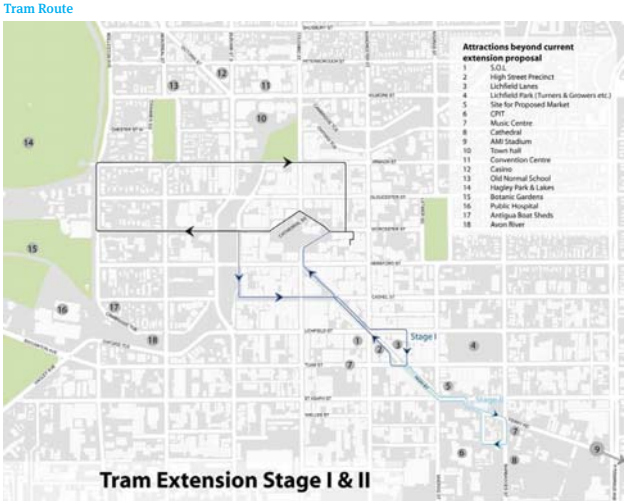


Figure 4.27: Coucil's plan to extend the route of tramway system (Source: Christchurch City Council, 2010)

Figure 4.28: Coucil's long term vision to propose a light-rail system for Greater Christchurch in the Draft Central City Plan (Source: Christchurch City Council, 2011)

Christchurch Tramway

Christchurch's first heritage tramway dates back to 1880 as a way of public transportation in the city. In 1995, trams were restored to Christchurch as a visitor attraction that runs in central city loop heritage tram system, and recently a smaller extension of the city loop is well underway. A new strategy report by Jan Gehl commissioned for Council and published in early 2010 suggested an extension of the tram system (and integration of the trams into the general public transport system) as one of a package of measures aimed at reducing car-dominance in the city (Gehl, 2010).

During the site selection process, one of the considerations was the location of the interchange must be in proximity to the existing tram system to be integrated into the public transport networks. The tram running on Worcester street now shares the same space as the pedestrians turning from vehicle only street into an attractive street environment.

Light-rail project

Christchurch city council has developed an ambitious plan to introduce a light rail system into the city as part of the central city's revitalisation and reconstruction. The aim is to generate economic growth and reduce traffic pressures on congested roads and seeks to increase public transport patronage as part of a fully integrated multi-modal transport system, while improving quality of life, city vitality and community health and wellbeing.

The exact routing of the light rail system is not known at this present, but the analysis through the Draft Central City Plan (2011) suggests the light rail goes through Manchester Street, hence the decision to place the interchange at the current proposed site contributes to the final decision.

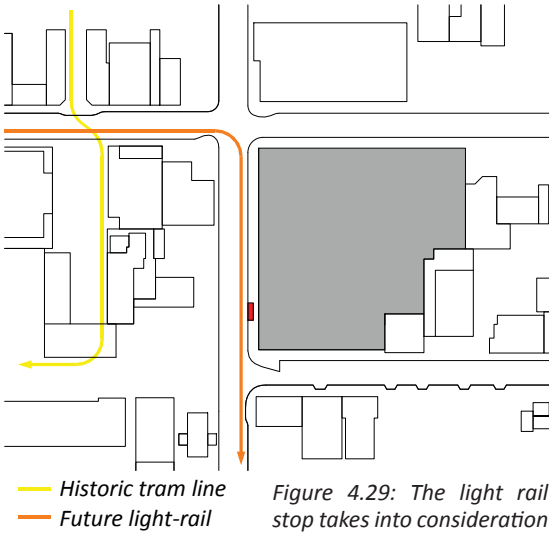
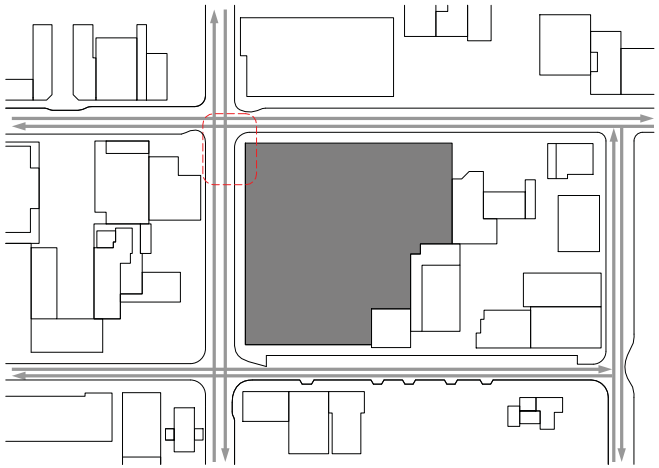


Figure 4.29: The light rail stop takes into consideration within the proposal

4.15.3: Analysis of flow between various modes of transportation:

TAXIS



Traffic volume
GLOUCESTER STREET
0 - 5,000 vehicles per day
(Source: Gehl, 2008)

Traffic volume
WORCESTER STREET
0 - 5,000 vehicles per day
(Source: Gehl, 2008)

Traffic volume
MANCHESTER STREET
10,000 - 15,000 vehicles per day
(Source: Gehl, 2008)

Traffic volume
LATIMER SQUARE
0 - 5,000 vehicles per day
(Source: Gehl, 2008)

Figure 4.30: Traffic volume count around the proposed site. (Source: Gehl, 2008)

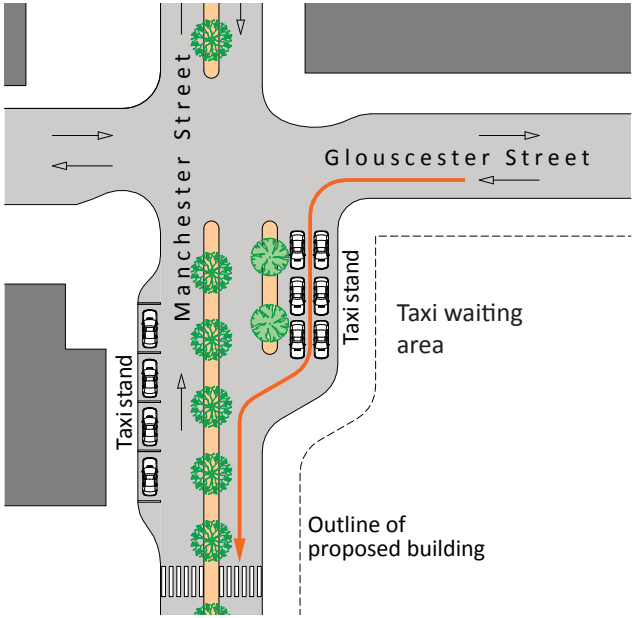


Figure 4.31: Proposed taxis stands layout

Individual public transport (IPT) services represent an important public transport mode in most towns and cities. This is typified by the taxi, a form of public transport which is available for the use of undividual travellers, or small groups travelling together between the same two points. Taxis offers a faster and more convenient alternative to mass public transport services. Encouraging the development of a good IPT service can slow growth in private transport usage, with beneficial results.

The dotted lines indicate potential layout of taxis stands in this proposal to be situated on Manchester Street, due to major nightclub scenes around the area.

4.15.4: Analysis of flow between various modes of transportation:

PEDESTRIANS

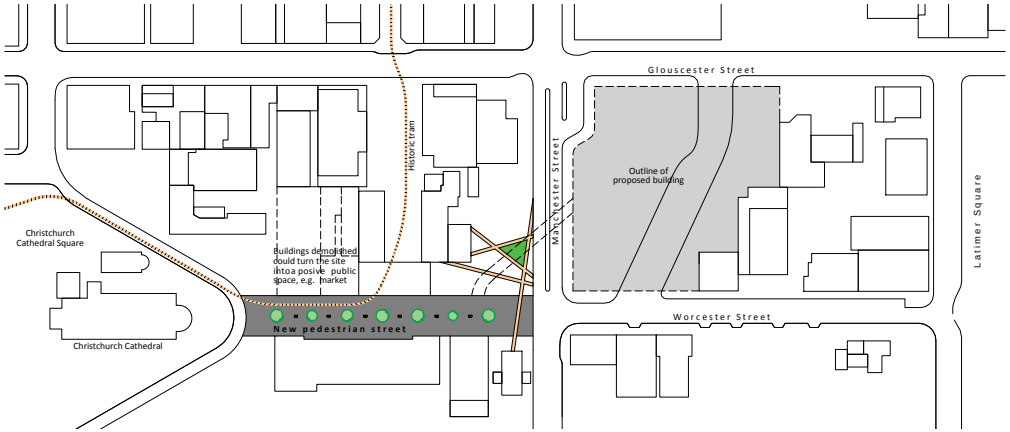


Figure 4.32:

In a study by Jan Gehl *Public Life Public Study* in various cities around the world, Gehl described the study to be focused on people and how people experience public spaces in a city. Walking is a mode of transport, but beyond that walking is a potential recreational activity and is nearly always a social activity as well as increase the health of the individual.

Due to the proximity of the proposed site to the Cathedral Square, the plan is to turn the traffic dominated street of Worcester Street (refer figure above) into a pedestrian street only to increase amount of people into the major public space in the city.

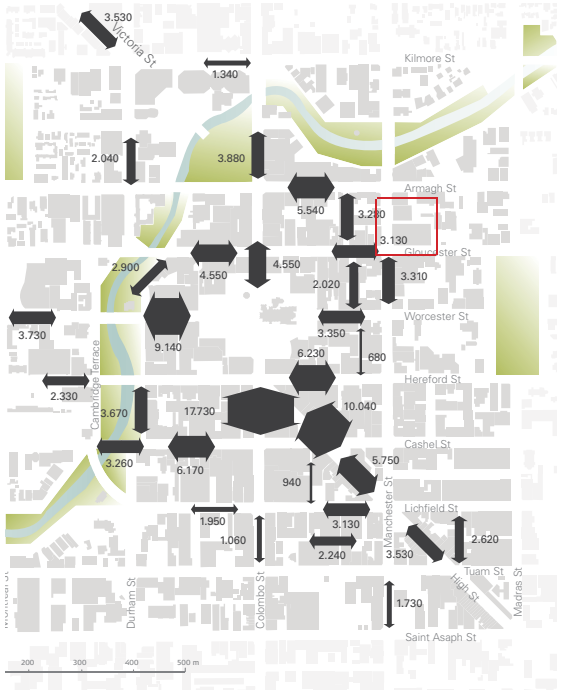


Figure 4.33: Pedestrian traffic count from Gehl (2008) in his Public Life Public Study in Christchurch.

4.15.5: Analysis of flow between various modes of transportation:

CYCLISTS

Figure 4.34 (Left): Existing cycle lane on Worcester Street leading to Latimer Square.The highlighted circle indicate conflicts with vehicle traffic on Manchester Street.

Figure 4.35 (Right): Proposed cycle route. To create a safety and pleasant environment for the cyclists, the need to reduce the conflict between the cyclists and the traffic needs to be addressed. The proposed route from Cathedral Square up into interchange's bike storage facility on first floor and exiting out through Glouscester Street level (or vice-versa) provides a seamless transition without any obstructions.

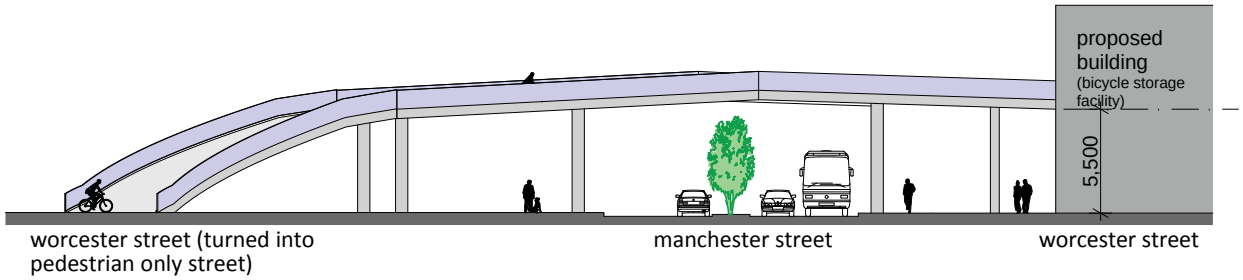


Figure 4.36: Section
Sectional drawing showing bicycle/pedestrian bridge encouraging the cyclists to use the facility inside the interchange while providing a safety route.

4.15.6 Experimenting with bicycle ramp

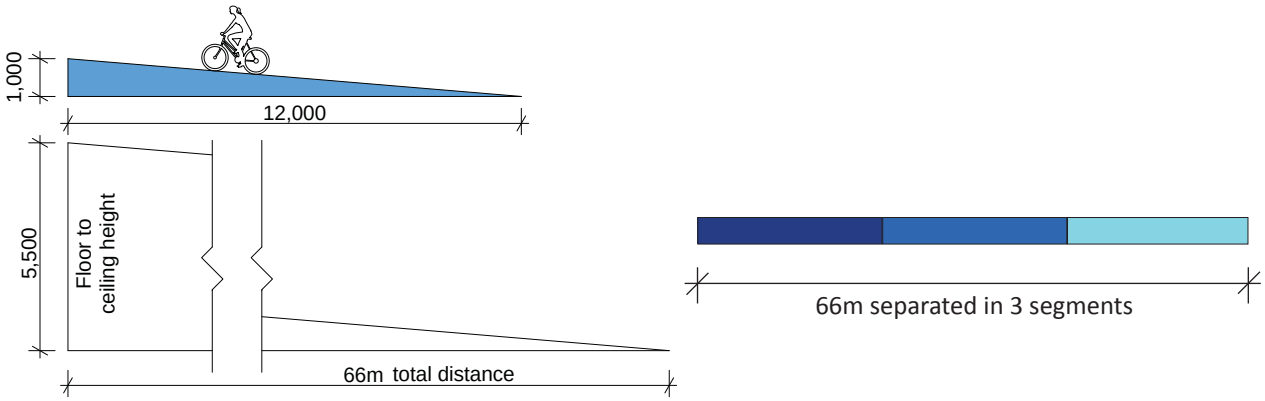


Figure 4.37: Due to the proposed 5.5m floor to ceiling height inside the interchange, 66m of distance is required as defined in NZBC for ramp ratio of 1:12.

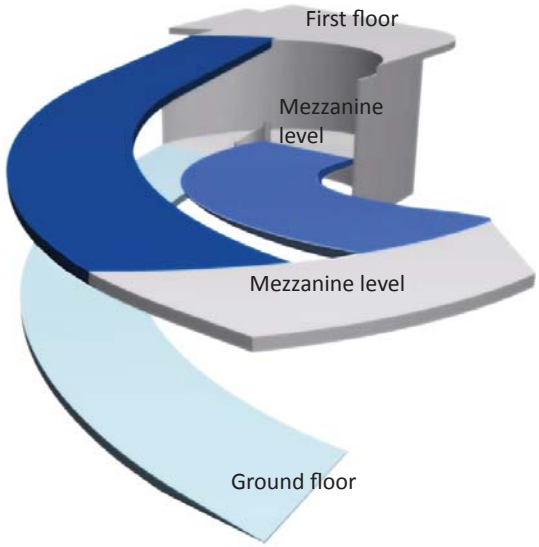


Figure 4.38: The coil structure is introduced for the ramp to accomodate enough length without comprimising the building's interior.

4.16: The design process

During the course of the research, several inspirational sources were explored as the project develops. The need for sustainability as the main drive for this project, movement suggests fluidity and dynamic shapes, the complexity of programmes and structural expression all to be contained in a low storey building. The next stage of the design process is to turn these sources into an investigation that shall probe the ideology in conjunction with its realisation to the approach, the circulation, the form, the enclosure and the details.

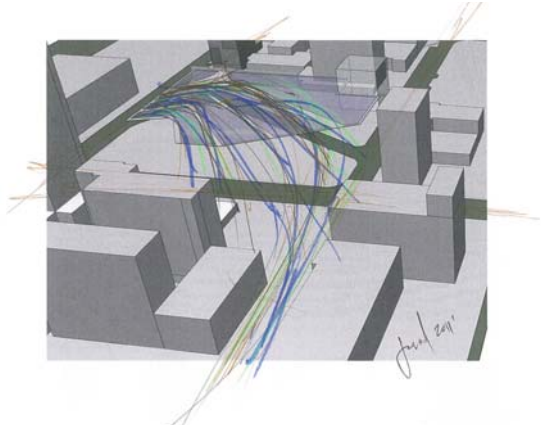
Form

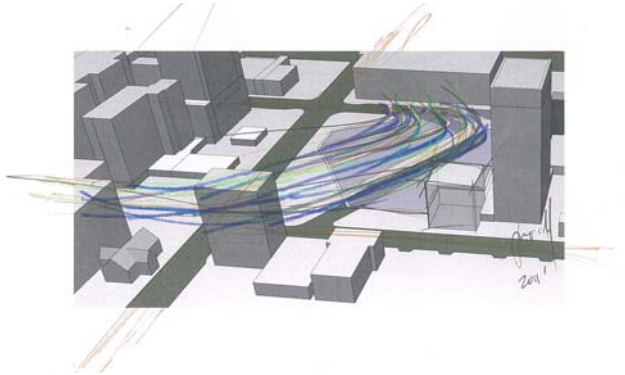
The relationship between architecture and structure can be enhanced through the articulation of form. The form of a structural armature is inevitably very closely related to that of the building which it supports, and the act of designing a building- of determining its overall form- is therefore also an act of structural design. The structures tell the passer-by how the walls or roofs that shelter them, or the support of floors that held together. They therefore constitute several points of reference for those who evolve in three dimensions.

4.16.1: Concept of form

The main concept drive for the proposed transport interchange is the relationship between the city's urban form and how the site can be linked to the closest major public amenities namely the Cathedral Square. It became clear that the project is about movement of people through the site and the surrounding. One of the questions was raised during the early stage of the design process was to show how people can get off from the transport interchange and pulling them to the Cathedral Square and vice versa.

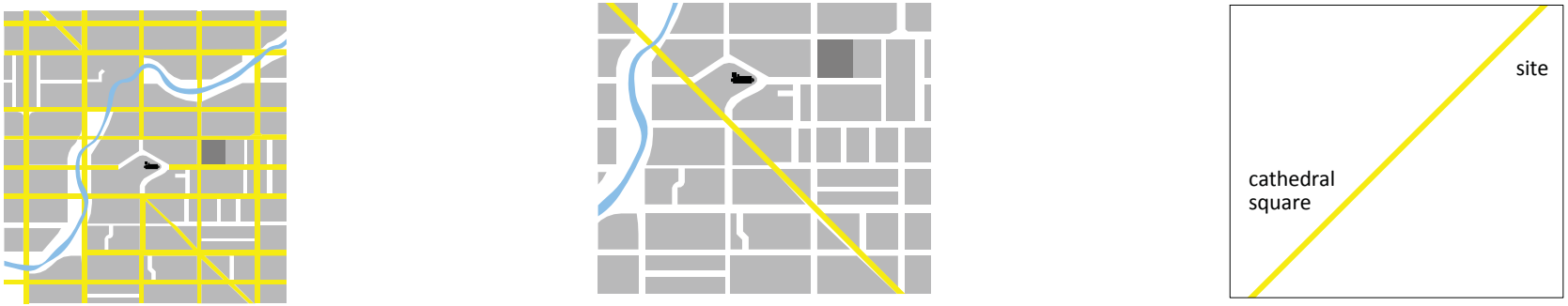
Early sketches show vector diagrams (see figure 4.24) as abstract analysis of people's movements through the site. This initial concept prompted two investigations: the first had to do with large-scale issues of the project such as how to access the site and which flows and forces might act as organisational vectors. The second investigation focused on the program brief, on what were asked to provide, on how the building was intended to work. This guiding principles began as a slow search for the general layout of the building. Once this began to take shape, the size and location of certain functions is assessed.



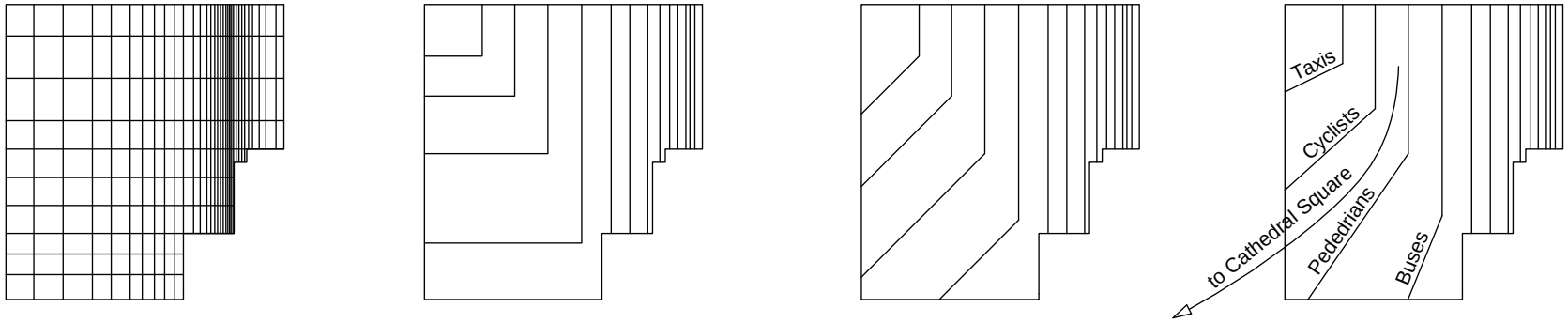


Figures 4.39-4.40: Early sketches during the design process, showing lines of movement as the main drive for the concept.

The notion of grid



Figures 4.41: Grid analysis diagrams showing the main concept drive behind the design



Figures 4.42: Preliminary vector diagrams

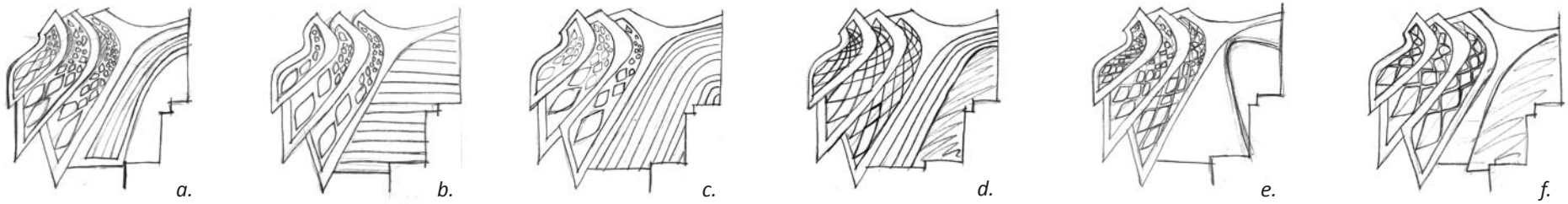


Figure 4.43a-f (top): Hand sketched drawings showing development of patterns on roof.

4.16.2: Roof

From conceptual stage it is apparent that the roof element is an important part of the design. The form derived from plan and the patterns started to generate through form. The patterns on the roof are taken from the concept of chain reactions, a sequence of reactions where a reactive product or by-product causes additional reactions to take place. So Imagine a force is applied in the middle and the energy is being released causing the reactions to be dispersed outwards. (See figure 53)

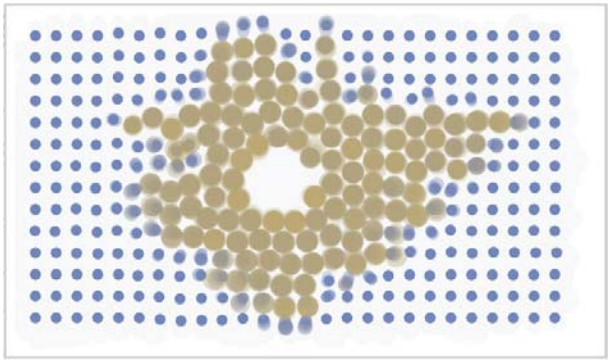


Figure 4.44: Concept of patterns on roof.

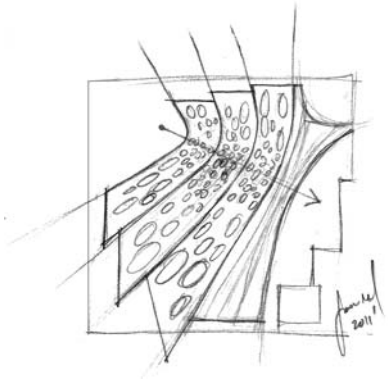


Figure 4.45: Initial concept of roof patterns.

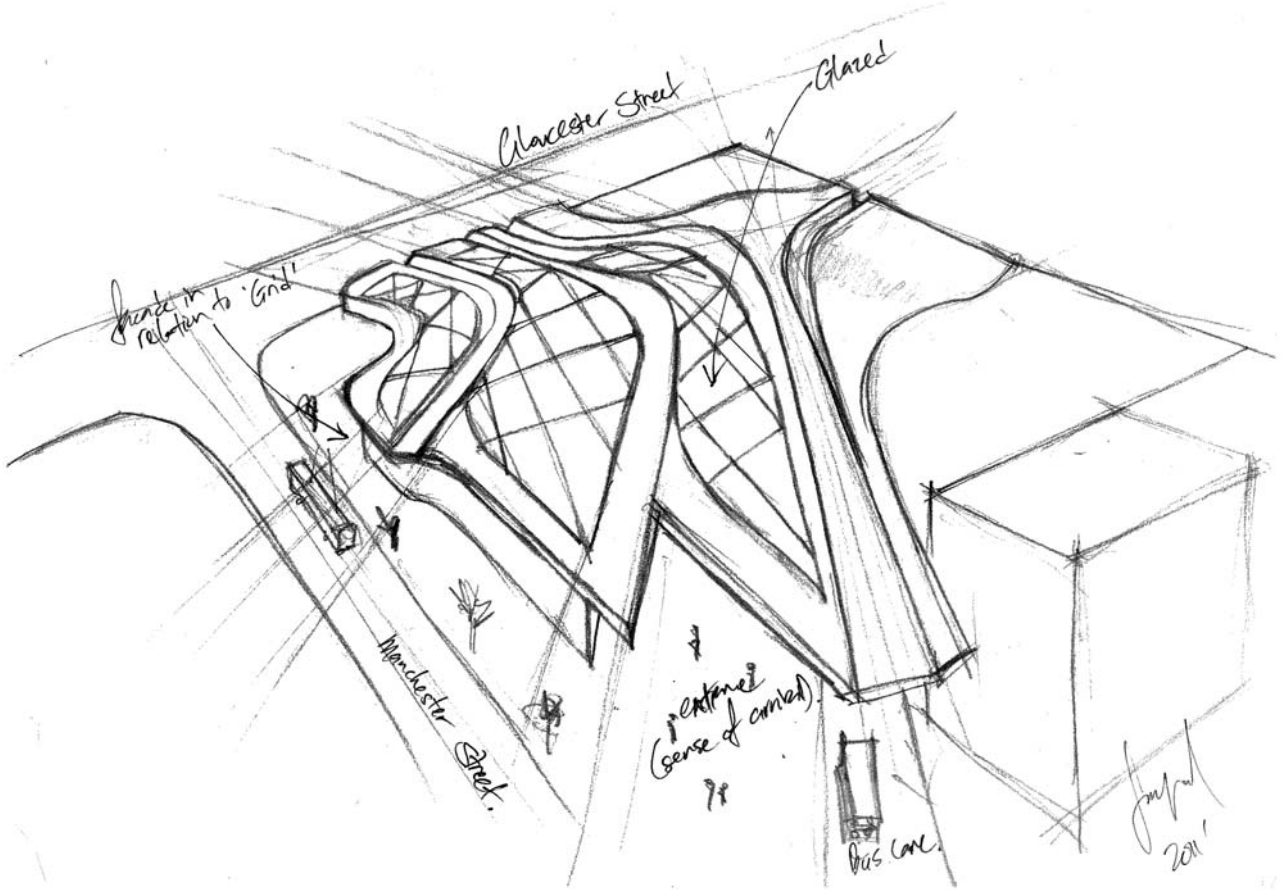


Figure 4.46: Early sketches by author.

Figure 4.47: Testing of laser cut model.

Figure 4.48: Testing of laser cut model after much design consideration

4.16.3: Preliminary floor plans and exterior design experiments

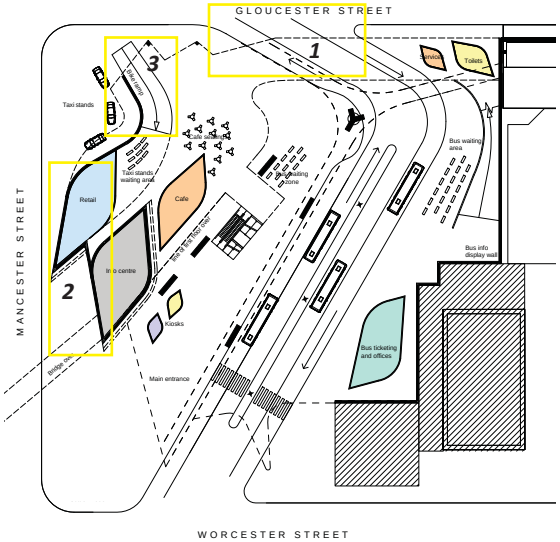


Figure 4.49: Preliminary Ground floor plan (NTS), coloured "pods" are the shapes reflected from roof patterns. Few problems encountered 1) too sharp of a turn for bus, 2) facade should relate to street grid, 3) bike ramp.

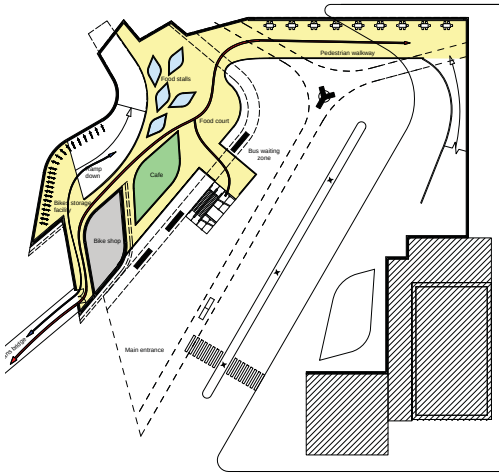


Figure 4.50: Preliminary first floor plan (NTS), suggested pedestrian bridge on the north side is inconsistent with the flow of plan.

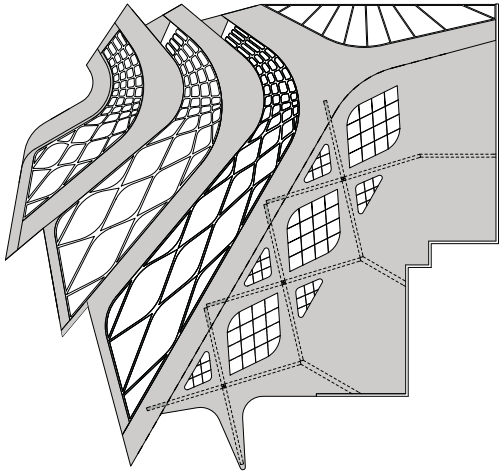


Figure 4.51: Preliminary roof plan (NTS), problems encountered include geometry of roof patterns not refined, and east side of roof is conflicting with adjacent roof.

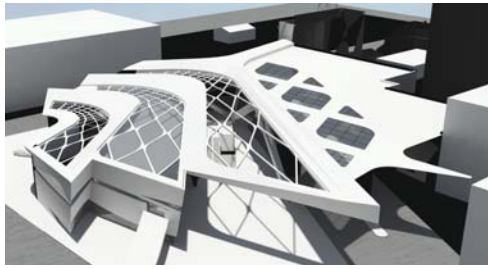


Figure 4.52: Iterations of roof design: patterns on the roof not refined.

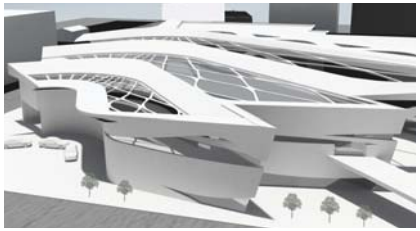


Figure 4.53: Critical comment made regarding the exterior facade to be too enclosed, instead it should be glazed to reflect the life on the street.

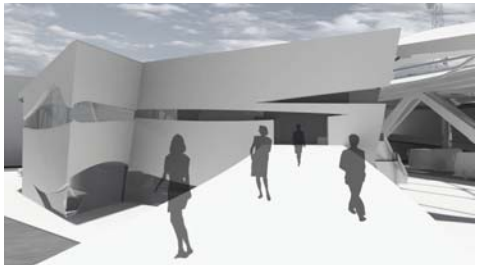


Figure 4.54: Pedestrians/cyclists bridge to invite people into the interchange. Exterior facade should also relate to the street grid.

Interior design experiments

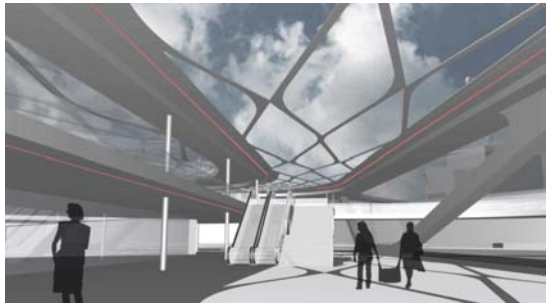


Figure 4.55: Initial idea is to create atrium type spaces filled with natural light. Comment received regarding the vertical columns should be inclined to enhance the sense of movement.

Figure 4.56: One of the major design decisions is whether the interior structure should be concrete or steel. Here, inclined concrete columns are used but due to the bulkiness of the material, the decision was turned to more light-weight structure of steel.

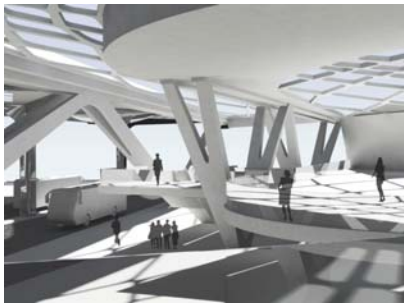


Figure 4.57: View from first floor looking down. The feeling of this interior shot was the sense of "heaviness" inside the interchange due to the concrete material, and so the decision to change to steel was the ideal choice.

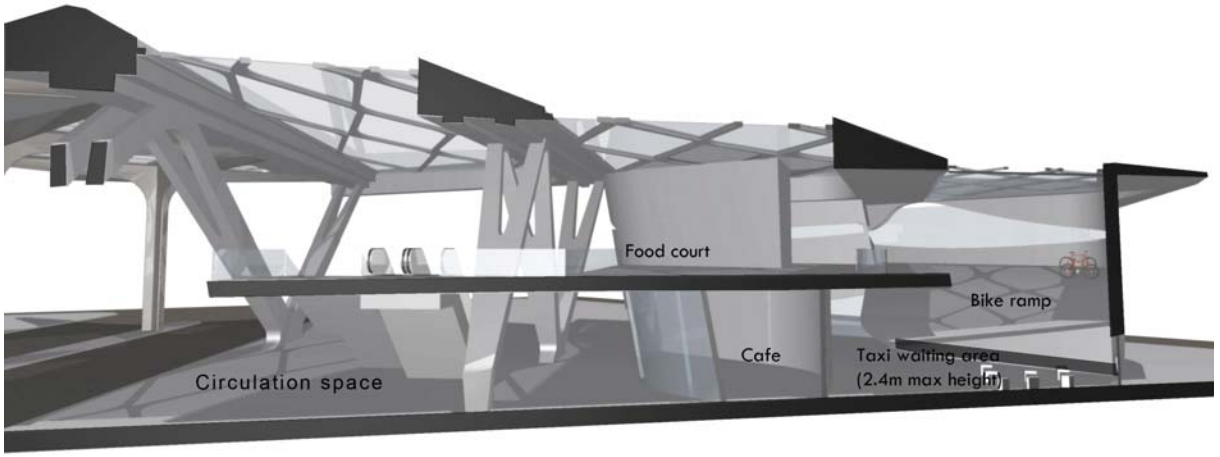


Figure 4.58: Preliminary section showing array of programmes inside the interchange.

4.17: Refining geometry

After much continuous design process, the attention must now turn to redefining the geometric order of roof patterns, which is important as it is the primary source to create harmony and order in architecture. The origin of this basic geometry is through the centre point, in which it radiates outward with various radius and 10 degree indifference in between each line as shown in figure 4.15. From then on, it is the matter of connecting the dots and the patterns on the roof started to develop into pinecone pattern.

Once the roof geometry is developed into a cohesive manner, what goes below where array of activities and life happening within spaces is also important. Interchanges have to organize the passage and exchanges that take place between numerous transport networks in a restricted space. They accommodate a multitude of commercial activities and have therefore become extremely complex amenities, but it is important that they remain simple to use for the citizen who must be able to understand everything that is to offer and how one can benefit from it.

Again it is geometry that makes this possible: geometry gives order to places, it sets out axes, scales, rhythms, and like a language or music, it reaches out to the passer-by to make the space in which one moves intelligible to them (Duthilleul, 1998). Every part and every detail reflects the whole and makes it possible for people to situate themselves with respect to it as a whole. Whereas journeys project people into the future, an interchange enables them to find their footing in a three-dimensional space which is expressed through geometry. The measures that articulate space and time partake of in this passage.

This application of measures is reflected through the natural lighting penetrated through the roof and wide open spaces throughout the whole building making the users easy to find their way around. The large overhang roof in the south-west corner of the site marking the main entrance giving it a sense of arrival, and with eight metres of high ceiling space, captures the feeling of serenity to daily travellers on their journey.

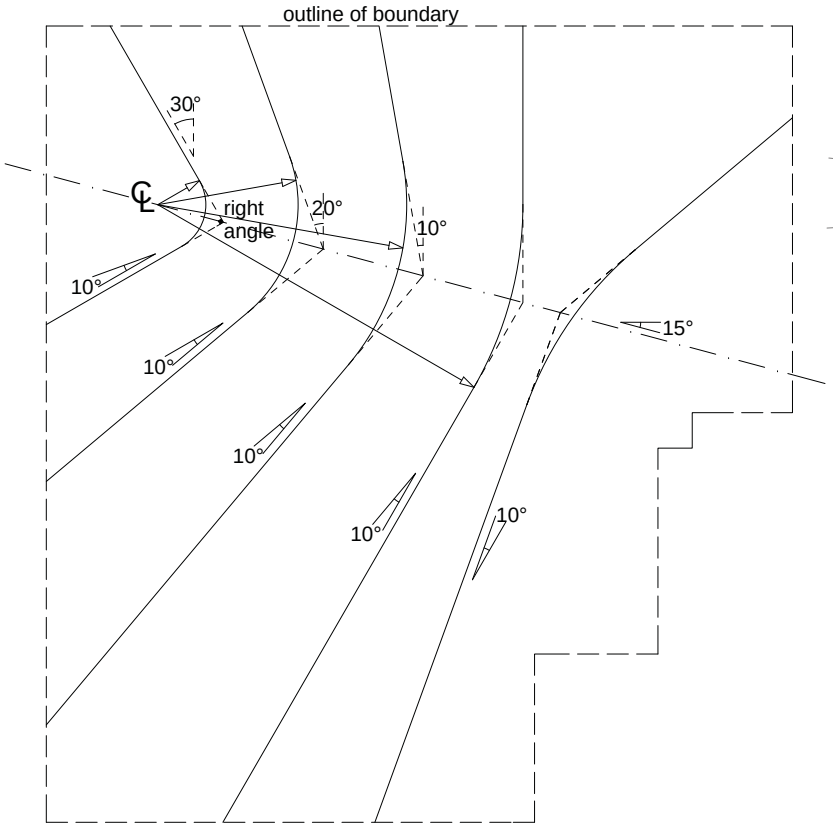


Figure 4.59: The form was geometrically defined to give sense of harmony and order in architecture.

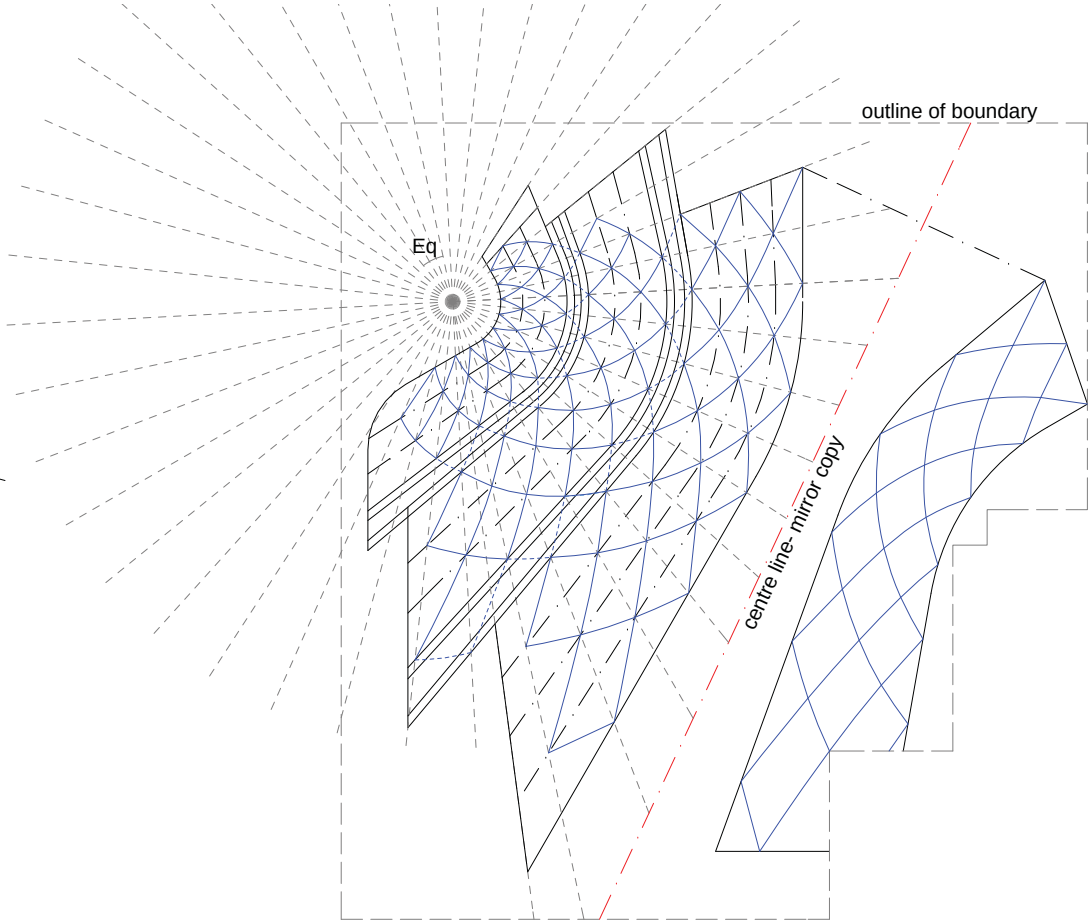


Figure 4.60: Once the basic roof form was determined, a mathematical term of angular displacement is applied in which a line is drawn from the origin and rotates equally about its axis in 360° circular motion. The patterns are then formed once the lines are drawn from point to point that gives patterns similar to a pinecone.

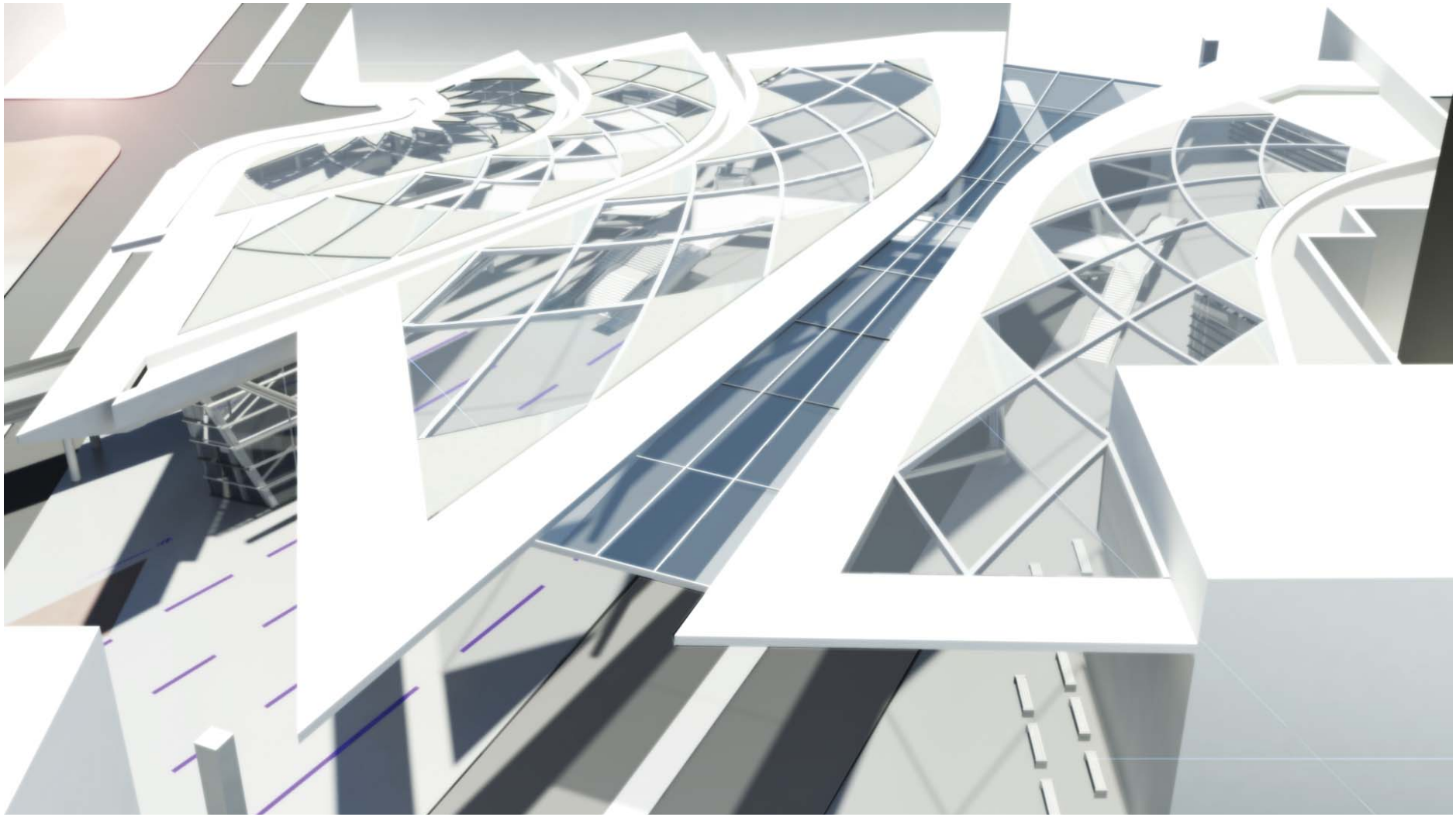


Figure 4.61: Aerial view of refined roof patterns.

4.18: Unifying structure

> *"...structure is columnar, planar, or a combination of these which a designer can intentionally use to reinforce or realise ideas. In this context, columns, walls and beams can be thought of in terms of concepts of frequency, pattern, simplicity, regularity, randomness and complexity. As such, structure can be used to define space, create units, articulate circulation, suggest movement, or develop composition and modulations. In this way, it becomes inextricably linked to the very elements which create architecture, its quality and excitement." (as cited in Charleson, 2005, p. 1)*

Interior structure as an architectural element coincides in its own right. It addresses the question of how structure enlivens and articulates interior spaces and surfaces. Interior structures can also read as responding to aspects such as a building's geometry or function. It maximises planning flexibility, subdivides space to facilitate separate functions and articulates circulation paths.

Therefore, the design for the interchange centres on building's geometry and function. The most notable structural element in the design is the use of steel inclined columns to suggest movement in the longitudinal direction since the function of the building is designed for transport. During the design process, one of the major decisions was to choose either steel or concrete as the main structural material for the proposed building. The initial concept was to use concrete structures throughout the building, including the inclined columns. But it was later changed to steel after numerous design implications due to the core nature of concrete properties being too heavy and bulky appearance. So the decision was changed to more lightweight structure of steel to support the roof, while the floors and beams remain to use concrete.

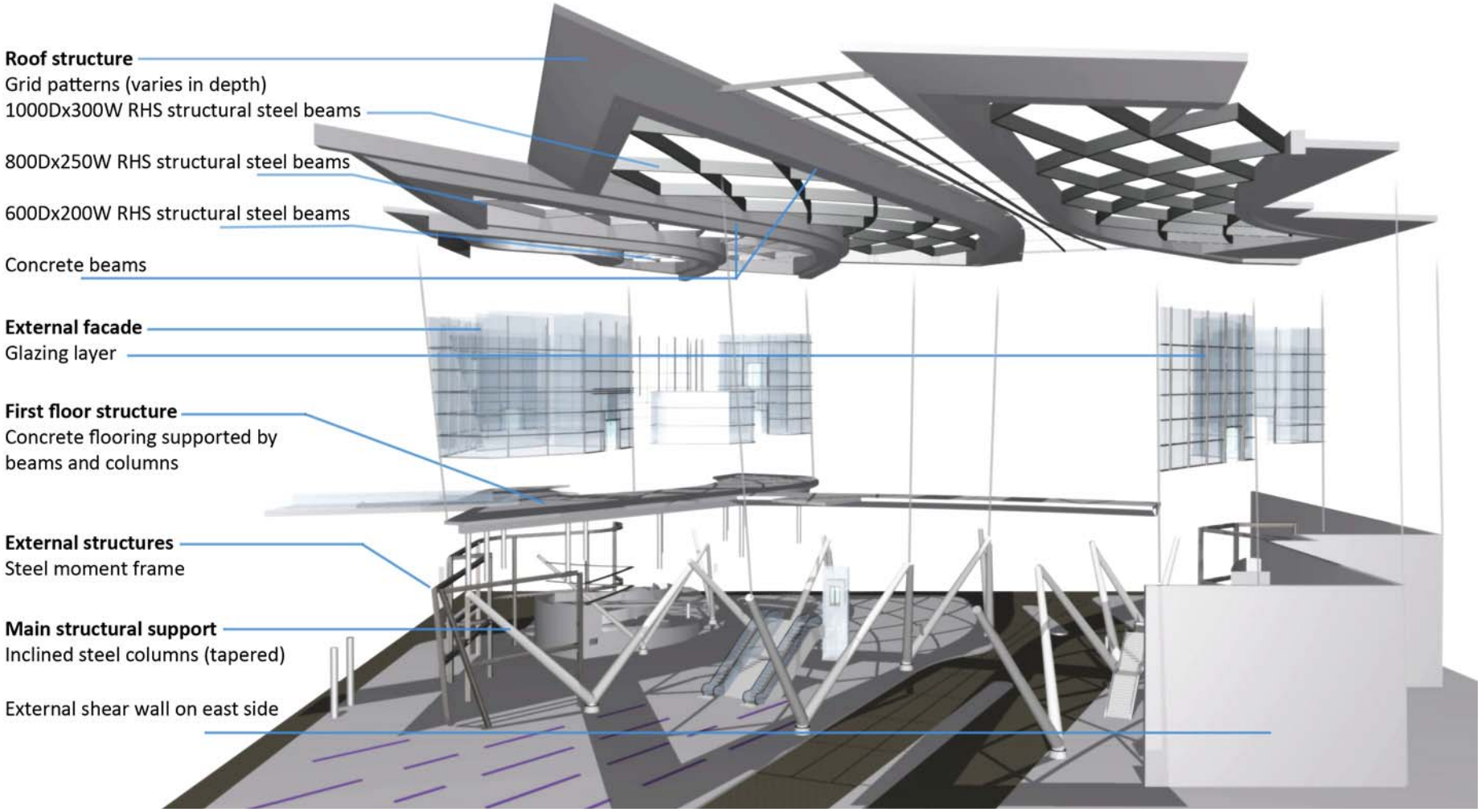


Figure 4.62: Exploded axo showing main structural components

4.19: True to its material

Often buildings can illustrate the architectural potential for enriching spaces by using exposed structure located on interior surfaces. All of the components are shown so that the reason for their existence is explained. The parts under tensile stress or compression are legible and the joints are exposed. The assemblages partake of this expression where every detail counts. The function of this construction is to hide the formal work of the architect, to hide the conventional nature by subordinating it to building systems and technology. Its effect is the naturalisation of form as the simple result of technology.

The design of the large span ribbed structures on the roof is exposed to express and accentuate building geometries. The connection of joints to the steel inclined columns supported by concrete beams is all exposed in such a way that leads to additional architectural enrichment. A high level of detail qualifies this structure as a hall.

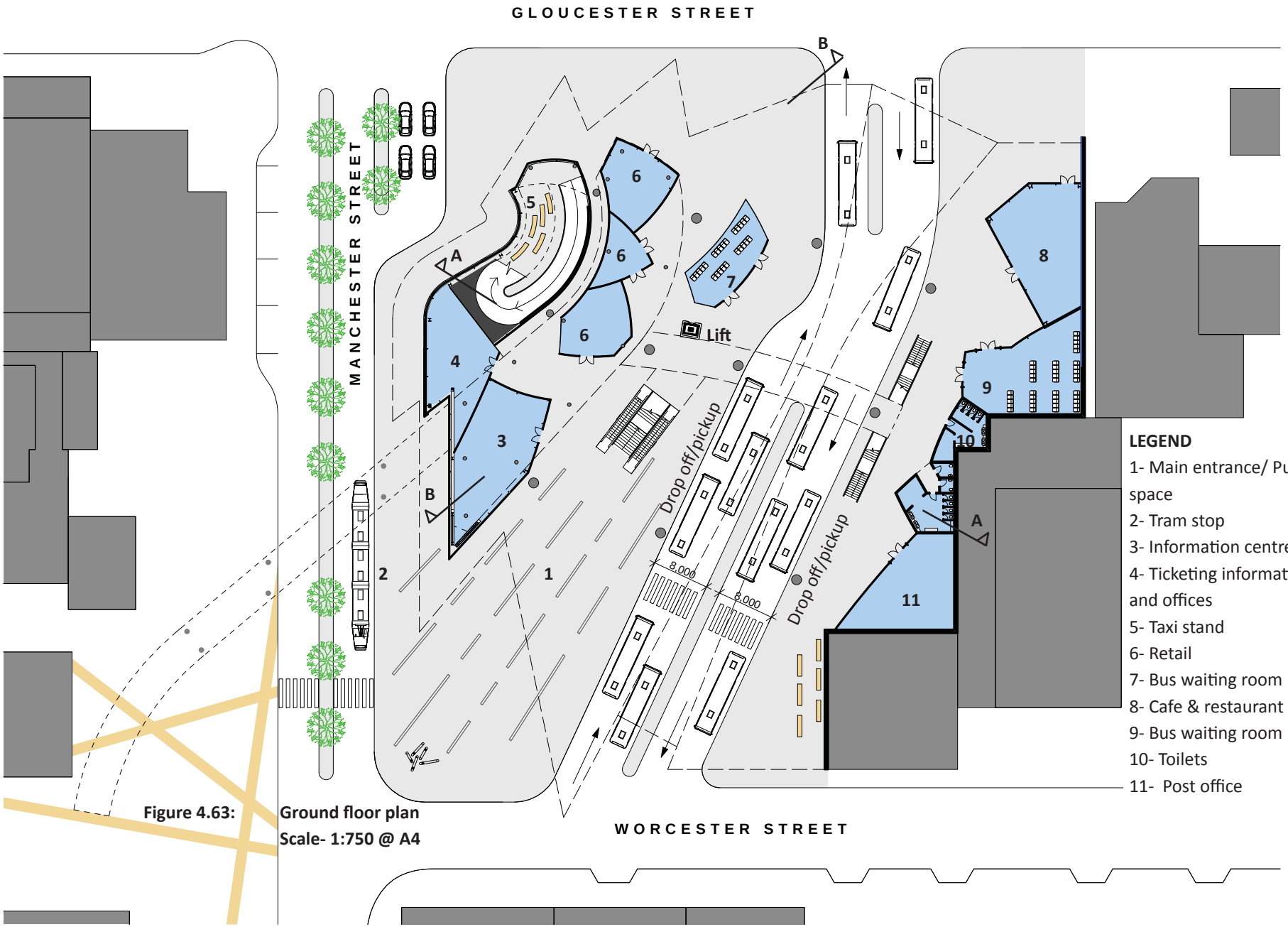
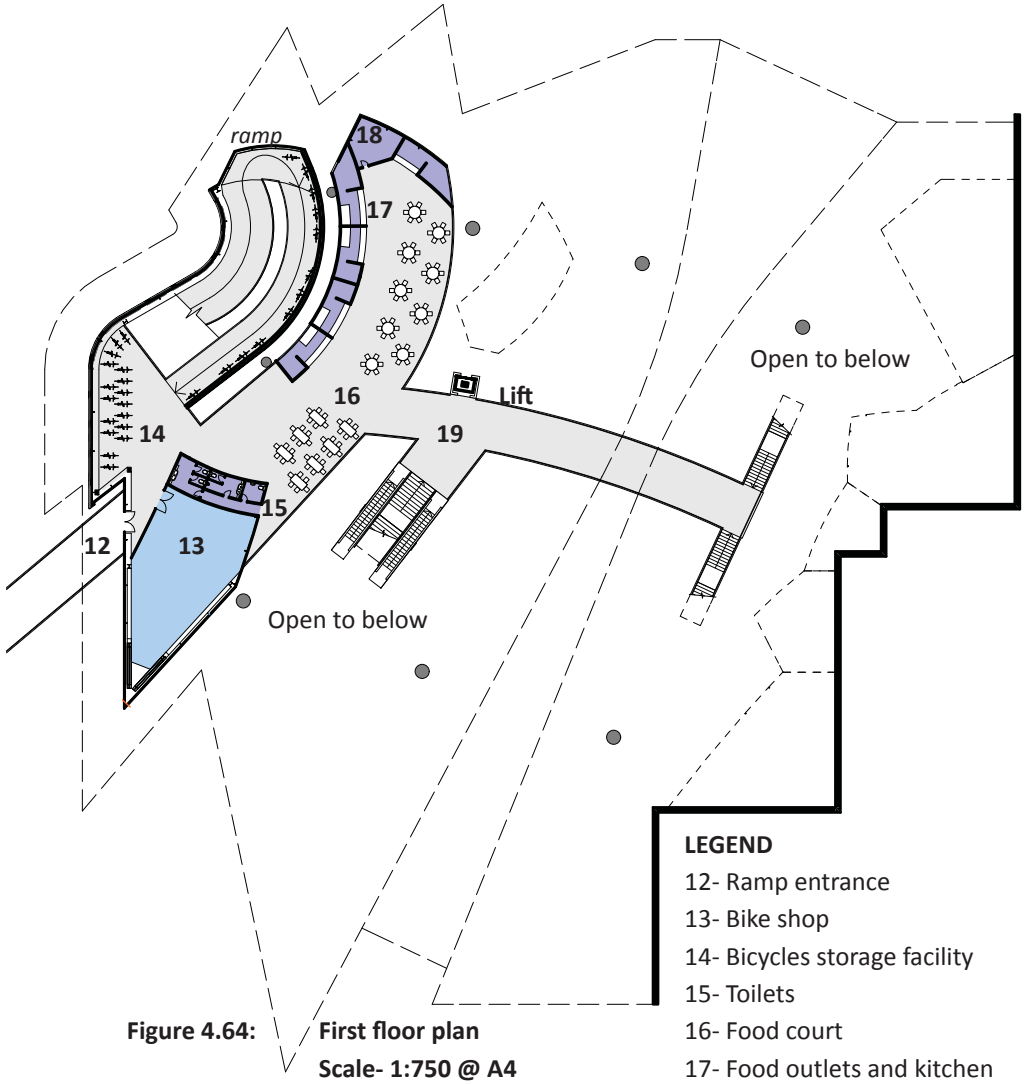


Figure 4.63: **Ground floor plan**
Scale- 1:750 @ A4

Figure 4.63: Floor plan design implications

The shape of the glass enclosure on the ground and first floor plans reflect the design of the roof patterns, in which it repeats from floor all the way up to the ceiling, enhancing the design elements through the dynamic shapes.



LEGEND

12- Ramp entrance
13- Bike shop
14- Bicycles storage facility
15- Toilets
16- Food court
17- Food outlets and kitchen
18. Services and storage
19- Walkway bridge

Figure 4.64: **First floor plan**
Scale- 1:750 @ A4

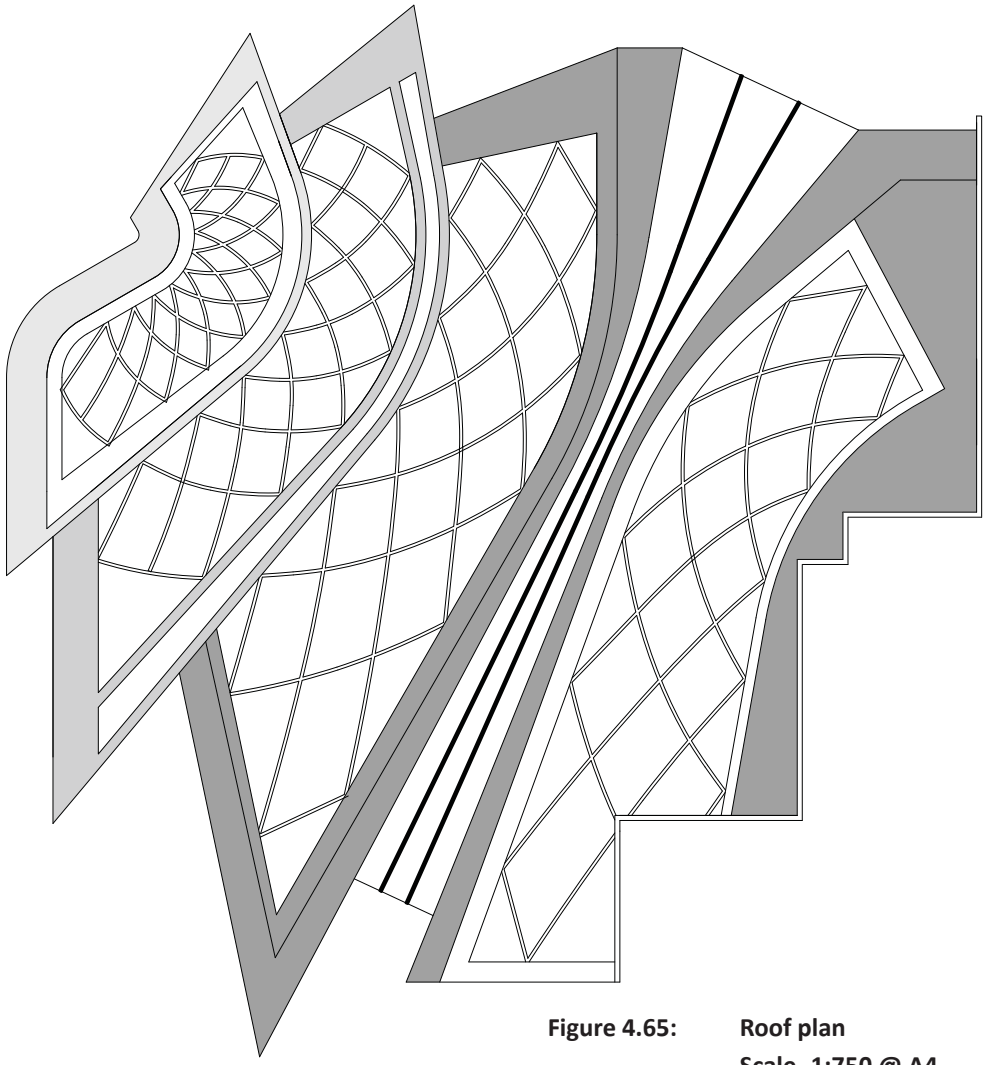


Figure 4.65: **Roof plan**
Scale- 1:750 @ A4

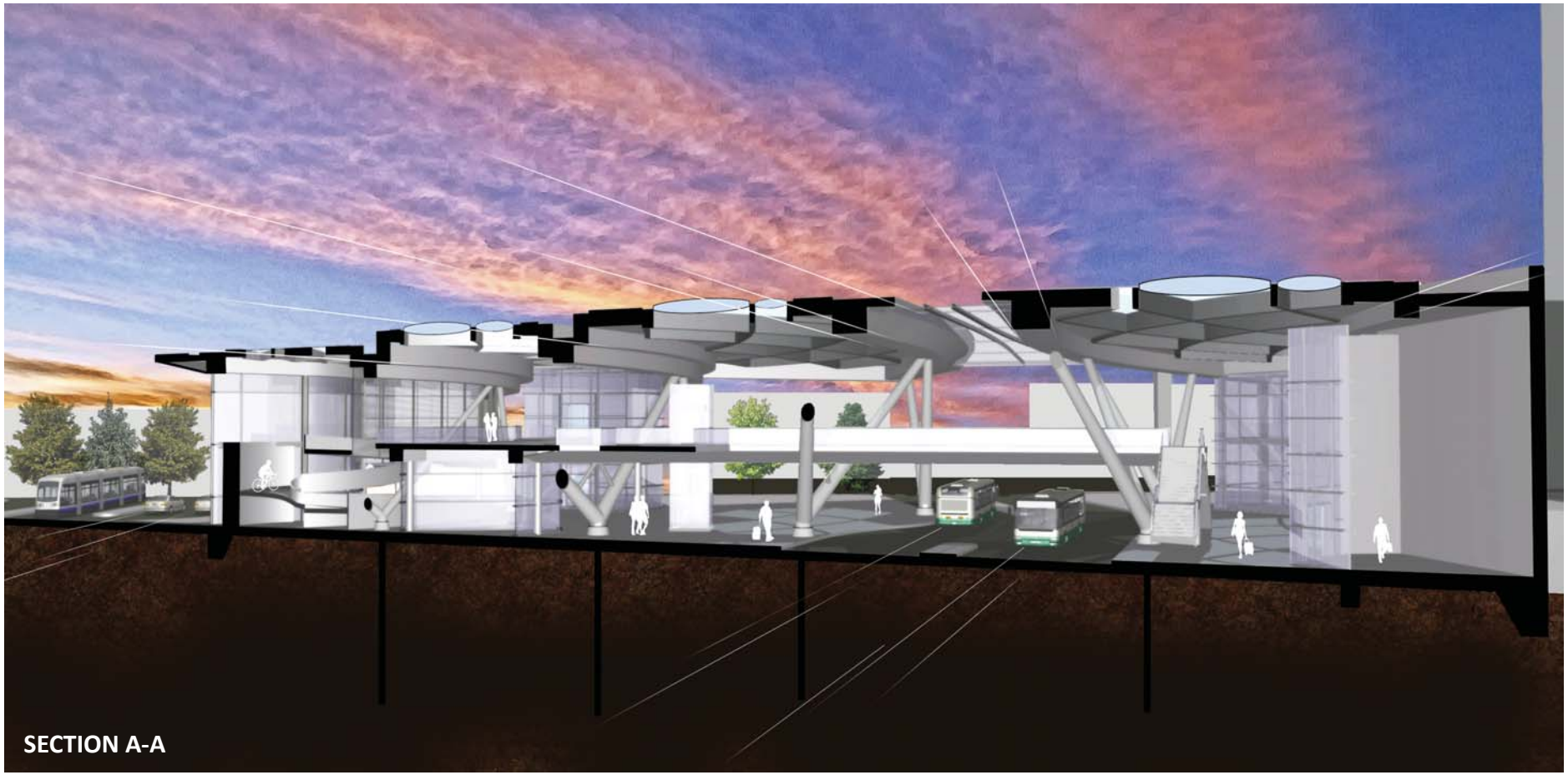
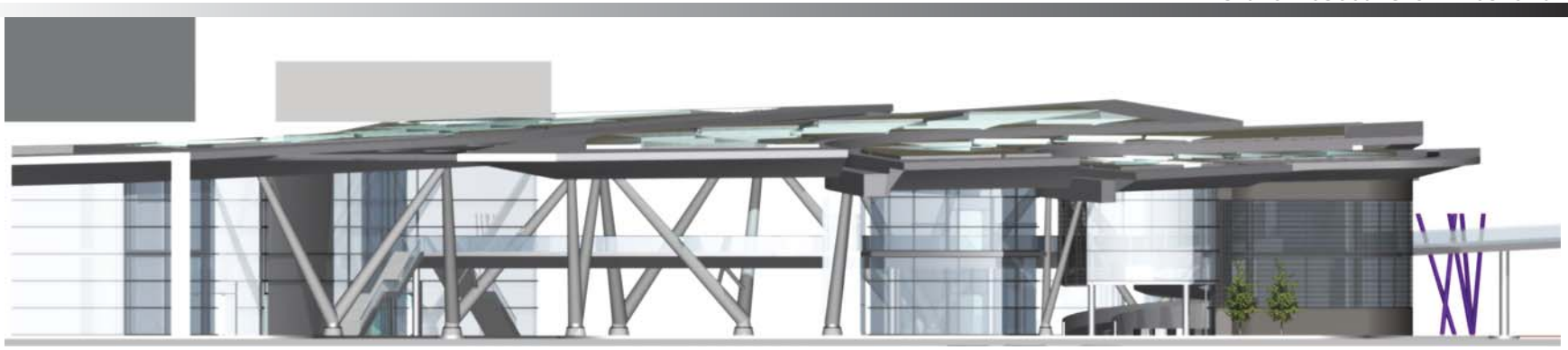


Figure 4.66: Sectional perspective

Figure 4.67: Sectional perspective



NORTH ELEVATION

SOUTH ELEVATION

WEST ELEVATION

Figure 4.68: Elevations

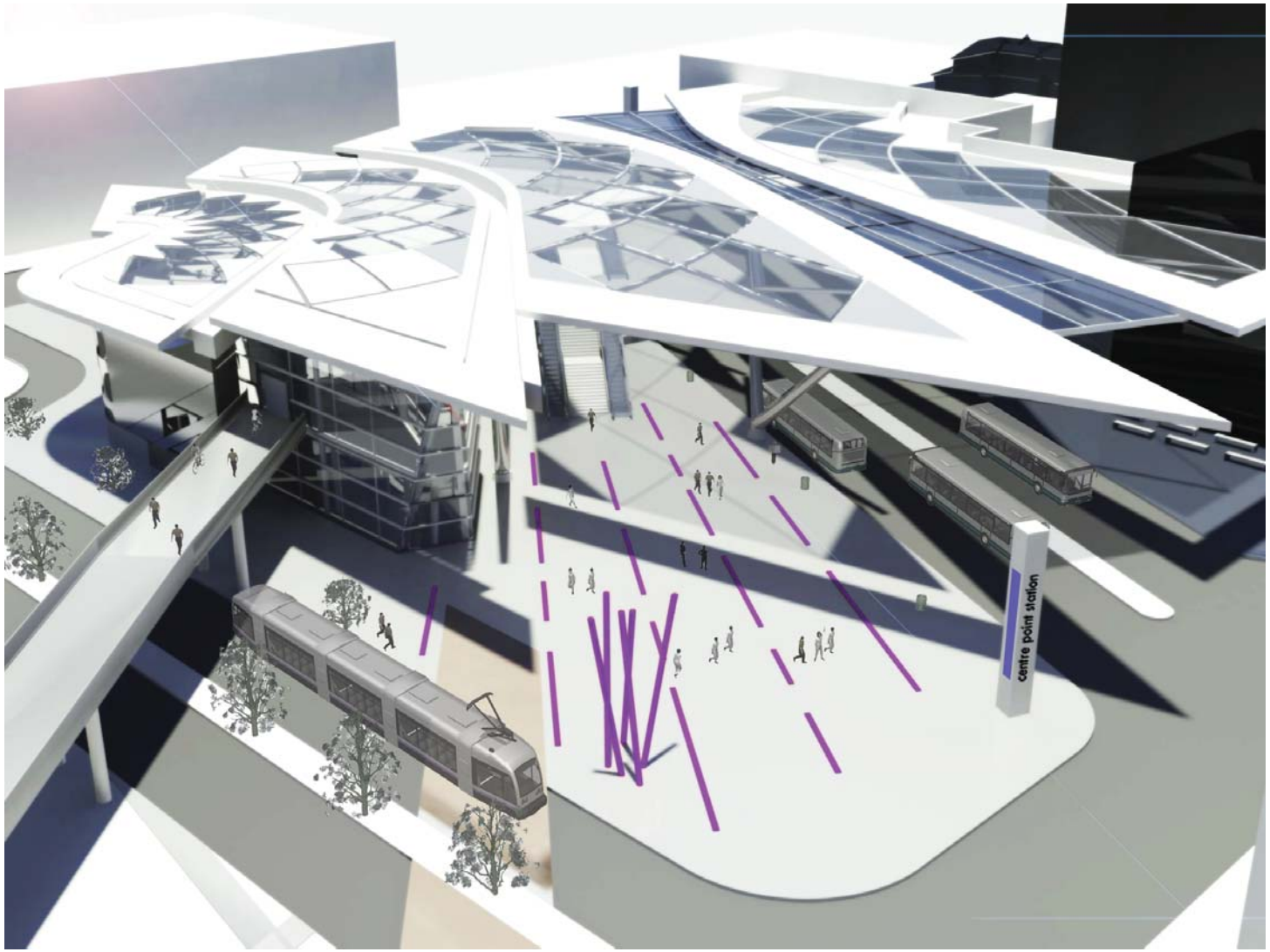


Figure 4.69: Aerial view of overall scheme. The design of the main entrance is intended as a public space for people to meet and hang out. The sculpture and the "lines" are marked as to give sense of arrival and to evoke sense of movement into the interchange.

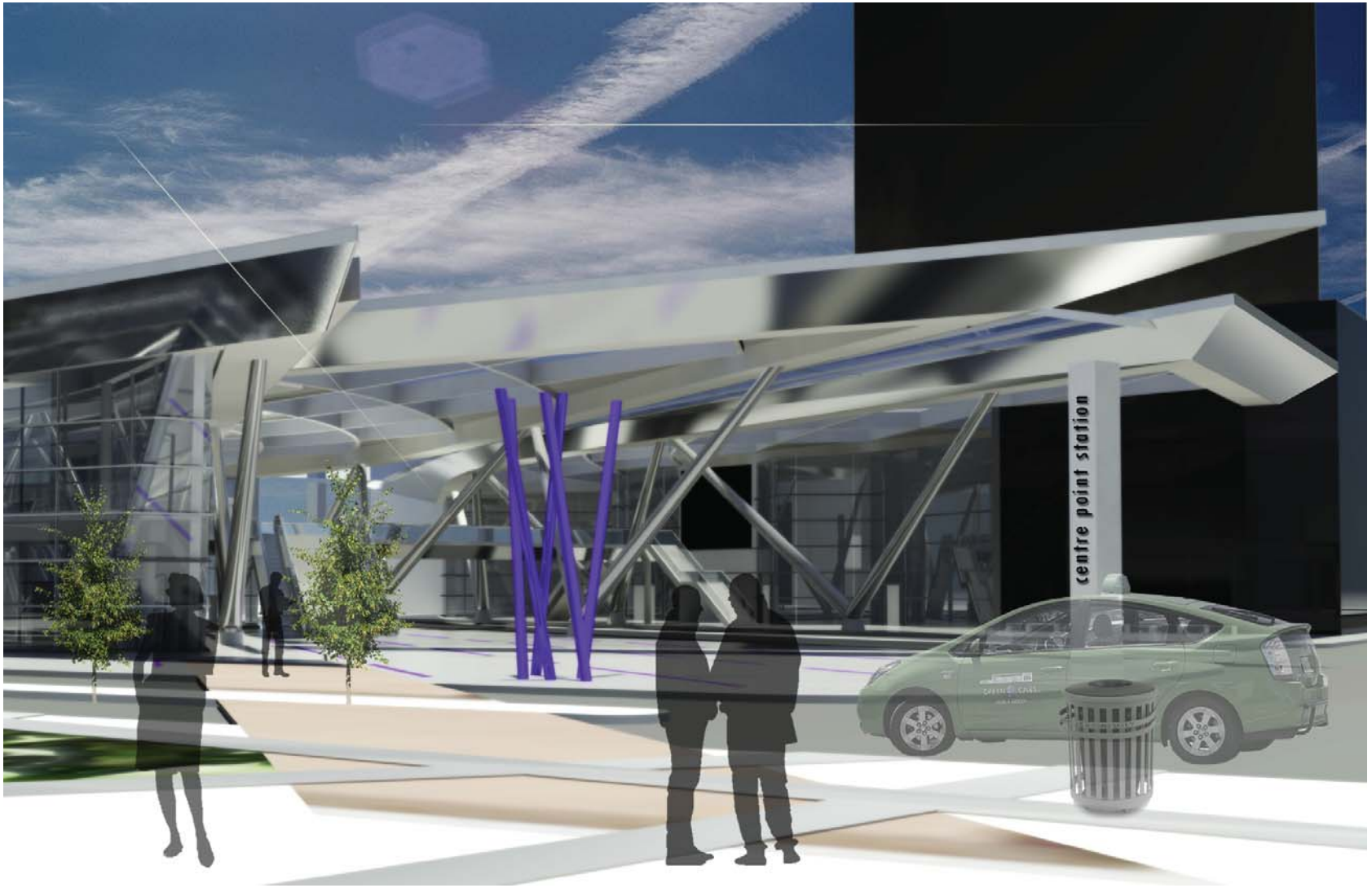


Figure 4.70: View to the entrance of the interchange.

4.19: Comfort and innovation for a 21st century transport interchange

Apart from effective protection from rain, wind and currents air, physiological comfort implies that the architectural design respect certain qualitative criteria. Accordingly, the simple and clear linking of spaces need to go hand in hand with the provision of technical amenities such as lifts, ramps or escalators that facilitate movement.

In climatic terms, preference is given to the efficiency of solar protection and the maintenance of an adequate temperature with respect to the nature of the premises, of the people's activity and the length of their stay. The concept of comfort in interchanges makes up a place's atmosphere or charm, providing the traveller's needs and desires in the most comfortable journey. These include natural ventilation (see figure 4.71), sense of security (see figure 4.72), and clarity of space filled with abundance of natural daylight (see figure 4.74).

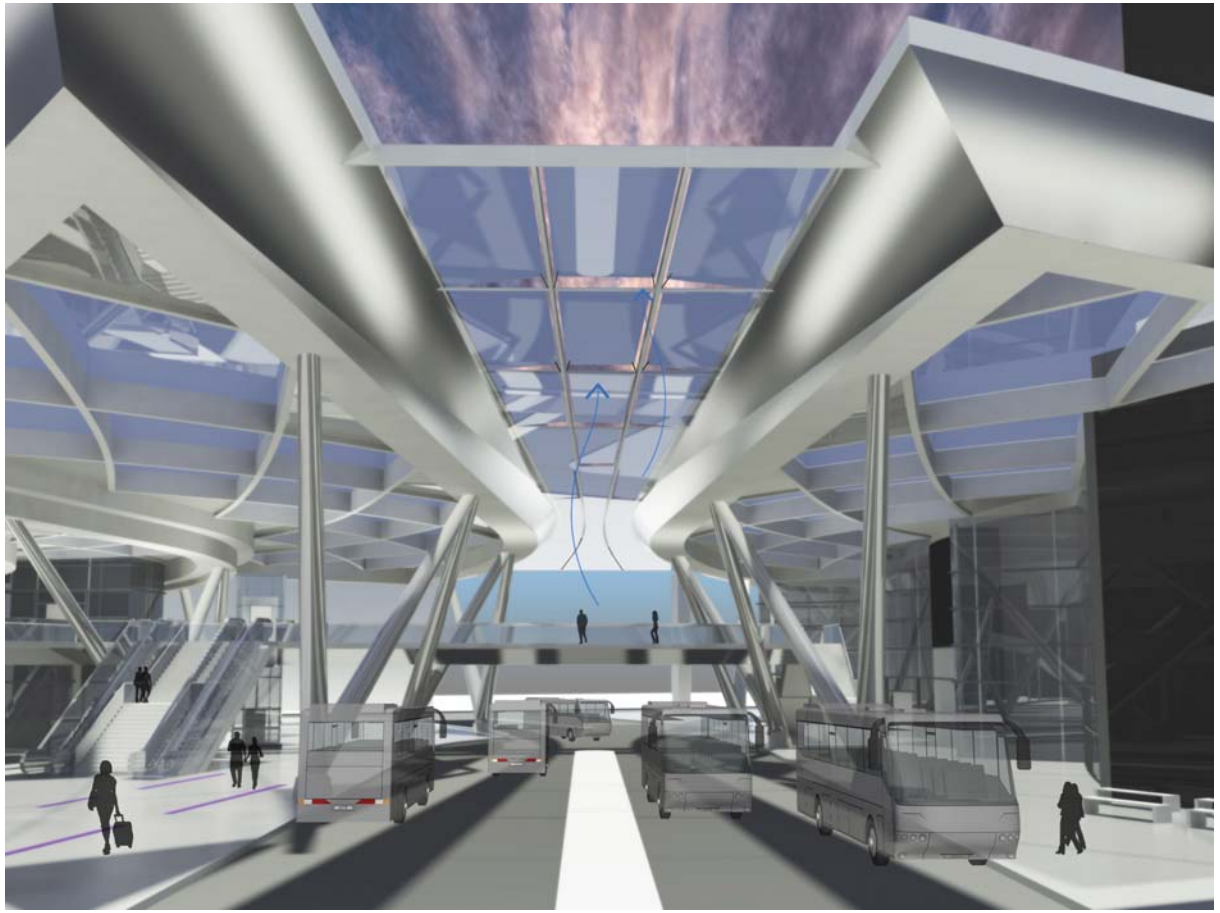


Figure 4.71: The control of sources of pollution is important in the interchange to provide a pleasant environment for the travellers and to evoke the idea of cleaniness. The extraction of bus fumes and diffusion of odours are operated through the operable roof lights above the bus lanes. The roof lights can be controlled depending the conditions of the weather.

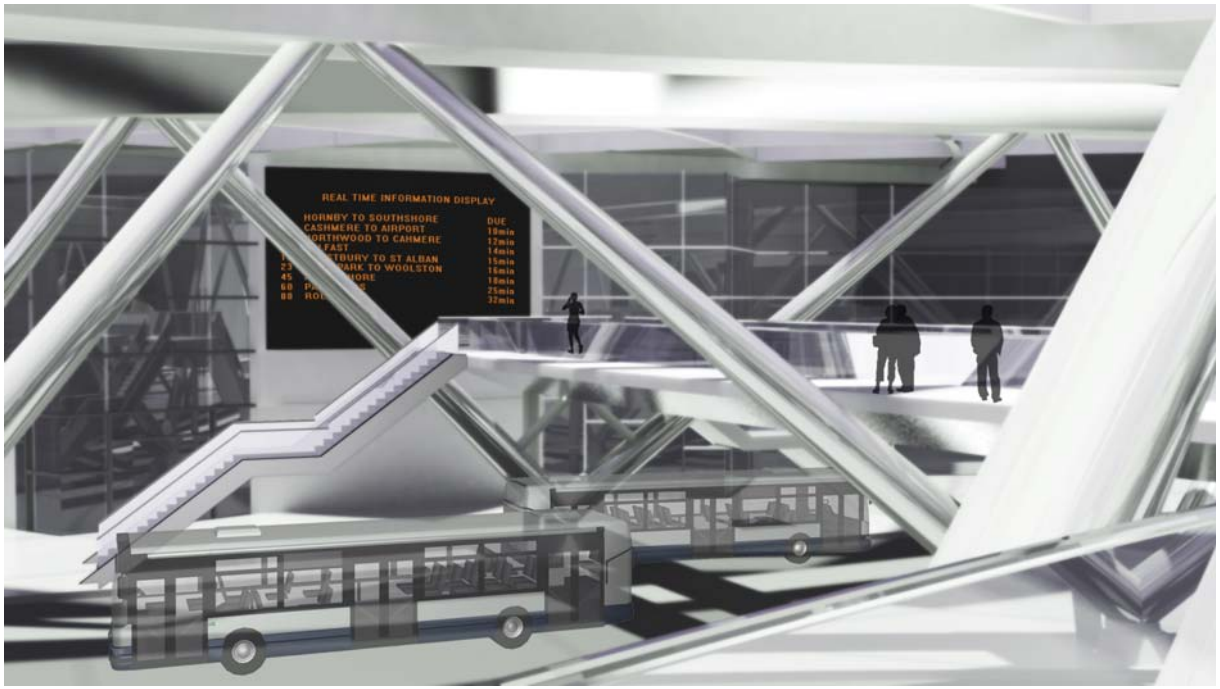


Figure 4.72: *People's psychological comfort depends on a sense of security. By providing wide open spaces allow people be able to visualise the place in its entirety and understand how it is organised. Here, the view from first floor food-court allow users to view what kind of activities are happening below and be able to visualise the whole space.*

Figure 4.73: View of the interior where the Real Time Display Information screen is clearly visible from all angles in the interchange, allowing passengers to be on schedule.

4.20: The effects of natural light

> *" The quality of light- especially a glimpse of sunlight- as you move through the building gives a spiritual uplift; and harnessing daylight means that it uses less energy, which is good news both for the environmentalists and the accountants." Norman Foster (Foster & Abel, 2010, p. 9)*

Natural light is an element of wellbeing as well as a means of orientating oneself, to the point of becoming an architectural susbtance in its own right. The measures and comings and goings of time cause it to change in subtle ways. Through its articulation with the structure, it fuses together creating contrasting effects such as play of shadows when daylight penetrates the interior onto the surfaces.

Light is therefore a central component in the design of the interchange. The central atrium is flooded with natural light through the transparent ETFE material creating light and airy atmospheric spaces within. The exterior facade consists of fully glazed cutain walls allow sunshine to illuminate the interior as well as framing the views out to the city, helps to make the building easier to navigate and feel friendlier.

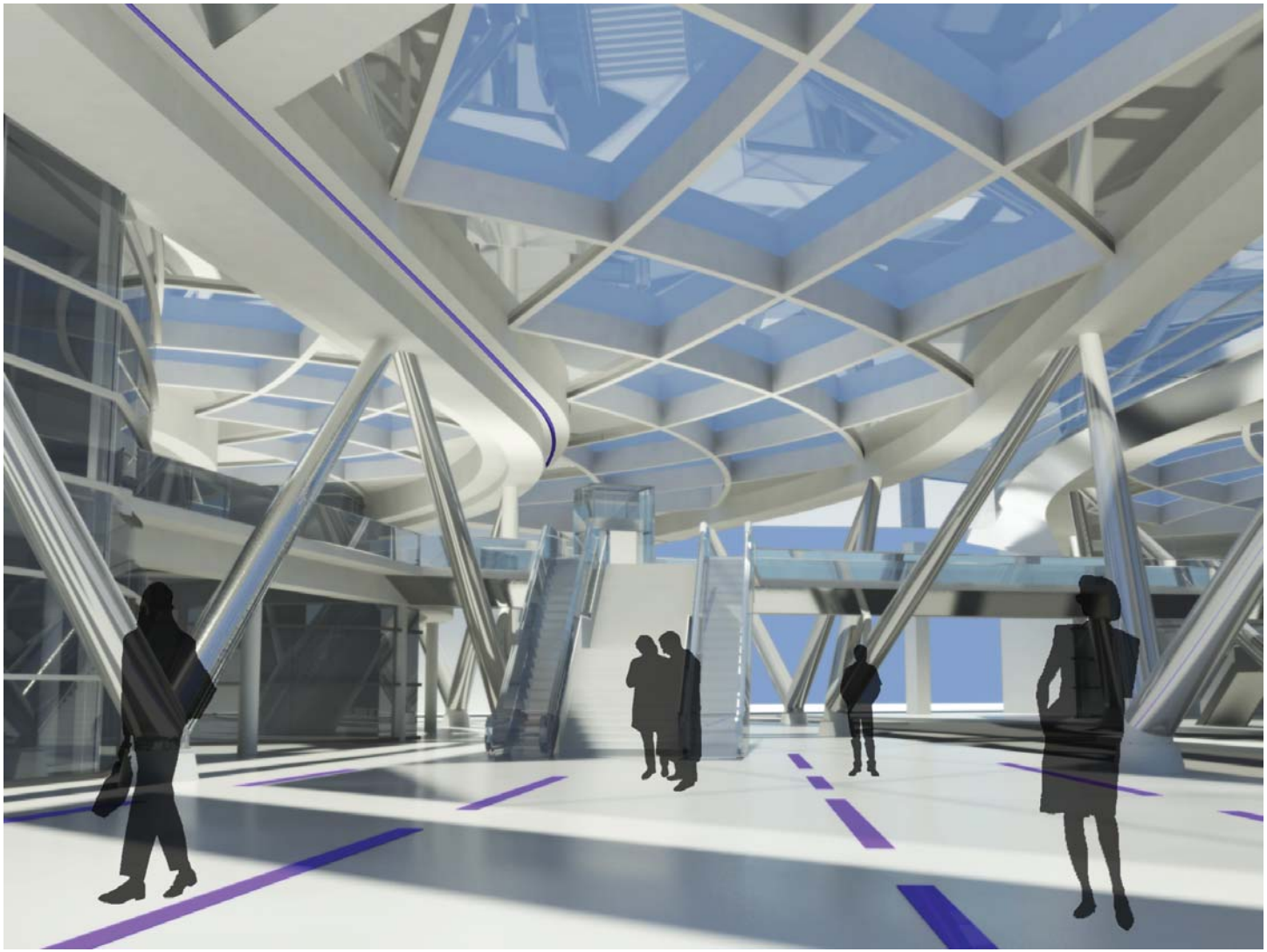
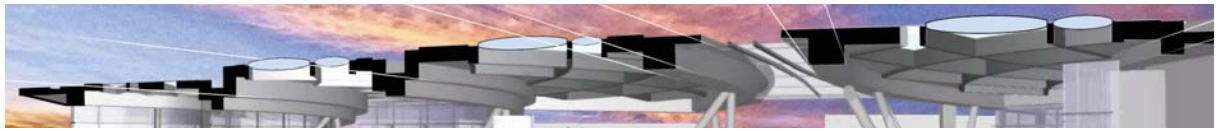


Figure 4.74: The clarity of spaces filled with abundance of natural daylight, the optimal use of artificial lighting and a mastery of contrasts and the rendering of colours, provide quality of space for the people and the public.

4.21: Materials



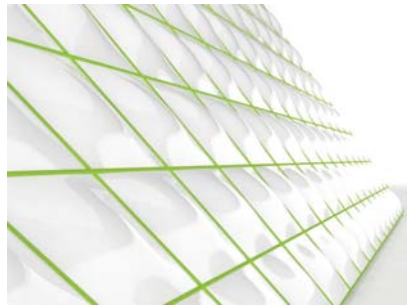


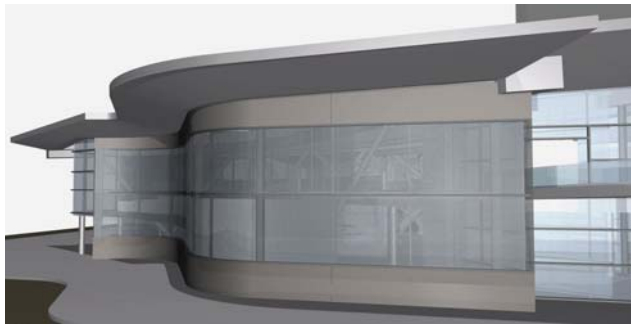
Figure 4.75 (top): ETFE cushion foil

4.21.1: ETFE: material of the future

The ETFE material (ethylene tetrafluoroethylene) was used as part of the roof structure and allows natural light to permeate through to the interior spaces with transparency as one of its properties. ETFE foil cushions also provide new opportunities for lightweight, tough and durable enclosures.

In order to assess the future for ETFE, it is worth examining the forces that shape architectural development: Reduction of prime and maintenance cost; improvement of long-term performance; better environmental performance; lower use of energy and recyclability are all major factors that contribute to the success of a technology. The use of ETFE satisfies all of these objectives and in many cases furthers them. ETFE material is also extremely useful for designing earthquake proof buildings. ETFE cushion's containment of pressurised air has huge abilities to absorb and damp deflections, while also stands tough against the climate and allow both the harvesting and manipulation of natural forces. They change their transmissivity and insulative qualities on demand to lower energy requirements and enhance the built environment.

Figure 4.75 (below): Showing the perforated material on the western facade.



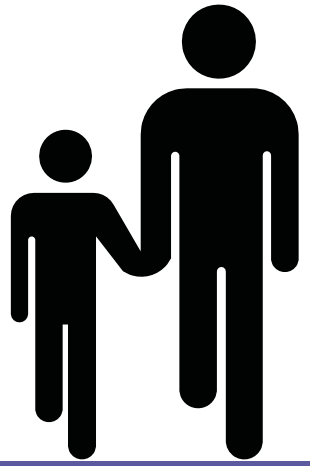
4.21.2: Perforated corrugated stainless steel sheets

The exterior cladding outside the bike ramp presents different material as to its adjacent wall of glass facade. Large panels of perforated corrugated stainless steel sheets supported by a galvanised structural steel framework are used due to the durability quality but which is also varied in its character and transparency. Despite this skin appearing transparent to the eye, it substantially blocks the wind due to the small size of the holes. The enclosed building provides bracing for the screen wall perimeter against lateral wind forces.

4.22 Conclusion

The design study was undertaken as a response to exploring a new transport building type for the city context in the 21st century. Through the design followed by reflection and critique then testing and redesign, the interchange started to evolved to a modern standard. It is an architectural study that tests and challenges many of the issues and opportunities brought up in the last three chapters. It exists as further research to help conclude what solutions might be available in the design and implementation of transport interchange in the future.

Towards the new century, our perception of space and of modes of transport is constantly changing, not only as a result of technological progress but also as a result of urban expansion of the city. Transport architecture in the 21st century moves away from the traditional “station” type to abundant of activities contained within a space where urban life are joined together. These new needs for transport linked-public spaces act as catalysts for urban development and where large numbers of people may be informed, find their way with ease, rest, meet each other or consume. Such spaces require different interior and exterior intervention works.



Chapter 5

Discussion and conclusions

5.1 Discussion and conclusions

This final chapter brings together some key themes discussed in the previous chapters and set out the discussion and conclusion for the preceding body of research. The main intention of the research was to focus on the transport interchange, but the questions are also raised about associated topics, such as sustainable development and social inclusion. The research also examined the challenges in developing a modern transport interchange for the 21st century. Hence, one conclusion is that of 'place-making' rather than just building-making. Another is the relationship between technology, space and architecture, and the importance of collaboration at the start of transport projects between architects and engineers. The order in which these elements are discussed reflects the layering of ideas and experimentation which has occurred throughout the duration of the research. Following this discussion is the implications of this research through the design outcome, which indentifies the success of the project, but also reflects on where the design research could have been taken further.

5.2 Discussion

The search for sustainable development

One theme that has been addressed in several chapters in this thesis is that of sustainable development and the associated concerns over global carbon emissions. Initial research highlighted transportation emissions are the fastest growing source of greenhouse gas emissions in New Zealand, much of it contributed from high usage of private motor vehicle use. The need to switch to alternative mode of transport is part of the solution for providing ever increasing mobility in a city. Moving people by public transport is far less energy intensive than by car. Therefore, one prime incentive to invest in public transportation is that of environmental sustainability. However, sustainable development touches also upon issues of economic development and social well-being. A shift to public transport and sustainable mobility helps economies to reduce their dependency on fossil fuel and improve their balance of payments, and the investment towards public transport infrastructure adds to social cohesion and community well-being. For many, the interchange can become the location for social and physical regeneration. To achieve these social goals, the interchange will not be a place for movement and transfer areas only, but also intend as a place to meet, a place to hang out and a place to experience space.

The transport interchanges building

As society becomes more complex in its movement patterns, there is a corresponding swing from singular building typologies to hybrid ones. Over the decades, singular types such as railway stations have evolved into complex interchanges accommodating various modes of transportation under one roof. Indeed, the modern transport interchanges challenges these places of travel into places not only of connection and/or of transfers, but also a place of social interaction by incorporating multi-functional facilities. Stefano (1998) notes that "In order to fulfil new needs for transport linked-public spaces which receive the public in ever increasing numbers, the need to design and construct living spaces which act as catalysts for urban development and where large numbers of people may be informed, find their way with ease, rest, meet each other or consume" (p.7).

Christchurch is in need of a central transport interchange after growing demand from increasing bus patronage over the years, and after the February 22nd earthquake, the proposal is incorporated into part of the rebuilding infrastructure. Several scholars including Paul Mees and Jan Gehl have highlighted the need to place a transport interchange in the centre of Christchurch city, where people can transfer with ease between most services across the city. It would also aid in the rebuild and recovery of the central city. The interchange could provide a one stop shop for business, entertainment, shopping, and culture, making the place a hive of activity.

Technological innovation in travel

One important influence in the emergence of new interchanges has been that of technological innovation in transport. The application of bio-fuels and new combustion technologies, bus guide lanes and flexible bus formations have helped in reconnecting existing underutilised transport facilities. This in turn has increased user levels, which has act as an engine for fresh investment. In the wake of technological innovation and the consequent diminishing use of cars and polluting buses for urban transport, there has been an improvement in air quality. This has made the interchange a place for habitation rather than merely a transfer point.

5.3 Further research

This design study attempts to reinterpret the interchange typology; it is not a final solution. Given the nature of research, further work is needed. This study offers an architectural contribution but does not suggest that architecture is the only solution.

Public transport facilities are complex in design and operation. Therefore, it would be useful to carry out a feasibility study for the current project. The collected data in this design study was accessible only through reliable sources such as government and city council's websites. Future research could focus on more detailed analysis by consultancy firms, and government or city's agencies to define spatial requirements accomodating large numbers of transferring passengers and complex movement patterns. This includes identifying the areas of population growth and planning suitable sites for the interchange in relation to traffic flows and safe access to amenities.

Following the earthquake on February 22nd, much of the city centre, the "red zone", remains inaccessible except to authorised contractors. The site selection process was analysed through available resources online, as well as much of the site photos. Given the fact that the nature of the project was to provide a transport interchange in the central city, much of the access areas were restricted. Further research could focus on the understanding of the site and the surrounding context once the city is back to normal.

One of the barriers to building public buildings in the central city is the acquisition and the cost of land. An extensive search for a suitable location for a transport interchange could be researched, as have been achieved from the city council during the site selection process for a temporary interchange following the earthquake. Apart from what is required on site, this could also include exploring multiuse programmes to ensure financial feasibility in the city.

5.4 Conclusion

This research has established that there is a strong future and necessity for a central public transport interchange building in Christchurch. Despite the pressure on a massive rebuilding effort following the earthquake, Christchurch has the opportunity to rethink the city and the transport infrastructure. A city built around people rather than cars, a city with innovative public transport system, including better infrastructure for cycling and better walking environment, and a city that is working towards a more sustainable future. It also provides new opportunities and solutions that will see the future interchange as part of the rebuilding infrastructure in the city centre. This text finds that architecture offers an opportunity to redefine the definition of interchange space, creating a new typology that responds to changing user needs.

This thesis concludes that the future of public transport interchange will become a hybrid of activities, and a place where the threads of urban life are joined together. It has become a major catalyst of urban regeneration- a focus for commerce and the flow of ideas as well as the movement of people. As interchanges grow in size the designer needs to search for new typological and spatial orders to solve the problems. As in any complex projects, there needs to be leadership and humility. Edwards (2008) conducted interviews of who is best able to offer the leadership necessary to provide the fusion of urban planning, design, engineering and procurement skills. Traditionally, it has been the engineer representing the main infrastructure company involved, but today the architect is taking the lead in an emerging form of practice. The concepts and design details controlled by architecture will always determine passenger convenience and comfort, developing ridership and public acceptance, while the engineering reflects largely on those design elements such as structural design and the design of building services. But close cooperation between the architectural and engineering design groups is essential to any good transport interchange. The architectural challenge accommodating the new transport technologies of the low-carbon age suggested by the case study design was in specific response to the generation of new interchange buildings. The architecture that reconciles the spirit of geometry, clarity of function, structural simplicity and luminosity- and the quality of the setting and the interior layout to create a true modern public transport interchanges for the 21st century.

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