BIKE YOUR CITY

Planning & Designing Cycling Infrastructure in
the Urban Environment
THE WELLINGTON CASE STUDY

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CYCLING | ARCHITECTURE | DESIGN | PLANNING | INFRASTRUCTURE

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PREFACE

I learnt to ride a bike at age 7, and mother bought me my first bike soon after. We did day trips around GuangZhou, China during the weekend on our bikes so that I could practice city cycling. By the time I was 14 I discovered mountain biking, I slaved at fast food stores for nine months to purchase my first real mountain bike and the bike obsession officially began.

The idea of doing a cycling project had been on my mind ever since I started my architecture degree, but the circumstances were never quite right. However at the start of 2011, I was struggling for topics for the master's research, I thought to myself that I should do a cycling thesis, and it would give me a great excuse to buy a new bike and go out cycling more. This decision was met with great enthusiasm by all my friends, and we set out the draft research plans over many afternoons with beers.

The romance of a cycling thesis died quickly when I opened the Pandora's Box of cycling infrastructure; I was confronted with a mountain of policies, politics, budgets and legal topics that had seemingly no relationship with my architecture degree. Like any good researcher I pushed on with a healthy dose of procrastination. My many hours of procrastination were spent on mountain biking, road cycling or riding to buy takeaways, during which I developed my research topic as well as my sun tan and fitness.

Designs and ideas were constantly been developed during my 'research' bike rides, however something was never quite right. My understanding of the architecture profession was confronted as I find myself reading, designing, developing, thinking and writing everything but architecture. Could it be that the research topic was too far away from the architecture degree that I was taught?

◀ THE OUTCOME OF ONE OF MY 'RESEARCH' BIKE RIDES

The struggle continued on until our visiting professor Peggy Deamer kick started my design research again. She said that I have to become that 'cycling guy' who knows all the cycling issues and is able to produce designs at every level to challenge the current situation. I will have to design the bikes, the buildings, the parks, the roads, the logos, and advertising, the pamphlets and everything there is to design with cycling, thus becoming that 'cycling guy'. My supervisors were patient and supportive, they encouraged me throughout the entire process, despite of not knowing where the research would ultimately take me.

Although it has been a hard road getting the research to where it is now, however I enjoyed every moment of it. I never would have dreamt that cycling and architecture would have come together so seamlessly and that I am actually completing my master's degree by doing what I enjoy the most.

ABSTRACT

Cycling is a memory of the past for most of us, the lack of support from the authorities on the cycling infrastructure made it difficult to attract people to cycle in the city. Urban sprawl, traffic congestion, car dependency, environmental pollution and public health concerns have pressured cities around the world to consider reintegrating cycling into the urban environment.

Design as a research method was utilised to investigate the effectiveness of design methodology and workflow for cycling infrastructure from an architecture and design perspective. Using Wellington City as a design case study, this research aimed to improve the legibility, usability and the image of cycling as a mode of transport in the city. To achieve this, a customisable graphical design framework and branding strategies were developed to structure and organise

the design components within cycling infrastructure. The findings from the iterative design processes were visualised through the appropriate architectural and presentation conventions.

This research provided an unique architectural perspectives on the issues of cycling infrastructure; the results would support the transportation advisers and urban planners to further the development and integration of cycling, as a viable mode of transport, within the city.

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INTRODUCTION

INTRODUCTION

01

Employed Population by Main Means of Travel to Work 1996 and 2006 Census days

FIGURE 01-001 - Main Means of Travel to Work, 2006 Census Results (Statistics New Zealand 2007)

FIGURE 01-002 - White Bicycle Plan 1965 (NVA 2010)

CYCLING & THE CITY

Cycling is an experience that affects a wide demographic. Many of us have memories that relate to cycling - as a child learning to cycle down a garden path, cruising with friends along the beach, or racing against competitors. However for most of us, the days of cycling as an everyday reality are gone; cycling is just a memory of the past.

The pleasant experience of cycling in cities relies on the implementation of high quality infrastructure in the city. With the increase of motor vehicles on the roads, the quality and quantity of the cycling infrastructure declines which leads to safety concerns for the public. Despite these issues, cycling numbers are on the rise, but in order to capitalise on this growing trend, the planning and design of cycling infrastructure needs to be examined.

In New Zealand, and throughout the world, contemporary city roads are designed to accommodate the flow of automobiles. The introduction of affordable automobiles brought convenient personal mobility to the masses; people with access to cars

could travel further and faster in any weather (Mees 2000). As the number of cars has grown, the use of other forms of urban transportation has declined. It has been difficult for most cities to find the balance between cyclists and motorists in terms of road use. The New Zealand Census showed that in 2006 more than 50% of the nation drove to work while the number of people cycling to work barely reached 4% (Statistics New Zealand 2007).

[SEE FIGURE 01-001]

The bicycle-friendly city of Amsterdam has long been the inspiration of urban cycling; its wide paths, bicycle-only roads and other facilities are the envy of many cities around the world. Cycling advocacy in Amsterdam has a long history dating back to 1965, when a group of activists called 'Provos' presented a bold proposal: distinctive white-painted bicycles were provided as a public service, free for all to use. The Provos planned to close the centre of Amsterdam to all motorised traffic with the intent of improving public transport by 40% (British-Library 2010; NVA 2010). Unfortunately most of the white bicycles were stolen or vandalised by the public during the

◀ **FIGURE 01-003** - Makara Peak Mountain Bike Park Map. (Makara Peak Mountain Bike Park 2011)

implementation period. Although this plan was viewed as a failure, the bike-sharing idea from the white bicycles became the foundation of bike-sharing systems today. *[SEE FIGURE 01-002]*

Cycling in New Zealand is mostly viewed as a recreational sport; this is largely due to the popularity of mountain biking in the country. In Wellington for example, the quantity, the diversity and the quality of dedicated off-road facilities for cyclists is impressive. Some of these tracks are only a five minute bike ride away from the CBD; bigger facilities such as the Makara Peak Mountain Bike Park can fill their car parks during the weekend or the holidays. The increase in recreational cycling is reflected in cycling in the city, but at a much slower rate. It seems that people would rather drive their cars in order to get to off road tracks than cycling in the city.

[SEE FIGURE 01-003]

The cycling experience in Wellington City is a sharp contrast to the pleasures offered by the off-road facilities. Cyclists need to navigate narrow roads and parked cars, dodging bus drivers and truck drivers. However, considering that the city has a healthy off-road

cycling scene, it seems logical that if the road infrastructure in Wellington City was planned and designed with the same amount of attention devoted to its off-road facilities, it would be easy to convince more cyclists to cycle on the roads.

CYCLING & ARCHITECTURE

Cycling infrastructure is considered within transportation and urban planning literature (McClintock 2002), but not in the literature of architecture. Seeing as the transportation system has the greatest potential to interact with and shape the urban form (Hickman and Banister 2005), it is appropriate to review the architecture of cycling in the broader context of urban planning.

- FIGURE 01-004 - Cover of *The City of Tomorrow and Its Planning* (Le Corbusier 1947)
- ◀◀ FIGURE 01-005 - “The Radiant City” (Le Corbusier 1947)
- ◀ FIGURE 01-006 - Cover of *A Very Public Solution* (Mees 2000)

CYCLING & TRANSPORTATION

Historically, the popularisation of affordable automobiles and the consequent changes in transport policy and road infrastructure made it difficult and inconvenient to choose other modes of transportation. The 'radiant city' unveiled by Le Corbusier in 1942 argued that the traditional form of the city was incompatible with cars, therefore the old city had to be destroyed to make way for high rise buildings, expressways and multi-level car parks (Le Corbusier 1947). These visions by Le Corbusier became the basic building blocks of modernist urban planning. As a result the post-modern image of the livable city is defined largely in reaction to the original vision of cars, roads and high-rise buildings (Mees 2000; Hall 2002). What this translates to in the modern city is urban sprawl, car dependency, and environmental pollution plus public health concerns (Jacobs 1961; Newman and Kenworthy 1999; Mees 2000).

The search for better transportation has traditionally focused on new technology (Thomson 1984; Mees 2000). However, in recent decades, the reintroduction of cycling into cities has become a popular topic

of discussion. A quick scan of media outlets, transportation conference proceedings or government documents will reveal that this trend is still gaining momentum internationally. In New Zealand, the trend of a long term decline of cycling in cities is reversing despite issues such as the helmet law and the lack of infrastructure (Woodward and Lindsay 2010). However the present configuration of roads still reflects old paradigms and the lack of policy and funding for cycling as a mode of transport. Narrow roads, poor road surfaces and the general lack of infrastructural support puts New Zealand cyclists in vulnerable situations where unnecessary injuries or death occurs on the roads. Therefore the quality of the cycling infrastructure needs to improve in order to sustain and increase cycling in cities.

The current risk profile of cyclists could be related to the fact that there are relatively low numbers of cyclists on New Zealand roads (Ministry of Transport 2007). If the number of individuals in New Zealand who cycle increases, the risk profile of cyclists may improve due to a "safety in numbers" effect. It is also likely

Hospitalisations of cyclists involved in motor vehicle accidents by age

FIGURE 01-007 - Cyclists Hospitalised or Killed from Crashes Involving Motor Vehicles on Public Roads

(Ministry of Transport 2007)

FIGURE 01-008 - Hospitalisations of Cyclists Involved in Motor Vehicle Accidents by Age

(Ministry of Transport 2007)

FIGURE 01-009 - Cyclist at Fault in Injury Crashes

(Ministry of Transport 2007)

that, if cycling numbers increase, this will increase demand for cycle-friendly road infrastructure. The number of cyclists hospitalised or killed from crashes involving motor vehicles on public road are graphed in Figure 01-007 which shows an increase of injuries leading up to the end of last decade. The breakdown of the injured cyclist by age group in Figure 01-008 shows that the majority of the cyclists are aged 10-14. Further statistics in Figure 01-009 Show that 64% of the crashes occurred where the cyclist was not at fault. These results from the Ministry of Transport raise concerns in the quality of the cycling infrastructure and the education about road behaviour in New Zealand.

The amount of interest shown for bicycle-friendly cities within New Zealand by both the citizens (bottom-up) and local government (top-down) is evident in government planning documents and news media. There is no doubt that authorities would like to present a 'green' image, therefore the current focus on environmental and public health issues make now a good time for planning the designs of cycling infrastructure (Keall, Chapman et al. 2010; Woodward and Lindsay 2010). As is the case for many other countries, the precedent cities that

New Zealand typically looks for cycling improvements to are all international. While international examples of bicycle-friendly cities provide an apparently pleasant environment for cyclists, influences such as differences in history, culture and even topography mean that what works for one city won't work for another. Each city's cycling infrastructure is a unique response to that city's specific local requirements. Different cities in New Zealand may have the same objectives, but without a flexible framework to adapt to the local requirements, the specific needs of the cycling infrastructure and design brief can be difficult to establish.

▲ **FIGURE 01-010** - Research Through Design Flow Chart

This thesis investigates the planning and design of cycling infrastructure. It begins with preliminary archival research and review of precedents, and then continues throughout the design process, with a combination of action research and iterative design processes.

[SEE FIGURE 01-007]

The research proposes to establish cycling as an important and legitimate mode of transport, integrating the cycling infrastructure with the existing urban environment of Wellington and finally improving the legibility, usability and the image of cycling within the New Zealand context.

DESIGN AS RESEARCH

Design as research is the method used to test the design solutions. This approach uses design as a form of research to produce knowledge on the planning and designing of cycling infrastructure (Downton 2003). Drawings and diagrams, sketches, computer modelling, traditional architectural drawing and presentation renderings will be utilised to visualise these designs.

Methods of collaboration with local stakeholders within the government and the community will be considered during the design case study. In this case, the designs have been influenced by information and documents released by NZ Transport Agency, Greater Wellington Regional Council and the Cycle Advocates' Network. This will be followed by ethnographic research, where a participant observation method has focused on the practices of the local cycling community (Plowman 2003). Data collection for design was conducted in parallel to the above research and focussed on the selected design sites.

Objectives were set at the beginning of the design process and a summary was produced to conclude the findings of the research section; this summary was then used to evaluate designs and to then propose further design objectives. Communication materials were visualised through appropriate architectural and presentation conventions and presentations were arranged at key stages of design. The audience for each presentation included people from diverse fields of public health, urban planning and cycling organisations.

Throughout the design stages, additional qualitative and quantitative design research was conducted in order to fulfil new design objectives as they arose. This new research is documented at the beginning of the appropriate design sections.

The Design Case Study chapters conclude and explore the findings from the design case study. These findings reflect the theories and issues explored in the literature review, and relate the research to real world issues.

THESIS STRUCTURE

It is the aim of this thesis to research the planning and the designing of cycling infrastructure from an architectural perspective. The design as research method was chosen to place emphasis on the design as a main component in this particular research.

The literature review chapter explores the theories, issues and barriers to cycling as a mode of transport; this is followed by review of precedents chapter which establishes best practice examples. The findings from this review have been used to guide the design case study stage of this thesis.

Chapter 04 documents the design exploration of this research. A total of four designs were completed; the aim was to research the planning and design of cycling infrastructure from micro to macro scale, where the first design specifically focused on architecture and the final design offered a complete package in terms of cycling infrastructure. The design outcomes which were produced can be used to demonstrate the knowledge

gained through research, therefore the diversity in design scale and aesthetics is justifiable (Downton 2003).

The conclusion chapter reviews the design case study in its entirety. It summarises the key findings in the designs and elaborates on the research results in detail. This chapter draws conclusions based on the evidence presented in the design case study.

The final chapter is divided into three sections; discussions, limitations and recommendations. The discussions reflect on the research and consider its relevance to transportation and planning; the limitations of the results are examined. Finally recommendations are proposed for both academia and the architectural profession.

This research aims to gain an idealistic view of what cycling could be in a city. The planning will consider the city as a whole while the design's individual facilities search for methods to increase the legibility and the image of cycling as an urban transportation system.

The current pressure for bicycle-friendly cities creates opportunities for research. By researching cycling from an architectural perspective, this research makes an important contribution to the planning and designing of cycling infrastructure and the understanding of its relationship with the urban form.

LITERATURE REVIEW

LITERATURE REVIEW

02

OVERVIEW

Cycling and architecture are two topics which do not have a strong relationship with each other in the literature with few publications that make the direct link. However, within the urban planning field a growing trend in publications shows signs that cycling and its infrastructure are gaining recognition as relevant issues for design. This is shown by exposure at various urban planning conferences, although mostly in conjunction with walking under the label of 'sustainable transport'.

This literature review focuses on four topics:

- Transport Policy
- Cycling Advocacy
- Cycling Infrastructure
- Bike Sharing

While these topics recognise the role of design in terms of land use and transport interaction, they investigate urban planning from a broader perspective (McClintock 2002; Hickman and Banister 2005). The goal for this thesis, then, is to review these topics and frame them within the fields of design and architecture.

The prominent authors in the fields of architecture that are introduced to review the cycling topics are Kevin Lynch (1960), Gordon Cullen (1971), Christopher Alexander (1977) and Jan Gehl (2010).

◀ **FIGURE 02-001** - *Cover of Design for Product Understanding. (Monö 1997)*

Subtle patterns in signs, symbols, colours and form can be included in a series of designs, this repetition creates a language which orders and groups the designs based on their aesthetic characteristics (Alexander, Ishikawa et al. 1977; Monö 1997). The exploration of these semiotics in design were first publicised by Monö in 1997, which examined the works of Saussure in linguistics from 1916 from the industrial design perspective in terms of form and aesthetics (Saussure 1983 ; Monö 1997). Monö notes that communication, technology and ergonomics of a product are the three main areas which inform the user of its function. By studying the three areas as a language of design, he aims to further the intuitive interface between the user and products.

Literature sources vary due to the nature of each topic. Sustainable transport policy has been academically covered by organisations, universities and government authorities around the world with many books and articles published. However, within this topic, specific applications to cycling often need to be inferred, as most articles concentrate on the bigger picture rather than cycling in particular. In contrast, readings on advocacy for cycling have less academic grounding,

as most of the discussion on this topic takes place on websites, blogs, or in some cases newspaper articles (Shepard 2011). Bike sharing is also a popular topic, with publication or research notes released by transport agencies, universities and consultancy firms; however, the contents generally skip the design integration to the urban environment and focus more on outcomes, such as feasibility studies, business and marketing operations and management, traffic management, technology and cost/benefit analysis (Holtzman 2008; DeMaio 2009; Shaheen, Guzman et al. 2010; DeMaio 2011; Haverman 2011; Shaheen 2011). Information on cycling infrastructure is available through more official channels. The specific dimensions and requirements for cycling infrastructure are documented in some form of design guideline in almost every local government. By and large, these design documents comprise best-practice guides from Europe with some variation to suit local requirements. The contents focus on segregated safety requirements for cyclists such as cycle lane designs, intersections and traffic management (Hudson 1978; Hudson 1984).

Although all cycling related literature is of interest to this thesis, this

literature review will focus on sources which deal with social context, cultural differences, political and funding structure, geographical separation and environmental conditions. The thesis will not cover topics which outline the benefits of cycling in urban environments; instead it will focus on cycling related literature which touches on issues of design and implementation.

Although Denmark and The Netherlands are generally regarded as the two main cycling icons of the western countries, the majority of the literature has been sourced from England, Australia, New Zealand and America. These countries are actively trying to re-establish the cycling culture and cycling infrastructure in their cities, whereas other countries mentioned already have a well-established cycling culture and infrastructure. In addition, Eastern countries such as Japan, Korea and China are actively seeking to reintroduce cycling into transport policy (Watts 2010; Xinhua 2010). Due to cultural gaps and differences in political and funding structure, that literature will be acknowledged but not reviewed in this writing.

In the last 120 years urban planning theories and practice have developed rapidly in search for sustainable urban form and sustainable transport systems (McClintock 2002; Hickman and Banister 2005). Recently, transportation problems have become the centre of discussions concerning 'efficient' urban form, however the pace of change for public policies which govern the direction of urban transport policy have become one of the greatest barriers to sustainable urban form and sustainable transport systems (Button and Gillingwater 1986; Richards 2001; Button 2005; Hickman and Banister 2005; Moore 2010)

Sustainable automobility appears attractive in theory, in practice it is a contradiction in terms. This applies to both the free-market version, with its privatised road system, as well as the 'planned' school. Better engine technology, alternative fuel sources and even road pricing may all have a part to play, but they cannot deliver sustainable urban transport by themselves. To address the environmental and equity problems created by urban travel it will be necessary to restrain, and if possible halt and even reverse, the growth of car travel, by shifting trips to (in order of preferences) walking, cycling and public transport. Providing attractive urban public transport in a necessary part of this approach, but must be combined with more direct measures to discourage excessive travel by car to form an integrated 'package' of policies.

- (Mees 2000). Page 76

Trips of less than seven kilometres in urban centres have high potential to be carried out by other modes of transport other than private motor vehicles. These modes, such as walking and cycling, are labelled as "green modes" or "active modes" (Hurn 2010; Woodward and Lindsay 2010). Green modes are ideal ways of travelling from the point of view of energy conservation, environmental impact, social equality and personal well-being. However, environmental factors such as urban topography and climate may pose particular problems for these modes of movement. As a result, these modes are not regarded seriously as a form of transport (Tolley 1995; Hurn 2010).

Cycling is one of the main components of what is termed 'sustainable transport'. Although cycling existed in the urban environment for more than a century, it is only in recent decades that it has started to impact public policy in the western cities (Monheim 1995; McClintock 2002). This is evident in the numerous official documents on transport; however, the impact these documents have on the outcome of transport policy is very limited, especially in the context on planning (Hillman 1995). It is difficult to see cycling in this context as more than

a topic for debate and discussion; the bulk of actual transport planning deals with automobiles. Looking back at the history of transport planning, cars have only been the central focus since their numbers started to grow in the 1920s. This leads many urbanists to argue that other forms of transport are simply unsuitable for the travel needs of “post-modern” cities, and transport policy should accept this fact and seek solutions based around car dominance (Mees 2000). At the same time, transport policy in western cities has gone through periods of positive engagement by governments with active interventions by local councils followed by periods of neglect by the authorities (Button and Gillingwater 1986). In recent decades, the public is increasingly interested in transport policy. This is reflected in the columns of newspaper articles, pages of online blogs and time devoted to it on the radio and the newscast on television (Button 2005). This increase in public interest in transport policy did spark more debates and research, but the impact of these debates and research on the actual shaping of transport policies are still uncertain.

There is no denying that technological advancements in transportation have shaped our cities; the introduction of cars has forever changed the road network systems from the historic cities (Le Corbusier 1947; Mees 2000; Finizio 2007). However, despite these advances, the great disappointment of our era is the failure of technology to produce a solution to the urban transport problem (Thomson 1984). Apart from cars, public transportation technology has been steadily developing over the past few decades. Traffic management technology has vastly improved, but that is in direct relation to the advancements made in the electronics industry. Specific transport systems are being tested around the world in recent years, using technologies such as high speed railway, electric cars and automated GPS vehicle guiding devices; all aim to improve the transportation experience (Richards 2001). Transport policy and technology then have a unique relationship with one another. Civil engineering has a long tradition of “building” its way out of problems, and the problem of transport in cities is no different (Button 2005). One of the long-standing beliefs in transport was that one could build one’s way out of congestion (Button 2005); the transport policies support a technological approach

FIGURE 02-002 - Barriers to Sustainable Transport (Banister 2005)

and the technology in turn provides opportunities for more “building” policies.

Banister has written extensively on transport policy, and he outlined that the achievement of successful policy implementation requires leadership and a commitment to change (Banister 2005). He listed the barrier types for sustainable transport

[SEE FIGURE 02-002]

He noted five key points for overcoming these barriers (Banister 2005):

1. *A national policy framework on spatial development*
2. *A sustainable transport strategy*
3. *Decentralisation of powers and responsibilities for transport*
4. *Consistency in policy direction*
5. *Public and private acceptability of policy*

In the case of New Zealand, Hurn (2010) notes that strong leadership is needed when there are many unranked objectives, many organisations with a stake in an outcome, an excess of statutory and non-statutory planning documents, and policies with different timelines. Transport policy exhibits all these challenges; one unique difficulty in New Zealand is the interaction between the Land Transport Management Act (2008), which has a long-term focus, and the Local Government Act (2002), which tends to have a shorter-term focus (Hurn 2010). Although the transport policies in New Zealand have many shortfalls, the underlining focus provided to councils on the national, regional and local level is on sustainable transport and its interaction with urban form.

In New Zealand, the movement for a sustainable cycling network is slow to gain momentum. The sustainability requirements built into the Resource Management Act, Local Government Act, Land Transport Act and Land Transport Management Act are taking effect, but slowly. It was noted that until very recently, cycle ways and other cycling related assets were not classified as a transport asset by the local councils, and also that cycling is seen as being distinct

from transport and is not favoured in infrastructure policy (Preval, Hulme-Moir et al. 2010). The major barrier to classifying cycling as a mode of transport is its friction with motor vehicles when it comes to road sharing, especially seeing as most New Zealand urban centres do not offer suitable or safe cycle ways. This can also be seen as a contributing factor to cycling's declining popularity in the country. Hudson identified criteria which cycle schemes should consider if they are to become successful. These criteria focus on a number of points: safety, continuity, directness, convenience, clarity, noise, shelter, maintenance and cleaning, and attractiveness and interest (Hudson 1984).

From a planning point of view, cycle schemes in New Zealand lack a clear conceptual model or an appropriate administrative framework (Preval, Hulme-Moir et al. 2010). In addition, unsympathetic public reaction to accidents involving cyclists calls into question the level of popular support for major developments. In general, New Zealanders seem very accepting of a certain level of road accidents, and treat them as a normal and unavoidable part of having a road network and owning a private vehicle. The typical response to accidents such as people

getting knocked by impatient drivers while crossing the road at traffic lights, or cyclists getting driven off the road by unyielding cars or being hit by a careless driver opening their door, tends to be "oh dear, what a shame, what a bad accident", rather than being "how can we stop this from happening again" (Moore 2010). The relaxed tolerance for road accidents involving cyclists means that less people are willing to risk their safety to participate in cycling in the city even if it is promoted by the local government.

FIGURE 02-003 - *The White Bike Plan 1965*
(NVA 2010)

CYCLING ADVOCACY

Activists have long campaigned for better and safer infrastructure in cities, and the increase of public interest for transport policy has demonstrated to more people that the design of the streets can be challenged and changed (Gehl 2010).

Cycling protests, like any other anti-establishment movement, have the capacity to force authorities to improve the infrastructure. One of most important movements of this type was initiated during the Dutch counter culture movement by 'Provos' in 1965 in Amsterdam; it was known as the 'Witte Fietsenplan' or the White Bicycle Plan. The plan was a bold proposal that offered painted white bicycle which were public property and free to use. It planned to close the centre of Amsterdam to all motorised traffic with the intent to improve public transport by 40% (British-Library 2010; NVA 2010).

"The White Bicycle Plan proposes to create bicycles for public use that cannot be locked. The white bicycle symbolizes simplicity and healthy living, as opposed to the gaudiness and filth of the authoritarian automobile."

- Provo manifesto (NVA 2010)

FIGURE 02-004 - *Bike Liberation Clowns 2005*
(Ross 2005)

The white bicycles challenged the political and philosophical stand of the authorities through the act of street art or urban intervention. Although the plan was short lived for various reasons such as theft and vandalism, its legacy lives on: the Public Use Bicycle system has been updated and 'officially' replicated in cities worldwide (British-Library 2010; NVA 2010).

A big part of cycling advocacy is campaigning. At every 'Velo-City' international bicycle planning conference, there are always examples of 'successful campaigns' or 'cycling revolution' presentations from cities around the world. One of the most influential cases to date is documented in 'Time's Up! Bike Liberation Clowns' in New York, USA, by Benjamin Shepard (2011) [SEE FIGURE 02-004]; it followed the progress of the advocacy group from 2005 to 2010. The strategy adopted by the New York group is to attack the seriousness of the legal and political issues through acts of performance art, then document and distribute these artistic interventions on the NYC Indymedia websites to generate public responses. Through internet forms such as blogging and posting, the movement solicited opinions on cycling in New York. The build up of

public interest and opinion pressured the local authorities to invest in transport research for cycling and improve and upgrade its cycling infrastructure (Shepard 2011). However, most transport policy makers are not active cyclists; therefore their comprehension of cycling concerns is often superficial (Pooley 2011). This makes the participation of an advocacy group in social discussions important for imparting relevant knowledge to politicians and alert the policy makers of the issues, despite the inefficiency of this second-hand method of communication (McClintock 2002).

The results of a cycling campaign takes time; the Bike Liberation Clowns took more than a decade to build up, during which fatal cycling accidents occurred on a daily basis. Safety is the major concern for western cities trying to integrate cycling into its automobile dominated transport infrastructure (Hudson 1978; Hudson 1984; Hillman 1995; Preston 1995; Tolley 1995; Woodward and Lindsay 2010). While policies are bounced back and forth by different government departments, the people grow impatient. In most cases, once funding is factored into the policy, the turnaround time for infrastructural improvement is around

FIGURE 02-005 - Advocates painting their own bike lanes on the road (Webster 2011)

a decade, and that is too long to be using unsafe roads (Hillman 1995; Roberts 1995). In recent years, 'guerrilla' style cycle lanes have been painted on to roads by cycle advocacy groups around the world. CNN in 2011 reported a group painting cycle lanes in the centre of Mexico City in response to local government stalling on its promise to build 300 kilometres of cycle lanes by the end of 2012 (Webster 2011). The Toronto Star also featured headlines about advocate groups painting their own cycle lanes in 2007 due to government disappointment (Doolittle 2007).

[SEE FIGURE 02-005]

Cycling advocacy is an essential aspect of refining the cycling infrastructure, and although the changes are made slowly, they do happen. By introducing public participation in the process of refining cycling policies and infrastructure, the quality and the efficiency can be improved (Lowndes, Pratchett et al. 2001; Bickerstaff, Tolley et al. 2002). This process can also eliminate the legal tension and conflict between cycling advocate groups and the general public (Shepard 2011).

The diversity of the active members of an advocacy group can have dramatic effects on the aim of the campaign. A recent report released by the Universities of Lancaster, Leeds and Oxford Brookes noted that the current daily cyclists in UK are viewed as a minority, dubbed the 'Lycra-Wearing-Elite', who against all odds successfully negotiated a hostile urban environment and weather conditions to incorporate cycling into their everyday routine (Pooley 2011). Therefore, from the point of view of cycling advocates and cycling policy makers, data for improvement in policy and infrastructure needs to be obtained from a balance of active cyclists, potential cyclists and non-cyclists (Pooley 2011).

Architects and designers present design solutions through the use of images, by collaborating with cycling advocates problems can be better explored, and then graphic illustrations can be used to present design alternatives that are engaging to both the authorities and the public.

CYCLING INFRASTRUCTURE

Making infrastructural improvements to cycling is one of the main methods for making cycling irresistible to people. European countries, especially Netherlands, Denmark and Germany, have decades of experience on improving their road networks to facilitate bicycle use (Pucher and Buehler 2008). The improvements are focused on providing separate cycle-ways along heavily travelled roads and at intersections, combined with extensive traffic calming of residential neighbourhoods (Pucher and Buehler 2005; Pucher and Buehler 2008). The effects of emphasising safety for the cycling network are not limited to the physical protects of cyclists to motorists; this emphasis on safety also creates a sense of psychological ease among all users of the road network (Lynch 1960; Pucher and Buehler 2008). Providing separate facilities to connect common origins and destinations promotes cycling for work, school and shopping trips, as opposed to mainly recreational cycling, where most separate cycling facilities are found along urban parks, rivers and lakes, or in rural areas (Pucher and Buehler 2005).

The detailed requirements for cycle-way width, intersection requirements, storage size and other cycling facilities are documented by Hudson (1978). While each local authority has their own design guides for cycling infrastructure, they are all essentially the same document (Hudson 1978; Hudson 1984; Kingham, Taylor et al. 2011). However, further collaboration between designers, engineers and users needs to be established, as the following list of complaints shows:

'Cyclists dismount' signs; narrow paths shared with pedestrians; bike lanes that go nowhere; bike tracks with priority given to motorists entering from side roads; short, pointless cycle lanes strewn with obstacles. This the sort of woeful cycle infrastructure designed by engineers who don't cycle and put in place by local authorities who fail to consult with cyclists or who go ahead ignoring user advice, or fail to design to recognised standards.

- (Pooley 2011)

New Zealand Transport Agency (NZTA) released new research to assess the type of cycling infrastructure required to attract new cyclists on New Zealand roads (Kingham, Taylor et al. 2011), their recommendations are:

- *Investment in cycling facilities of all kinds should be encouraged throughout the country, with the choice of facility subject, where necessary, to practical considerations and best-practice guidance.*
- *The uptake of cycling infrastructure that allows cyclists further separation from traffic (including behind parking and kerblines) should be encouraged, whilst providing adequate safe-design details at intersections and driveways.*
- *A wide variety of cycling infrastructure types should be trialled throughout the country (particularly those that were well supported by the participants in this study) and their actual safety records*

should be monitored, as well as road-user understanding and acceptance of them.

- *Consistent infrastructure for cyclists at junctions, such as hook-turn facilities and dedicated cycle signals, should be implemented.*
- *On-site signage and markings should be improved, along with education for all road users on how to interact with and use various cycling facilities.*
- *More low-speed (30/40km/h) zones and cycle-friendly traffic management should be implemented throughout the country, so that people become more familiar with the concepts.*
- *The continuity and understanding of existing cycling facilities, both in terms of physical road/path features and signage/markings guidance, should be improved.*

- *Further investigation of the effect of access to company vehicles on the uptake of utilitarian cycling should be carried out, both in terms of vehicles provided for travel to/from home, and vehicles available for private use during the day.*
- *Those involved in the planning and design of cycling infrastructure should be encouraged to consider the broader health benefits associated with increased cycle use, in addition to the safety implications of infrastructure design.*

- (Kingham, Taylor et al. 2011)

Traffic planning and street design are traditionally the role of traffic engineers or civil engineers, whose goal is to move vehicle traffic through the street, rather than to attract people to linger (Button 2005). However, the contemporary street is treated as a public space, and the impact of this street typology on the wider urban form is still being explored (Gehl 2010; Shepard 2011). Cycle lanes as a branch of street design have their own unique attributes, as the social behaviour of cyclists is more akin to that of pedestrians than motorists, however their traffic movement pattern is more similar to motorists than pedestrians, and this creates a set of unique problems related only to cycling (Shepard 2011).

Family Tree of Bicycle Programs

FIGURE 02-006 - Electronic Device for Activating Bicycles (DeMaio 2011)

FIGURE 02-007 - Family Tree of Bicycle Programs (DeMaio 2009)

BIKE - SHARING

As mentioned in the above section, The White Bicycle Plan from Provos, Amsterdam 1965, was the first initiative to introduce bicycles to the masses as a form of transportation (British-Library 2010; NVA 2010). Decades on, the idea of using a bicycle for public transportation has evolved and matured and it is coming up on its fourth generation of iterations (DeMaio 2011; Haverman 2011). In recent years, interest in bike-sharing has spread across the globe; as of 2011, there are estimated 136 programs in approximately 160 cities worldwide with more than 236,700 bicycles with 13,500 stations on four continents and another 35 programs planned in 16 nations in the immediate future (Shaheen, Guzman et al. 2010; Shaheen 2011). Wellington had its own proposal for bike sharing in 2011, but the difficulties faced by both local authorities and the private businesses were too great, and the scheme was cancelled (Hulls 2011).

The first generation of bike-sharing was the White Bikes or free-to-use bike system. This scheme then evolved into a coin-deposit system in 1991 in Farso and Grena in Denmark (DeMaio 2009). The most commonly used systems are based on information technology, also known

as the third generation (Shaheen, Guzman et al. 2010). The development of the fourth generation is a hi-tech approach that is based on real-time information update systems, where GPS is used on each bicycle and the user can use their smart-phones to view and locate bicycles then use electronic chips to activate the system (DeMaio 2011).

[SEE FIGURE 02-006]

Since the inception of bike-sharing, various models of provision have existed. Bike-sharing providers have included governments, quasi-governmental transport agencies, universities, non-profits, advertising companies, and for-profits (DeMaio 2009). It is worth noting that currently bike-sharing is financially supported by government funding or advertising agencies, and this has a dramatic effect on the business models of the bike-sharing system (Holtzman 2008)

[SEE FIGURE 02-007]

FIGURE 02-008 - *Lyon Mayor, Gerard Collomb
Cycling in the city 2011
(Juste 2011)*

Despite the growth of bike-sharing, barriers and uncertainty remain. These include future demand, safety, sustainability of business models, limited cycling infrastructure, challenges to integrate with public transportation systems, technology cost and user convenience such as helmet, cargo space or adjustable seat height (DeMaio and Gifford 2004; DeMaio 2009; Shaheen, Guzman et al. 2010). However, the future of bike-sharing is clear: there will be a lot more of it. Gilles Vesco, Vice President of Greater Lyon, France, quotes his mayor as saying, “There are two types of mayors in the world: those who have bike-sharing and those who want bike-sharing.” (DeMaio 2009; Andreolli 2011). Currently, the research direction for bike-sharing is focused on gaining a better understanding of bike-sharing’s effects, operation, and business models in light of its reported growth and benefits (Shaheen, Guzman et al. 2010; Shaheen 2011).

[SEE FIGURE 02-008]

The aesthetics of a bike sharing system for a city would have strong impacts on the visual quality of the urban environment because it represents a mode of public transport for the city. As the research deepens into the functionality of bike sharing, the visual qualities of bike sharing would need to be explored also.

CYCLING, PLANNING, DESIGN & ARCHITECTURE

The issues of cycling are shared across a wide variety of disciplines, and assigning a hierarchical order of priority to these issues is often difficult because they are all essential to the sustainability of cycling in the city.

Banister has written extensively on the issues of transport policy, but the texts do not mention the role of design other than using the phrase 'urban design' in a fairly generic sense; this is despite the fact that transport policy has the greatest potential to interact, determine and shape the urban form (Hickman and Banister 2005). When cycling policies are prioritised in the transport policy for the local government, cycling can have an influence on the image, legibility and function of the city (Pucher and Buehler 2008). While many have published on the topics of sustainable transport without specific reference to cycling, no direct literature has explored sustainable transport policy, its resulting infrastructure and its relationship to the urban environment from an architectural or urban planning perspective.

Cycling advocacy demonstrates that road users should want to be involved in the design solution, since cycling infrastructure affects every citizen. However, it has been shown that the design explorations for infrastructural solution do not proceed parallel with cycling advocacy, but rather conceptual designs generally comes long after the campaign, when passion for the advocated issues has decreased and lost momentum (Lowndes, Pratchett et al. 2001; Bickerstaff, Tolley et al. 2002). The involvements of provincial and central government are also crucial; no cycle-friendly infrastructure would exist without top-down support. Cycling advocacy builds up public interests and concerns which lead to discussion in policy and the design of infrastructure; however the implementation of infrastructural changes is limited by the process of policy and more importantly, politics and funding. Also, interaction between the policy makers, designers and the advocates is limited during the design phase, which creates uncertainty in the effectiveness of the resulting infrastructure (Pooley 2011).

Cycling infrastructure encompasses all cycling related facilities and designs; this can range from road networks and bicycle storage units to street signs and marketing logos.

Bike-sharing systems are a fragment of cycling infrastructure for a city. The success of bike-sharing systems pivots heavily on the quantity and the quality of the cycling infrastructure provided by the city. As a transport system, cycle-ways, bike-sharing systems and cycling related facilities are all dependent on each other for sustainability; however, the lack of cohesive design methodology for all cycling related infrastructure is evident. This cohesive relationship that connects bike-sharing system and the broader scope of cycling infrastructure is rarely considered. As a result, the legibility of the overall transport system is decreased (Lynch 1960; Alexander, Ishikawa et al. 1977; Monö 1997).

By considering the cycling infrastructure as an integral part of transportation system that contributes to the form and visual qualities of the city (Lynch 1960), the scope of its responsibility can be broadened to affect the wide context of urban planning, not only the cycling infrastructure and its immediate concerns. When design strategies are introduced, they are very specific, generally taking the form of a design guide, with measurements and picture diagrams to illustrate the exact requirements. It seems that in terms of transport planning for cycling, the authorities are efficient at providing some form of overall goal and excellent at offering specific solutions, but nothing that connects them together (Hurn 2010). These hesitations on the support of cycling infrastructure can translate to years of inactivity from the local authorities and unhappy cyclists in the city (Lowndes, Pratchett et al. 2001; Bickerstaff, Tolley et al. 2002; Shepard 2011).

Jacobs (1961) proposed that cars should be adapted to the city, and that considerations for road designs should be reprioritised (Jacobs 1961; Mees 2000). Contemporary street designs explore how the design of the streets and its facilities can have an effect on people's activities (Gehl 2010). The social behaviours of the cyclist and the impact of those behaviours on the design of the cycle ways is barely explored, since cycling behaviours are often included with pedestrian behaviours (Shepard 2011). In addition the aesthetic relationship within cycle infrastructure, such as the design of the cycle road network in relation to the cycling components is overlooked (Monö 1997). Finally, from the design collaboration perspective, the planning and design process of cycling infrastructure needs to include designers, engineers, cyclist and non-cyclists - not just engineers with some cycle-friendly knowledge (Pooley 2011).

CONCLUSION

Inquires into current cycling literature revealed that local authorities hesitate to develop cycling infrastructure from a policy level and that semiotics relationship in the cycling infrastructure is rarely designed or considered. While the trend of cycling is increasing around the globe, the demand for refining the design, the business and the funding models are strong. At the same time, the pressures of congestion, air-pollution, petrol prices, and so forth all point towards an evolution in the way people move around the city. As part of this process of evolution, the recognition of cycling as an important aspect of transport policy, combined with a commitment to integrate cycling with existing urban transport, would result in a range of environmental, safety, energy, congestion and public health benefits.

Policy issues need to be considered when conducting the design case study, and the collaboration between the authorities and the cycling advocates need to be facilitated to understand the transport barriers. Finally graphic illustrations need to be shown to present a vision of cycling that the authorities and the cycling advocates can easily engage with and discuss in order to further the active transport effort in the city.

PRECEDENTS

PRECEDENTS

03

OVERVIEW

The existing cycling infrastructure has improved and evolved dramatically since its early days; these improvements range from segregated roadways to high-tech bike-sharing and automated storage. This chapter aims to provide an overview of best-practice and distinctive precedents in certain key areas of cycling infrastructure. The chapter is divided into three sections. First, it reviews some industrial design elements such as bike-share docks and urban furniture; it then focuses on bicycle hubs or buildings on an architectural scale; finally it examines the urban planning perspective of cycling infrastructure with examples from three different cities.

The category of cycling infrastructure covered in this chapter includes but is not limited to road and street design, storage, bike-sharing and bicycle services. When considering cycling infrastructure, all cycling related facilities and amenities should be considered as they all contribute to the experience of cycling in a city. In order to create diversity from an urban planning perspective, the precedents chosen for this section came from Europe, America and Australia.

The cities chosen have either recently reintegrated or are in the process of integrating cycling into their current urban transport system, as a result historic cycling cities with established cycling culture in Denmark and the Netherlands are intentionally not explored. Also, precedents from Asia are not reviewed due to the differences in context. For example, the population difference between Beijing and most western cities is far too great: the estimated population of Beijing is 20 million, compared with San Francisco at 8 million or Paris at 2 million (according to official releases). These differences and others create a different set of problems compared to Europe and America.

This review analysed the cycling infrastructure in the cities of Paris, San Francisco and Sydney, and considered two questions:

- How effective is the cycling road network integrated into the existing road infrastructure?
- How legible is cycling as a transport system?

The review focused on the connectivity and continuity features of each precedents. The term 'legibility' used for reviewing the precedents in this chapter is based on the interpretation of Lynch (1960); this term expresses concepts such as clarity and imageability, as outlined in the chapter 'The Image of the Environment' in the book 'The Image of the City' (Lynch 1960). The term 'semiotics' in relation to design was proposed by Monö (1997), it explores the aesthetics of products, then utilise form to suggest and improve the effectiveness of user interaction (Monö 1997; Hjelm 2002).

➤ **FIGURE 03-001** - Vélib' Logo (Vélib' 2010)

➤ **FIGURE 03-002** - Typical View of a Bike Station (Uffelen 2010)

➤ **FIGURE 03-003** - Vélib' & MUPI and Attachments on the Side of a Paris Street (Uffelen 2010)

URBAN FURNITURE

The theory and practice of cycling involves many professional fields, but industrial design is perhaps one of the most important; it affects all the most immediate interactions a bicycle user has with their equipment. The way a bicycle rides, the convenience of a locking-stand, and other small things contribute to the experience of cycling. Attention to this sort of industrial detail in the broader scheme of cycling infrastructure is essential to the success of the transport system.

VÉLIB AND MUPI, PARIS

The urban furniture shown in *FIGURE 03-002* and *FIGURE 03-003* was designed by Patrick Jouin, a French industrial designer, and commissioned by JCDecaux as a part of the bike-sharing scheme for the city of Paris. The design features two main elements: the Vélib 'freedom bicycle' and MUPI 'Mobilier Urbain Pour l'information' or information terminal. The MUPI terminal was distributed approximately every 300 meters throughout Paris with minimum of 10 Vélib bikes at each station.

The entire system is designed for vandalism resistance and modulation; therefore it is made from cast aluminium and is located between the footpath and cycle lanes. The MUPI terminal has electronic access on both sides plus a large map of nearby destinations and docking stations. The Vélib bicycles feature commuter friendly elements such as mud or chain skirt guards, basket, bell, three gears and a small information map on the handle bars. The Vélib bicycles and MUPI terminals are connected together with attachment stands that share the same design language as the MUPI, while the graphic design of the Vélib colours and logo connect the whole system together visually.

[SEE FIGURE 03-003]

◀ FIGURE 03-004 - *Bike Fixtation*
(Bike Fixtation 2012)

◀ FIGURE 03-005 - *Detail of Bike Fixtation in Use* (Bike Fixtation 2012)

▶ FIGURE 03-006 - *Piano by ADDI* (ADDI 2008)

BIKE FIXTATION, MINNEAPOLIS

When cycling around the city, a flat tire is the most common reason for stopping that activity. While most bike shops are happy to sell and fix the bike for you, it is costly and time consuming. Most cyclists are comfortable with fixing a puncture on their bike, but do not always carry the necessary tools or equipment. Bike Fixtation from America addresses this problem by offering a self-service kiosk of vending machine for parts and tools, and a service stand for securing your bike while you fix the problem.

[SEE FIGURE 03-004 & FIGURE 03-005]

The concept of a self-service bike station has the potential to become an important asset to the cycling infrastructure and the overall cycling experience. However, in this particular case, while the station functionally fulfills the niche, barriers such as private ownership and lack of state funding or recognition result in a functionally great design which contributes little to the overall design of the cycling infrastructure. Currently there is only one Fixtation available in the Minneapolis Uptown Transit Station with another one planned for the near future.

PIANO, SWEDEN

Swedish industrial design group ADDI produced Piano in 2008; it is a combined bike stand and outdoor bench.

[SEE FIGURE 03-006]

The white bench has a 90 degree profile; the seats and legs connect together with finger joints to form the seating platform while the gaps between the finger joints create slots to accommodate bicycles.

This design has the potential to reduce the amount of urban furniture in cities, offering cycle-friendly short term parking and seating at the same time. If the creation of this design was commissioned by authorities within a design framework, then the design language could have a closer relationship with the cycling infrastructure and urban design of the city, but Piano from ADDI failed to make those connections.

Definitief ontwerp Vinkenstraat 46 - 01-07-2010

Alle functies in één omhulling

Indeling: fietsenstalling en werkplaats

Een expressieve constructie in hout

ARCHITECTURAL CYCLING FACILITIES

The introduction of more bicycles on the road means the need to improve cycling facilities; bicycle storage is one of the most important requirements in the planning and the designing of a cycling infrastructure. This section will provide examples of four long term storage facilities; one from The Netherlands, two from America and one from Australia.

FIETSENPAKHUIS, ZAA NSTAD

The Fietsenpakhuis is a commercial warehouse that combines public space, cafe and retail, bike rental, recharging stations for electric bicycles, and changing room and toilet facilities with 700 free-to-use indoor bicycle parking spaces. The building, state funded and designed by Nunc Architects in collaboration with local cyclists in 2010, was finished in 2011. It is located at Zaandam, an industrial area with a population under 150,000 just outside of Amsterdam, The Netherlands.

[SEE FIGURE 03-007]

The building has two stories. The ground floor is a mixed-use open plan of bicycle retail and some storage spaces, while the upstairs is all storage. Many bicycle-friendly features have been designed: neatly stacked double-decker storage units, wide path ways and gentle sloped stairs with integrated bicycle tracks. The street elevation of the building maintains the warehouse typology, with natural daylight and ventilation keeping the

FIGURE 03-007 - *Fietsenpakhuis Front View*
(NUNC 2011)

FIGURE 03-008 - *Fietsenpakhuis Plan*
(NUNC 2010)

FIGURE 03-009 - *Fietsenpakhuis Program*
Diagrams (NUNC 2010)

- FIGURE 03-010 - *Fietsenpakhuis Interior View* (NUNC 2011)
- FIGURE 03-011 - *Fietsenpakhuis Bike Storage Details* (NUNC 2011)
- FIGURE 03-012 - *Fietsenpakhuis transverse Section* (NUNC 2010)

building bright and airy, while a combination of glass, wood, bricks and polished concrete finishes the modern and minimalistic aesthetics of the building. The structural elements take their design inspiration from old cathedrals and industrial warehouses, but the building is finished with modern timber materials and building techniques.

[SEE FIGURE 03-010 & FIGURE 03-011]

This building accommodates commuters as well as casual cyclists. The storage facility provided by the building is easily accessible, and most importantly, it is free. The addition of the toilet changing room facilities means that cyclists can travel from further away and not be limited by their clothing. Casual cyclists are able to rent bicycle on short term basis and without worrying about maintenance, since the bike is professionally serviced by the shop. The building interacts with pedestrians as well as cyclists, by inviting them inside through the transparency of materials and form. The minimalistic aesthetics reveals all of the building's functions to the users. This is a successful facility as it contributes to the functions of

the existing cycle infrastructure and also provides the necessary cultural catalyst for cyclists within the surrounding area.

The clear design concept, logical layout, minimalistic material composition and sensitivity to the existing urban context made this building a good storage facility; however, it is the inclusion of cafe and retail, public thoroughfare and toilet facilities which make this a great example of a modern bicycle storage facility. Not only does the building store bicycles, it also deals with the social and economical needs of the pedestrians and cyclists.

FIGURE 03-013 - Union Station Bike Transit Center Night View
(KGP Design Studio 2009)

FIGURE 03-014 - Union Station Bike Transit Center Diagram
(KGP Design Studio 2009)

FIGURE 03-015 - Union Station Bike Transit Center Site Plan
(KGP Design Studio 2009)

UNION STATION BICYCLE TRANSIT CENTRE, WASHINGTON DC

The Union Station Bicycle Transit Centre at Washington DC, designed by KGP Design Studio in 2011, has a complete contrast in terms of aesthetic to the European example; the minimalistic and natural material palette from Amsterdam is contrasted with an iconic design of glass and steel. The site is located parallel to the front entrance of a major transit hub in the central Washington DC. The building footprint responds to the adjacent vehicular and pedestrian circulation; it utilises, expands and divides the footpath to create a dedicated pedestrian and cycling path which is complemented by planting on the southern end. The owner and client for this project is the District Department of Transportation with private management outsourced to BikeStation, which operates similar bicycle storage facilities throughout America.

[SEE FIGURE 03-014 & FIGURE 03-015]

This Bicycle Transit Centre is divided into two main areas, bicycle parking and retail. Apart from storage and retail, it also offers bicycle rental, repair and servicing, lockers, changing rooms and shower facilities. The 150 secure

bicycle spaces, changing rooms and locker storage are available with a monthly payment; the 40 outdoor spaces are free to use.

The form of the structure is inspired by the bicycle wheel, and the interior is planned with retail services, shower and storage at the entrance, which then links onto a central access pathway with double-decker bike storage on either side. Glass covers the entire structure providing daylight and natural surveillance while promoting cycling as transport.

[SEE FIGURE 03-016 & FIGURE 03-017]

This building provides a destination stop for commuter cyclists in Washington DC as it combines long term storage, short term bike-sharing and other services under one roof. The location of this bike hub means that other modes of transport are easily accessible once the cyclist parks their bicycle. Public transport commuters have the opportunity to come out of Union Station and go to the building to rent a bicycle from the bike-sharing system. The bike-sharing system is distributed throughout the city; however, this building is the only one that provides this type of comprehensive service to cyclists. A

- ◀ **FIGURE 03-016** - Union Station Bike Transit Center Interior
(KGP Design Studio 2009)
- ◀ **FIGURE 03-017** - Union Station Bike Transit Center Glass Panel Detail
(KGP Design Studio 2009)

few more bicycle transit centres like this one at other major transport hubs would improve the cycling infrastructure even further.

This bicycle transit centre fulfils an iconic and symbolic role for cycling in Washington DC. While it does offer dedicated cycling services, it can be read that those functions are secondary to the marketing image which the building carries.

BIKEPARK, MELBOURNE

BikePark is the first full service bicycle storage facility for cyclists in Melbourne, it is located adjacent to the Yarra Trail bicycle path beside Queensbridge Street, it is within 5 minute walking distance to the centre of Melbourne CBD. It opened for business in 2010.

The facilities of BikePark are located within an old renovated nightclub. The modest use of glass and aluminium contrasting with the masonry construction, plus the bright and natural interior colour scheme and finish, provide this facility with a level of intimacy not found in larger facilities. The main storage area is visible from the front entrance, with shower, storage and laundry services through an entry to the side. While the design of the facility is not as extravagant as the other examples, its function focuses on the key issues

- ◀ **FIGURE 03-018** - *BikePark, Melbourne, Exterior*
(BikePark 2011)
- ◀ **FIGURE 03-019** - *BikePark, Melbourne, Interior*
(BikePark 2011)

and needs of cyclists, and integrates into the cycling infrastructure of Melbourne.

This bike facility is particularly unique because it is renovated, maintained, and operated by a private owner. This contrasts with the other examples above where state funding and ownership was the key driver for the project. BikePark is funded mainly by user membership and by affiliated services such as bike maintenance and cafe. From a user's perspective, the ownership of these facilities is not important, however if the facility was supported by the local authorities, then the membership fee could be restructured in the user's favour.

The role of this building is similar to the other two building above, but the private ownership and the lack of public funding mean that this particular facility will always have difficulties integrating into the wider cycling infrastructure of Melbourne. On the other hand, this facility contributes greatly to the cycling culture of the city. The owner operated nature of the business creates a personal relationship with

the cycling community; the owner is an active cyclist as well. The participation of the owner in the local cycling community is unmatched by the other facilities.

[SEE FIGURE 03-018 & FIGURE 03-019]

LES NOUVEAUX PRIX

		Les nouvelles offres		2007	2011
COURTE DURÉE	velib'				
	• Ticket 1 jour	30 min offertes	1 €	1,70 €	
	• Ticket 7 jours	30 min offertes	5 €	8 €	
ABONNEMENTS ANNUELS	• Classique	30 min offertes	29 €	29 €	
	• Passion	45 min offertes		39 €	
	• 14 - 26 ans	45 min offertes		29 €	
	• Boursiers et insertion pro	45 min offertes		19 €	

FIGURE 03-020 - Vélib' Stations within Paris CBD, Note the Density (Vélib' 2011)

FIGURE 03-021 - Vélib' Pricing (Vélib' 2011)

URBAN PLANNING

The cycle network between cities are vastly different, while the primary goal of promoting cycling and moving cycling traffic throughout the city is the same, however the planning considerations are different. These examples show a range of solutions from around the world.

PARIS

Cars have long dominated the streets of Paris, though this all changed in 2007 when the city of Paris decided to commit to building cycling and pedestrian infrastructure. This was evident as the city launched its own system of rental bike service called Vélib, and built more than 400km of cycle lanes.

Vélib is managed by JCDecaux, an advertising company mainly based in France, with more than 7000 bikes and 750 Vélib stations planned and launched at its initiation. In 2008, the bike rental service grew to more than 20000 bikes and 1450 rental stations, with each station spaced roughly 300m throughout Paris. This made Vélib the largest system of its kind in the world. The specific design details on the bikes and the rental stations were covered earlier in this chapter.

[SEE FIGURE 03-020]

◀ **FIGURE 03-022** - Cycle Network Plan of Paris 2010 (Mairie De Paris 2010)
 ▶ **FIGURE 03-023** - Vélib' Zones Within Paris (Vélib' 2011)

In order to accommodate the increase of bicycles on the streets of Paris, the city planned and implemented a comprehensive bicycle road network. The Map of Paris release of April 2010 indicates the existing and planned expansion of cycle lanes.

As of 2010 there are more than 440km of cycle lanes in Paris, and it was announced that the city plans to expand the network to 700km by 2014. Once complete the network will connect Paris and its surrounding municipalities with branches of cycle lanes originating from Paris with rings of more marked cycle lanes to connect network together. Further connections to outer regions are indicated on the April 2010 map for 2015-2020.

[SEE FIGURE 03-022]

The cycle network planned for 2014 effectively integrates cycling into the existing road network by building road infrastructure which recognises the importance of bikes as road traffic. From an urban planning perspective, for a flat city such as Paris, the rings of roads is a successful method for linking the cycling infrastructure together; there are currently three rings of cycle lanes surrounding Paris. As Paris is divided by the river

Seine, the cycle lanes along the length of the river are well developed and major bridge connections linking the two islands have either been converted or are planned to be converted to be cycling friendly. Also within the rings of cycle lane network, a hierarchy of the major commuting routes from north to south and east to west is clearly identified to be implemented by 2014.

The planning of the Vélib stations throughout Paris has divided the city into eight alphabetical and colour coded sectors. There is a map for each sector indicating the location of Vélib stations and the cycle lanes. The map information provided by the city of Paris integrates the cycle lane network and locations of the Vélib system; this provides the users with a high level of confidence and legibility for Vélib as a viable transport system.

◀ **FIGURE 03-024** - Existing Bicycle Route Network
(San Francisco Municipal Transportation Agency 2009)

▶ **FIGURE 03-025** - Cycling on San Francisco Hills (Chan 2009)

SAN FRANCISCO

The hilly city of San Francisco is fast becoming one of the most cycle-friendly cities in America. This is the results of years of collaboration between San Francisco Bicycle Coalition (SFBC), the main cycle advocate group, and SF Municipal Transportation Agency (SFMTA).

Compared to Paris, the planning of the cycle lane network in San Francisco has been much less comprehensive and organised. In Paris, the cycle lane infrastructure is planned and design by the city, with positive financial collaboration with businesses. In contrast, from 2005 to 2010, the city of San Francisco was legally incapable of planning cycling infrastructure due to environmental laws; therefore the overall bicycle network was treated as an individual project in the larger transport policy framework. However, a local advocacy group, San Francisco Bicycle Coalition, has campaigned for the creation of cycle lanes, resulting in a cycling infrastructure consisting of sections of cycle lanes connected together by normal road infrastructure. This strategy provided location specific fixes, gradually

building the number of individual infrastructures, then focusing on linking them together. This process is evident in the 2009 cycle map of San Francisco.

[SEE FIGURE 03-024]

From a planning perspective, location fixes do not deal with transportation issues on the larger scale. While such fixes offer a taste of what the infrastructure can become, they do not offer support for cycling as transportation. For people to utilise bicycles for transportation, connected and continuous cycle lanes are needed, just as continuous roads are needed for cars. Therefore the effectiveness of the overall system could be improved.

Currently, the development of the cycle lane network is ongoing. In general, SFMTA divides the cycle lanes into different classes: class I for off-street paths, class II for bicycle lanes, and class III for wide curb lanes and signed routes. These classes of roads give the transport infrastructure the necessary hierarchy for dealing with traffic capacity and speed. The network does not link together in rings like those found in Paris, but they do focus on connectivity throughout the

Recommended Near-Term and Long-Term Improvements to the Bicycle Route Network

- Near-Term Bicycle Improvement Projects
- Long-Term Bicycle Improvement Projects
- Minor Improvements to Bicycle Route Network
- Existing Bicycle Route Network
- Long-Term Transbay Transit Center Connection
- Parks and Openspace

0 0.5 1 2 Miles
Data Source: SFMTA
August 5, 2008

- ◀ **FIGURE 03-026** - Recommended Near-Term and Long-Term Improvements to the Bicycle Route Network (San Francisco Municipal Transportation Agency 2009)
- ▶ **FIGURE 03-027** - Web-based Cycling Route Planner for San Francisco (SF-Bike-Planner 2009)

entire city in the north to south and east to west direction while following the existing urban planning grid.

[SEE FIGURE 03-026]

Hills in San Francisco produce unique planning and design problems for cycling infrastructure. While the existing and planned cycle lanes mainly focus on developing the flat areas of downtown San Francisco, planning discussion always focuses on the hilly terrain. Plans for integrating bicycle storage on public transport can ease the hill journey substantially; the most effective method for getting around the hills is to plan the journey and the infrastructure correctly. Bike route planning can be done online via a dedicated website where the user can input details such as hill gradient, bike-friendly roads only, flat roads only and the shortest distance.

[SEE FIGURE 03-025 & FIGURE 03-027]

The combined effect of good cycle lanes and route planning means that the cycling experience in San Francisco is different to that of a flat city such as Paris. However, dealing with hills in a city can be as much about experience and knowledge as it is about fitness; experienced cyclists can often choose

alternative route to motor vehicles to avoid hills or certain roads. SFMTA and SFBC support the city's cyclists in this area by offering classes for all levels of cyclists, would-be-cyclists and motorists in multiple languages. These classes focus on road behaviour education, road rules, riding skills and general cycling knowledge.

The overall legibility of the cycling infrastructure is constantly improving in San Francisco. The combination of cycle lane networks, the route planner, and the education services presents cycling as an easy, convenient and safe mode of transport. However, although the recognition of cycling in the city is high, a cohesive semiotic relationship between the different services is lacking. For example when searching for cycle lanes and routes in San Francisco online, SFMTA, SFBC and SF Bike Route Planner all offer relevant data, but they each have their own method for providing information. This disconnect in the cycling infrastructure creates a psychological barrier between the user and the facilities and therefore lowers the overall legibility of the transport system.

Types of Cycleways

The City of Sydney is building a 200km cycle network across the entire City area.

We have designed the network to improve connections between employment, recreation and residential destinations to make cycling an attractive and safe transport choice.

By increasing the number of bicycle riders we will reduce road congestion, cut emissions and improve public health.

The network itself will consist of various types of cycleways and intersection treatments including:

- [Separated cycleway with parking](#)
- [Separated cycleway without parking](#)
- [Shared Paths](#)
- [Contra-flow cycling access](#)
- [Contra-flow bike lane with separator](#)
- [Mixed traffic lanes](#)
- [Separated cycleway bend out intersection](#)

Last Updated: Friday 27 August, 2010

◀ **FIGURE 03-028** - *Cycle Strategy & Action Plan 2007-2017*

(City of Sydney Council 2007)

▶ **FIGURE 03-029** - *Types of Cycleways Screenshot*

(City of Sydney Council 2010)

SYDNEY

The City of Sydney Council has made the commitment to carry out a ten year cycle plan in 2007 to improve the number of cycle trips and to integrate cycling into the existing road network. The specific details are released in a 76 page report titled Cycle Strategy and Action Plan 2007-2017(City of Sydney Council 2007).

This cycle strategy and plan is a most comprehensive and informative document. It covers vision, authority and funding structure for cycling, provides road maps for major cycle lane intervention and a year by year break down of cycle lanes in the road network, and contains design examples for major roads, streets and intersections. In 2010 an additional document took the planning and designing of cycling infrastructure even further by providing a design guideline for directional signage in the bicycle network (Salomon 2010).

The overall planning of the cycle routes in Sydney is determined by the Cycling Route Planning Framework, which outlines five types of facility that are to cater for cyclists. These

facility types are recreational cycle facilities, local roads, local cycling networks connecting the villages, regional cycling networks and high difficulty roads. The existing road infrastructure is then studied under the cycling route typologies provided by the framework; examples of the case studies are outlined in the 2007 document. These case studies focused on identifying major connections and then determining the level of intervention each connection would require for it to become cycle friendly.

As with San Francisco, the Sydney cycle lanes are divided into categories; the same document provides designs solutions for each category, then an implementation priority map for a phased coverage of the overall cycle network.

Compared to documents released in New Zealand (NZ Transport Agency 2010), the cycle network planning strategy utilised by City of Sydney is much more comprehensive: it considers cycling as a mode of transport, and then plans roads which will complement bicycles as well as cars. The framework first proposes the types of cycling infrastructure needed, and then provides draft design solutions to address the needs. This

Shared path pavement markings

A pavement marking system to encourage bicycle riders and pedestrians to behave in a predictable and co-operative manner has been developed for use on shared paths within the City of Sydney. Guidance pavement markings to communicate key behavioural messages to path users have been developed for use singly or in groups to suit each shared path situation (See Figure 8).

To improve management of shared paths through the promotion of key behavioural messages, a tiered implementation framework is recommended and is detailed in the City of Sydney *Shared Pathways Pavement Markings Guidelines* manual. Choosing the appropriate level of path marking requires a site-specific analysis of the types of path user and the operational conditions relating to each location.

T1502

T1503-L

T 503-R

T1501

T1501

Figure 6 (above left): Facilities and services signs for use on regional and local routes. Facilities and services signs for tourist and recreational signs are shown on Figure 4. Figure 7 (above right): Recommended logos for use on bicycle network facilities and service signage. Logos are white on a dark blue background (standard services colour). Logos shown are relevant for signing bicycle routes. For additional services logos refer to AS1742. Figure 8 (left and below): City of Sydney Shared path pavement markings. See separate design guidelines for full details.

Notes

1. This drawing is to be read in conjunction with the City of Sydney Street Name Sign Standard Drawing.
2. See separate diagram for typical intersection sign layout and mounting methodology.
3. Direction signs use AS1700 Royal Blue lettering, logos and arrows on white retro-reflective background. Letter sizes as shown.
4. Typoface used is GIL Sans mixed capitals and lower case. Where distances are less than 10km these should be indicated to the nearest 100 metres expressed in standard decimal form with the sub-kilometre numeral 75% of the height of the kilometre numerals.
5. Distance numerals are located adjacent to the direction arrow.
6. Signs are manufactured from 6mm aluminium plate sanded then acid washed, followed by a two-pack etch primer and a two-pack polyurethane coating to the required background colour. Sign height as above and cut to length.
7. Sign lettering and graphics are then applied and finished with a coating of two-pack anti-graffiti paint.
8. Fingerboard signs are mounted on poles using standard pipe clamps. Clamps should be pinned to prevent accidental movement due to wind or vandalism.
9. Direction arrows for markers are AS1743 - short arrow.

FIGURE 03-030 - Signage and Logos for Affiliated Facilities (Salomon 2010)

FIGURE 03-031 - Excerpt of the Signage Guide (Salomon 2010)

workflow of strategic framework and design solution is missing from the New Zealand document. The 2010 document (Salomon 2010) further structures the designs of the cycling infrastructure by improving the legibility of the network with a design guideline for cycling signage. This additional document started to affiliate cycling and cycle lanes with other public facilities with a set of logos to identify the destinations.

marketing cycling combined with the high quality planning and design of the infrastructure made for a positive, successful and cohesive project for Sydney.

The overall legibility of the cycling system in Sydney is very high; the comprehensive colour coded cycle lane network plus the regulated cycling signage logo and design language all contribute greatly to the positive cycling experience. However, the most important aspect of the positive, user friendly and legible feeling of the Sydney cycling system is the fact that all cycling related information is on the City of Sydney website under one page. This is convenient for anyone that might be considering cycling - they can familiarise themselves with the designs of the infrastructure, download maps of the network, sign up for educational classes and get in touch with local cycling representative. This extra step in advertising and

THE SCALES OF CYCLING INFRASTRUCTURE

The results of transport infrastructure can be seen in some form in the design of urban furniture, and this is no different with cycling. Larger implementations such as Vélib and MUPI took over the urban landscape of Paris and are now the international image of cycling for the city, while other furniture such as Bike Fixtation and Piano can create similar effects for a city if recognised by transport planning authorities.

The cycle storage facilities examined here functionally fulfil similar roles within the cycle infrastructure, but the diversity in design concept and business model is worth noting. The maturity of the cycle culture in Amsterdam is reflected in the minimalistic design details, natural materiality and the modest design statement of Fietsenpakhuis, while Washington DC takes the flamboyant approach in order to create positive statement and public awareness with their Union Station Bicycle Transit Centre. The scale and quality of the cycling facility in Melbourne, Australia is unmatched to the European and American precedents mainly due to the lack of civic recognition and support; this resulted in the creation

of BikePark, where one man owns and operates the facility in order to bridge the gap in the cycling infrastructure.

The urban planning precedents above show that leadership can have major effects on the quality of the cycle network, and that the underlying issues of connectivity and continuity within the cycle lane network need to be considered on par with the road system.

Graphic design elements are present throughout all levels of cycling infrastructure; however in the city scale unity rarely exists between the different scales of design. The purple logo of Vélib, the blue and green of BikePark and the bright red of Bike Fixtation fail to make semiotic connections with the larger cycling infrastructure in their respective locations, despite the quality of these facilities. It could be argued that these decisions promote design diversity, however a cohesive design language throughout the entire transport infrastructure should also be considered (Monö 1997; Hjelm 2002).

CONCLUSION

All of the chosen precedents show that designers have the ability to innovate and create high quality facilities for individual elements within the cycling infrastructure. Therefore it is evident that the broader semiotic relationship bridging all disciplines of design is lacking.

Some of the design ideas discussed above will be considered in the design case study. The exploration of a cycling network is needed, the inclusion of a bike sharing system will be a necessity and the need for an iconic architecture to celebrate cycling will be considered.

While the current precedents seem to function well in their respective cities, further infrastructural improvements can be made by accommodating semiotic consideration in the planning and design methodology of the cycling infrastructure. This applies both to cities that are cycle-friendly and those which are looking to become cycle-friendly (Saussure 1983; Monö 1997; Hjelm 2002).

By investigating the design link between individual cycling facility and the overall cycling infrastructure, the connectedness or disconnectedness of the semiotic relationship can be revealed. The chosen precedents showed that designers have the ability to innovate and create high quality facilities for individual elements within the cycling infrastructure; however, it is evident that the broader semiotic relationship bridging all scales of design disciplines within one system is lacking. This bridge is important as it can improve the cohesiveness of cycling infrastructure, increase legibility within the transport system, and therefore affect the wider context of city planning, urban form and ultimately, the visual and psychological image of the city (Lynch 1960).

DESIGN CASE STUDY

DESIGN CASE STUDY

04

OVERVIEW

The case study offers design solutions to the research questions. Within the time-frame of this thesis four designs were explored; these are documented in four sections. Each section starts with a brief explanation of the design intention, followed by design specific research, then the design outcome. The findings are concluded at the end along with recommendations for improvements.

The scope of each design increases sequentially, and the research information for the design case studies are both additive and accumulative. As a result, new research materials are inserted at their appropriate design sections.

- ▣ DESIGN 01 - Iconic Cycling Hub
- ▣ DESIGN 02 - Bike Sharing
- ▣ DESIGN 03 - Cycling Urban Integration
- ▣ DESIGN 04 - Cycling Brand Identity

▲ **FIGURE 04-001** - Cohesive Workflow for Planning and Designing Cycling Infrastructure

The workflow for the designs followed is graphically summarised in *FIGURE 04-001*, where all cycling components identified in the literature review are researched cohesively. The framework was developed during Design 03 but finalised in Design 04.

To better accommodate for the scope of the cycling infrastructure, the design case study started with the design and development of individual cycling components then transitions to combining different design components together to form the comprehensive cycling infrastructure.

Design 01 aimed to promote cycling through an iconic architecture, and Design 02 explored the aesthetics of bike sharing systems.

Design 03 combined cycling networks, architecture and the bike sharing system to provide a more comprehensive concept of cycling infrastructure.

The final design offered the complete cycling infrastructure package. It started by following the workflow and developed a framework to structure the design of different cycling infrastructure components. A cycling branding identity was designed for the city to improve the legibility and image of cycling as a mode of transport. These cycling components included redesigned elements and ideas from the first three designs, plus others that are identified in the literature review and precedents.

PHASE 1:

Focus on casual cycling within Wellington CBD (2km)

PHASE 2:

Connecting CBD with surrounding suburbs (2km-5km)

PHASE 3:

Link to wider Infrastructure (Beyond 5km)

◀ **FIGURE 04-002** - *Outline Area of Design Research*

Wellington is a compact city. Most of the city centre is on flat land, which creates opportunities for cycling. It was selected as the city for the design case study.

The site for the design investigation is Central Wellington; the case study will focus on developing design interventions within a 2 kilometre radius from the CBD.

The designs for cycling in Wellington are divided into three phases based on distance away from Wellington CBD. The case studies focus on the first phase of the design.

Greater Wellington Regional Council leads the developments of cycle ways in Wellington, with Cycling Advocates' Network representing the cycling community. It is important to establish the main stakeholders in Wellington.

ICONIC CYCLING HUB

The aim of this design is to create a standout architectural intervention in Wellington CBD for promoting cycling, this will raise the awareness of cycling to the public.

Te Aro Park was chosen for its strategic location. “The Golden Mile” is an important feature of the Wellington CBD, and Te Aro Park connects the business end (Lambton Quay) with the leisure end (Courtney Place) where people most travel through.

Following the precedent from Washington DC, the facility needs to combine multiple functions. The design aims to attract commuter cyclists by offering secure outdoor bicycle

storage facilities, workshops and close proximity to CBD destinations and other forms of public transport. Bold graphics and colours are used to form a way-finding system to and from the hub.

The way-finding tool took the form of a light post in the shape of an umbrella, these posts are connected with LED lighting strips and coloured ground texture. These iconic light posts are designed to be scattered along the safe cycle routes throughout Wellington CBD. The orange accent used throughout the design reflects the colour scheme of the online Journey Planner for walking and cycling in Wellington.

Central Wellington is stretched out towards the north and south directions.

The main suburbs of Wellington are indicated on **FIGURE 04-004**.

The waterfront is one of the main features of Wellington, cycling is promoted along the entire stretch of the waterfront.

‘The Golden Mile’ is the main business and shopping road in the city, it runs from Lambton Quay to Courtney Place, which is indicated in orange on **FIGURE 05-002**.

➤ **FIGURE 04-003** - Waterfront Cycle Way
➤ **FIGURE 04-004** - Mapping of Major Destinations

Te Aro Park is located in the centre of 'The Golden Mile'.

The park is surrounded by cafes and retail stores and it provides a connection from Eva Street to the Opera House Lane.

The site chosen is at the western side of the park where a block of public toilets is currently located.

- FIGURE 04-005 - Location of Site
- FIGURE 04-006 - Photo of Existing Site
- FIGURE 04-007 - Site Plan of Te Aro Park

- ▲ **FIGURE 04-008** - *Courtyard of Cafe facing the Toilet Block*
- └ **FIGURE 04-009** - *Scattered Scooter Parking Around the Current Site*
- **FIGURE 04-010** - *Front View of the Toilet Block Looking Towards Eva Street*
- » **FIGURE 04-011** - *Major Bus Stop Next to Te Aro Park*

The Cycling & Walking Journey Planner is an interactive web-based tool for finding the different routes within the Wellington region.

It has the ability to suggest different routes based on specific requirement such as distance and hill gradient. It is a useful guide to get around the city.

➤ **FIGURE 04-012** - Screen-shot of Journey Planner Web Interface
<http://www.journeyplanner.org.nz/>
 accessed on 24/01/2012

>> 01 DESIGN OUTCOME

The way-finding device is in the form of an umbrella, and the bicycle designed for this system has complementary lighting features built in.

The way-finding umbrellas are linked back to the central hub with ground painting and coloured LED lighting.

The bike is made from composite lugs with aluminium tubing. Safety features such as coloured lighting were incorporated into the frame and are powered by a wheel dynamo. It is driven by a crank shaft for easy maintenance and 2:1 gear ratio for manageable cruising speed.

The hub itself is built from two modular shells. One for the cafe and one for the bicycle service station. There are windows facing Te Aro Park and bicycle parking facility, and the entrance is on the eastern side.

FIGURE 04-013 - Design of Commuter Bicycle

FIGURE 04-014 - Scale of the Way Finding Umbrella

- ┐
FIGURE 04-015 - *Exterior Perspective Showing the Relation Between the Umbrella and the Bike Hub*
- **FIGURE 04-016** - *View through Ally*
- **FIGURE 04-017** - *Site Plan Showing the Layout of the Hub and the Umbrellas*

CONCISE SUMMARY

This design is visually bold, but it is a location specific solution and fails to consider the city context. More functions, more locations, and more facilities are needed to support cycling as a form of urban transport in Central Wellington.

The form and colour of the umbrella is easily recognisable throughout the city, however the hub itself fails to promote cyclist interaction with it, other than passing by.

The scope of this architectural intervention is too narrow, and the facilities are only aimed at users wanting short-term storage. The integration of the cafe provides secondary functions, but it would compete with existing cafe culture on Cuba Street. The Bike Service Station, although it would be a good addition, does not create enough bicycle traffic to become a hub that people would want to use.

The failure of this design is that it failed to capture the essence of cycling in a broader sense. This singular hub cannot fulfil the needs of cyclists in a city. However, where one hub is unsuccessful, perhaps multiple hubs linked together with the umbrella motif could be a solution. Also, this hub only caters for people who already own bicycles, so a bike sharing system should be designed and included in this hub, and at other location throughout the city, to facilitate more cycling uptake.

BIKE SHARING

This design explores a bike-sharing system which builds on the form and aesthetics of the previous design to further address the cycling infrastructure in Central Wellington.

Design considerations were given to the structure of the dock, and the integration of these docks into different locations.

The bike for the bike sharing system is retained from the previous design. The docks for the bikes kept the idea of an umbrella, but introduce information panels to complement the system.

>> 02 DESIGN RESEARCH

Precedents for bike sharing systems traditionally are distributed horizontally. For example Vélib in Paris and Capital BikeShare in Washington DC.

The bike sharing system for Design 02 is distributed radially, and includes a variation of horizontal and vertical docking stations. This docking station was able to hold more bikes per square meter compared to the precedents.

- ▲ **FIGURE 04-018** - MUPI and Vélib on the Streets of Paris. (Uffelen 2010)
- └ **FIGURE 04-019** - CAD Model of MUPI and the Dock for Vélib (Uffelen 2010)
- **FIGURE 04-020** - Capital BikeShare at Washington DC
- **FIGURE 04-021** - Details of the Bike Dock

>> 02 DESIGN OUTCOME

FIGURE 04-022 - Sketch of the Tensegrity Relationship

FIGURE 04-023 - Model of a Standard 3 Member Tensegrity Model

FIGURE 04-024 - 3 Member Tensegrity Model Designed with One Member for Column Support

FIGURE 04-025 - Diagram of Docking Station for Central Access, and Sketch Diagram of Docking Action

FIGURE 04-026 - Sketches of the Information Canopy in Relation to the Bikes and the User

The tensegrity structure is designed to provide the bike sharing infrastructure with an unique identity that can be recognised easily within the city. A tensegrity structure is where all support members in the system are in tension, a bicycle wheel is built with this principle.

The bikes are docked vertically in a circular pattern to save space.

-
FIGURE 04-027 - *Model of Modified 3 Member Tensegrity Model*
-
FIGURE 04-028 - *The Modified Tensegrity Structure is Arrayed in a Circulation Pattern*
-
FIGURE 04-029 - *The Bike Docking Station with Ground Track for Locking*

The finalised docking station holds maximum of 18 bikes.

Instead of designing a separate station for the information, the information panels are integrated with the docking stations. The illuminated panels provides information for the users and also lights up the docking station at night.

FIGURE 04-030 - Render of the Bike Docking Station in Circular Configuration

FIGURE 04-031 - Top View of Bike Docking Station in Circular Configuration

FIGURE 04-032 - Render of the Bike Docking Station in Half-Circular Configuration

FIGURE 04-033 - Render of the Bike Docking Station in Semi-Circular Configuration

FIGURE 04-034 - Top View of Bike Docking Station in Half-Circular Configuration

FIGURE 04-035 - Top View of Bike Docking Station in Semi-Circular Configuration

CONCISE SUMMARY

The iconic tensegrity structure identifies bike sharing, but the design failed to consider the architecture and urban planning context of Wellington.

The design bike sharing dock is eye catching and is flexible to insert into different sites. Orange accents are still included in the system to tie it to the Journey Planner.

The tensegrity structure is light weight, easy to assemble and has minimal impact on existing road infrastructure. It provides the system with an iconic design that can be recognised throughout the city. Considerations were given to the number of information panels and also whether they could provide rain shelter.

This design focused solely on the design of the bike sharing docks and bikes and therefore it failed to consider the architecture and urban planning context. The combination of ideas from design 01 and 02 should address these problems.

URBAN INTEGRATION

This design aims to combine the first two design components, and produce a network of cycling infrastructure as well as architectural facilities and a bike sharing system to support the cycle commuters and bike sharing users.

A major hub will be designed at the Wellington Railway Station to promote cycling to commuter groups.

The bike sharing system will be inserted throughout the city, and Tory Street to test the street integration of the design. A cycle lane network is drafted to support the bike sharing system and to connect the major hub with Te Aro Park. Street design is also explored to improve the functionality of existing footpath and road to cope with the increase in cyclists.

To structure these design elements, a cycling category framework is developed. This framework is used to distinguish different design components within cycling infrastructure and produce hierarchical relationships between different scales of design and facilities.

When considering the city as the site, further analysis of the urban form is necessary. Wellington City Council published a comprehensive document on Wellington City named Wellington Broad Analysis.

This document contains earthquake zones, typography, soil conditions, historic buildings and building age information plus more.

Wellington Broad Analysis - Published 20/02/2011 (From WCC)

- **FIGURE 04-036** - Cross Sections of Wellington
- **FIGURE 04-037** - Historic Buildings throughout the City
- **FIGURE 04-038** - Building Age in Wellington

The Wellington 2040 Final Report provided the most recent space syntax analysis for Wellington.

The mapping within the report gives a visual interpretation of the pedestrian movement in the Wellington CBD. This information will inform the location and the design of the cycle lane network to either share with pedestrians or avoid them.

This space syntax analysis will need to be combined with vehicle traffic information in order to gain a clearer understanding of the movement of people in Wellington CBD.

3.11 Spatial Accessibility Analysis Existing and private routes Pedestrian Infrastructure 800m

6.6 Pedestrian Movement Analysis Average all pedestrians WEEKEND (6am – 8pm)

Wellington 2040 Final Report

- Published April 2011
(From WCC)

- ▲ FIGURE 04-039 - Pedestrian Flow for Existing Roads
- ▲ FIGURE 04-040 - Pedestrian Movement per Hour
- ▲ FIGURE 04-041 - Pedestrian Traffic Weekend Average

6.19 Pedestrian Movement Analysis Average pedestrians – categories WEEKDAY (6am – 8pm)

The main routes through the city are highlighted in the map, along with bus routes.

These routes translate to potentially dangerous roads for cyclists; therefore the cycle lane network should seek roads or laneways that allow cycle traffic to avoid fast-travelling, large vehicles.

Bus

◀ **FIGURE 04-042** - Major Roads & Bus Routes in Wellington CBD

A cyclist generally feels comfortable cycling on roads with vehicle speed limit of 30km/h. This is because the average cyclist can travel with the vehicle traffic at that speed and avoid the dangerous situation of cars wanting to overtake them.

This map estimates vehicle speed based on the speed limit of the city and also observation and cycling experience.

Note that Wellington City has one set of shared cycle lane at the waterfront, and then a stretch of road leading out of the city on the northern end.

➤ **FIGURE 04-043** - *Speed of Automobile through Wellington CBD*

<i>WALKING</i>	
<i>Casual Walking Speed = 3.2km/h (0.9m/s)</i>	
<i>Commute Walking Speed = 4.8km/h (1.3m/s)</i>	
<i>5min Connections = 270m</i>	
<i>10min Connections = 540m</i>	
<i>CYCLING</i>	
<i>Casual Cycling Speed = 15km/h (4.2m/s)</i>	
<i>Commute Cycling Speed = 25km/h (7.0m/s)</i>	
<i>5min Connections = 1260m</i>	
<i>10min Connections = 2100m</i>	

The distance a cyclist can theoretically travel in 5 minutes is more than four times of a pedestrian.

By overlaying this information on the map, it is evident that a cyclist has the potential to move through the Wellington CBD in less than 10 minutes.

Public green space throughout the city are generally 5 minutes walking distance apart, however cyclists can connect these public spaces together in less time, this have the potential to compact the perceived size of Wellington City.

FIGURE 04-044 - Mapping Analysis of Walking versus Cycling Distance in Wellington

<div> <div>PHASE 1:</div> <div>Focus on casual cycling within Wellington CBD (2km)</div> </div>		
PRIMARY INFRASTRUCTURE: PERMANENT STRUCTURES	SUPPORT INFRASTRUCTURE: FACILITIES TO SUPPORT CYCLING CULTURE	FLEXIBLE INFRASTRUCTURE: FLEXIBLE FACILITIES
Cycle Lanes Bike Hub Club space	Retail Healthcare Information Centre Service Shops Toilets / Shower	Bike Hire Lockers Bike Storage Water & Air Signage

This chart separates the cycling infrastructure into categories based on their scale and quantity.

This informs the function of the resulting designs to reflect their category requirements.

TABLE 04-001 - Framework for Categorising
 Cycling Infrastructure

The urban form of Wellington is difficult to plan for cycling; however, a hierarchy of cycle lanes can be designed and integrated to the existing road infrastructure.

The Cycle Lane Network for Wellington is designed to have two high volume, high speed bypasses at the northern and southern end of the city, and then branches of slower cycle lanes to connect the city to the bypass.

The northern route will utilise the waterfront, and the southern route will need to be integrated with the inner city section of State Highway One.

One major commuting route is designed at the western boundary of the city to connect the two bypasses. Parallel to the commuting route are slower cycle lanes to connect the rest of the city together.

Existing laneways will be utilised to provide segregated pedestrian and cycle lanes. These laneways will connect to the bypass via the faster commuter routes.

➤ **FIGURE 04-045** - Map of Cycle Lane Network

Tory Street orientates parallel to the main commuter route. The aim of this cycle lane is to create a street typology with shared pedestrian and cycle lane to transition cyclists from the slower laneways to the bypass.

Some on-street car parking is sacrificed in order to accommodate a wide footpath to include cyclists.

Planting is used to separate parked cars from cyclists.

FIGURE 04-046 - Map indicating the location of Tory Street

FIGURE 04-047 - Sketch section of the shared cycle lane typology

FIGURE 04-048 - Photo of Existing Site

The car parking for Tory street alternates on either side of the footwalk between city blocks, and planting will further separate parked cars from cyclists.

This planting is necessary as a opened car door can cause dangerous accidents for cyclists. The planting will provide a barrier between the car door and the travelling cyclists to avoid such accidents.

Traffic calming features are designed for Tory Street. The pedestrian platform at the intersection, and the slight bend on the road, will ease pedestrian crossing and slow cars.

The bike sharing docks from design 02 is integrated to the corner of the street. It is located next to the cycle lane.

➤ **FIGURE 04-049** - Plan of Tory Street, Ebor Street and Lorne Street Intersection

The bike docking station is structurally integrated with the existing street lamp post. The digital information panels lights the area and the orange accents from the bikes and the docking station reflect the orange cycle lanes.

The orange strips on the footpath, which indicate the cycle lane, produce a subtle sound when a bike rolls over them to inform pedestrians of the presence of a cyclist.

➤ **FIGURE 04-050** - *Street Perspective of Redesigned Tory Street*

The major bike hub is designed at the railway station. The pedestrian flow means that the park in front of the station is a good location for promoting cycling.

- FIGURE 04-051 - Map Indicating the Location of The Railway Station
- FIGURE 04-052 - Diagram of the Bike Hub at The Railway Station
- FIGURE 04-053 - Photo of Existing Site

Two main facilities are designed at the bike hub; the cafe at the eastern end and the bike service shop at the western side. These facilities are connected to the surrounding streets via two major pedestrian and cycling shared lanes.

These sketches indicate the type of pedestrian and cycling shared lane. Note the wide pathway with canopy covering on the pedestrian side: thin columns are used to divide the pathway for cyclists, and consideration was given to the existing planting at the site.

FIGURE 04-054 - Sketch of Pathway with Bike Docking Station

FIGURE 04-055 - Composite Sketches of Pathway Showing Perspective, Plan and Section

- FIGURE 04-056 - Sketch of Tension Cable tying the Pathway Canopy to Structural Columns
- FIGURE 04-057 - Detailed Sketch of Cable to Canopy Connection
- FIGURE 04-058 - Detailed Sketch of Column to Canopy Connection
- FIGURE 04-059 - Section Sketch of Canopy and Interior of Cafe

There are two main canopies, one for the cafe and one for the bike service shop.

The canopy is made from aluminium panels welded to aluminium grids, creating an aluminium shell. The underside has orange panels, in the motif of the digital information panel from the bike docking station, inserted for accent. Gravity only columns support the weight of the canopy and the entire structure is torsionally tied to structural columns.

The minimalist details are inspired by the 2009 Serpentine Pavilion by SANAA.

FIGURE 04-060 - Overall Form of Cafe Canopy
 FIGURE 04-061 - Exploded Diagram Indicating the Structural Layers of the Canopy

The materiality of the project is kept simple, only using combinations of aluminium, glass, natural timber and orange accents.

The bike sharing docking station is integrated to the columns or street lamps around the site.

Extensive use of orange accent draws visual connections between the cycle lanes, canopies and the bike-sharing system.

- └
FIGURE 04-062 - *View of the Seating Area Outside the Cafe*
- └
FIGURE 04-063 - *Pathway for Cyclists Towards the Railway Station*
- >
FIGURE 04-064 - *View of the Shared Pathway*

CONCISE SUMMARY

This design is comprehensive and provides multiple facilities to support the cycling culture. However, each design element within the cycling infrastructure uses a different aesthetic language, and therefore they ultimately lack the semiotic connection between designs.

This design started to structure and test a framework for the facilities needed within cycling infrastructure. The results from this framework are reflected in the quantity and diversity of the design outcome.

It is a success that this design provides a comprehensive range and scale of facilities to improve the cycling infrastructure, and it also indicates the scope of design that is needed for cycling infrastructure. But it ultimately lacked the cohesive vision to connect the diversity of the designs. Therefore although they all function as a part of the cycling infrastructure, yet they all have different design language.

A fragmented design language and the lack of semiotic relationship within the cycling infrastructure are criticised in the review of precedents, and this design falls into the same design trap.

The reason for this is that the overall outcome of this iteration is an accumulation of previous designs, and while each of them were good designs at the time, they lacked the cohesive language to link them together.

To overcome this, the development of the framework is crucial and also the design needs to start from a blank slate.

CYCLING BRAND IDENTITY

The lessons learnt from the previous designs concluded that the lack of cohesive planning and vision produced fragmented design language and the lack of semiotic relationship within the cycling infrastructure.

This design first produces a flexible framework to categorise and determine the relationship between individual cycling facilities and their users, then use brand identity to market cycling within Wellington.

By recognising cycling infrastructure in Wellington as a transport brand, it is clear that the content of this brand package will need to expand from the previous designs.

The framework should inform on the type of facilities needed at specific locations and the cycling brand will outline the design language of the resulting outcome.

The content of this design includes elements of graphic design, industrial design, interior design, architecture, landscape and urban planning.

TYPES OF CYCLISTS

Cyclists can be grouped into the above three categories, and each group overlaps another by a certain percentage. The box representing each cyclist group can expand or shift based on local statistics. The above is the estimate for Wellington.

The ownership of bicycles needs to be considered for bike storage and the bike sharing system.

▲ TABLE 04-002 - Diagram of the Types of Cyclists

CATEGORIES OF CYCLING RELATED DESIGN COMPONENTS

This is a modified version of the previous framework, the grouping has changed and more items were added. More contents can be added or subtracted from these categories based on the requirement of the city.

This table is tailored for Wellington CBD.

➤ **TABLE 04-003** - Categories of Cycling Related Design Components

Infrastructure	Traditional Roads Bike Paths Laneway Bicycle Priority Lane Footpath Signage
Public Facilities	Shower/Changing Room Toilet Spare parts vending Bicycle Workstand Locking Stand Secure Parking Goods Storage Public Bike Sharing
Cultural Facilities	Bicycle Service Station Bicycle Retail Cafe Meeting Space Education Space Bike Share Office

The groups of cyclists are laid out horizontally with the design components listed vertically. Then using a bar graph style chart, the relationship between the cyclist groups and the facilities can be examined.

Certain facilities would only affect a selected group of cyclists; however design components such as street signs will affect all cyclist groups.

The bars for each design component can shift left or right and expand or subtract based on their relationship with the cyclist group.

The idea for this framework is that the designer makes the decision for a given site based on the demographic of the cyclists, then relate the users to the types of design components. When this design process is repeated throughout multiple sites, the underlining coherency and organisation will benefit the consistency of the resulting cycling infrastructure in the city.

This design will test the framework for three different scales of facilities, which are documented in a later chapter.

➤ **TABLE 04-004** - *Design Framework for Planning and Designing Cycling Infrastructure in Wellington*

	Casual (Bicycle Share)		Commuting		Sports/Exercise	
Infrastructure						Traditional Roads Bike Path Laneways Bicycle Priority Lane Footpath Signage
Public Facilities						Shower/Changing Room Toilet Spare Parts Vending Bicycle Workstand Locking Stand Secure Parking Goods Storage Public Bicycle Sharing
Private Facilities						Bicycle Service Station Bicycle Retail Cafe Meeting Space Education Space Bike-Sharing Office

>> 04
DESIGN OUTCOME
INFRASTRUCTURE

The concept is to insert bike sharing stations around the city. By connecting these stations together, a movement pattern can be shown. Then the design of cycling hubs can be located at where these paths intersect.

< **FIGURE 04-065** - *Conceptual Diagram of Movement Pattern for Cyclists*

CYCLEWAY NETWORK

The distance between the Bike Sharing Docking Station is kept at a maximum of 400 metres apart. Due to the size of the city, 25 locations will produce satisfactory coverage.

More locations could be considered along the waterfront or towards the railway station; however for the purpose of this design, this distribution pattern has met expectation.

Cycle Network in Wellington overlaid with Bicycle Sharing Docking Station Distribution

25 Locations

Maximum walking distance apart = 400m

➤ **FIGURE 04-066** - Map indicating the density of the Bike Sharing Docking Stations

WC Tronic 402 for Ströer Out-of-Home-Media, Germany is designed in 2008 to exceed the highest hygiene standard in Germany. It is a fully automated system, vandalism resistant and virtually maintenance free.

This design component is incorporated into Design 04 to fulfil the requirement of the design framework.

- ▲ **FIGURE 04-067** - Exterior View of Toilet
(Uffelen 2010)
- └ **FIGURE 04-068** - Interior Toilet
(Uffelen 2010)
- **FIGURE 04-069** - Section of WC Tronic 402
(Uffelen 2010)

Cyclepods is a British company that designs and manufactures vertical bicycle storage systems. Their Spacepods are chosen to be incorporated into the design on the larger bicycle storage facilities of this design.

- ▲ **FIGURE 04-070** - *Cyclepods with Shelter*
(Cyclepods 2011)
- ▮ **FIGURE 04-071** - *Spacepods Used Outdoors*
(Cyclepods 2011)
- **FIGURE 04-072** - *CAD drawing of Spacepods*
(Cyclepods 2011)
- **FIGURE 04-073** - *Spacepods used for underground cycle storage*
(Cyclepods 2011)

>> 04 DESIGN OUTCOME BRANDING

The design of the cycling identity and brand was necessary to communicate the values of the cycling infrastructure to people and their city. This identity or brand will structure, represent and influence the design of all cycling infrastructural products, services and properties.

BikeHere is the brand for cycling in Wellington. It recognises the desire to cycle in the city, and it represents a convenient, dynamic, fun, and in terms of the bike sharing system, a high tech mode of urban travel.

In order to improve the legibility of the cycling facilities, a series of logos were designed to recognise the products within the Wellington cycling infrastructure as one design family. These logos are synchronised in terms of colour, style and form.

These Logos will appear on the appropriate cycling facilities.

FIGURE 04-074 - Cycling Brand for Wellington
 FIGURE 04-075 - Logos for Cycling Facilities in Wellington

>> 04 DESIGN OUTCOME

BIKEHERE MODULES

The functions of the BikeHere modules are derived from the list of design components from the framework.

These design components will be reproduced at multiple locations throughout the city, therefore modularity in the design products became the main driving concept behind the construction of the BikeHere products.

Smaller designs such as bike sharing docking stations and short-term bike storage will be mass produced in quantity, and larger facilities such as long-term bike storage with toilet and shower unit will be produced per location. Although the scales of these designs differ, the design language is consistent and reflects the BikeHere brand.

	GREEN (SCULPTURE OBJECT)	ORANGE (FUNCTIONAL)	SPOTS/STATIONS
Traditional Route			
Bike Path			
Greenway			
Bicycle Parking Lane			
Footpath			
Pathway			
Shower/Changing Room			
Toilet			
Space for a Stand			
Bicycle Rack			
Locking Stand			
Secure Parking			
Secure Storage			
Public Bicycle Sharing			
Bicycle Service Station			
Bicycle Repair			
Safe			
Waiting Space			
Bicycle Shop			
Bike Sharing Office			

THE DESIGN COMPONENTS ARE LISTED IN THE
FRAMEWORK

TABLE 04-005 - Design Framework for
Wellington

The base dimensions of the BikeHere modules are 600mm x 600mm, which is based on the general physical dimension of a domestic vehicle. This is to ensure that all BikeHere modules are able to connect together and expand based on structured dimensions, and also that most modules can integrate into existing car parks.

FIGURE 04-076 - General Dimension of a Car
FIGURE 04-077 - Diagram of Modulation Strategy

The *RentHere* Bike Sharing System aims to use fourth generation bike sharing technology to include swipe card access, GPS tracking and real time docking information updates.

The RentHere system has three parts; an orange control module, a white docking module, and white and orange bicycles. Each docking station has a maximum capacity of 19 bikes. Four bikes at the control module, and five bikes at the docking modules.

The control module is a standalone unit that can function by itself, however if more bicycle capacity is needed at a given site, the white docking modules can be added to increase the maximum carrying capacity.

The bicycle is specifically designed for the RentHere system. It features full mud guards, crank drive gears, wheel dynamo to power LED safety lights, basket on handlebar and cellphone charging while you pedal.

The circular modular system means that the various configurations can be designed to fit around existing street furniture or building corners, or at full configuration to surround lamp posts or trees.

Each control module has built-in information panels, and the logo of RentHere is set into its concrete base. The whole system is colour matched to the BikeHere brand.

- ▲ FIGURE 04-078 - RentHere Bike
- FIGURE 04-079 - RentHere Logo
- FIGURE 04-080 - RentHere Bike Sharing System

FIGURE 04-081 - Control Module for Bike Sharing System

FIGURE 04-082 - Control Module Plus One Docking Station

FIGURE 04-083 - Control Module Plus Two Docking Stations

FIGURE 04-084 - Sketches of the Bike Docking Actions

▲ FIGURE 04-085 - Control Module Plus Three Docking Stations

▮ FIGURE 04-086 - Solar Panel Integrated on Individual Modules

RentHere

➤ FIGURE 04-087 - Complete Bike Docking Station integrated with Street Lamp Post

In order to facilitate the various design elements, a base module was designed to house the different design products.

The construction methods used for these modules are borrowed from naval architecture. Aluminium panels are flush riveted to aluminium ribs to give the structure the torsional strength and form, and then composite panels are moulded around the ribs to give the interior finish. Light fixtures are designed into the composite panels, and the whole structure is spray painted with automobile grade white paint.

Aluminium plates are integrated at the ends of each module which can be bolted together for expansion.

An aluminium shell of 1200 millimetres wide form the basic structure, this can be expanded horizontally modularly. Then two end pieces can be connected onto the basic shell to provide structural support with 50 millimetre diameter brushed aluminium columns. The different modules combined complete one base module.

+

=

^ **FIGURE 04-088** - Basic Structure, 1200mm

^ **FIGURE 04-089** - Basic Structure, 1200mm x 2

^ **FIGURE 04-090** - End Modules

^ **FIGURE 04-091** - Complete Base Module, 1200mm x 3

> **FIGURE 04-092** - Complete Base Module, 1200mm x 4

The base module is 1200mm x 4800mm, which can comfortably be inserted to a car park space.

This thin aluminium shell provides a blank canvas for integrating industrial elements of cycling infrastructure. Each module has a set of solar panels built-in, and all wiring is sandwiched between aluminium and composite panels. The location of the panel lines for the composite panels is carefully considered as well.

Polished precast concrete tiles with stainless steel boundaries are used for ground treatment. Drainage gaps are designed for each module.

- ^ **FIGURE 04-093** - *Back View of Base Module*
- └ **FIGURE 04-094** - *Roof view of Base Module*
- > **FIGURE 04-095** - *Column to Roof Detail*
- >> **FIGURE 04-096** - *Column to Ground Detail*

Building upon the 1200mm multiply by 3 base module is the *PayHere* station. It is similar to the pay stations at public carparks.

This module can be connected with the RentHere modules to introduce the incentive to 'pay for your carpark ticket here, and rent a bike next to it.'

The design treatments have been considered in terms of the BikeHere brand.

- └ **FIGURE 04-097** - *PayHere Logo*
- > **FIGURE 04-098** - *Base Module, 1200mm x 3*
- >> **FIGURE 04-099** - *PayHere Station, 1200mm x 3*

The *FixHere* stand includes a bike workstand with the base module.

This workstand is a simple T-bar, where the users hang their bike by the seat, and let the bike naturally hang down. This eliminated any complicated clamping mechanism; also this workstand allows two bikes to be hung up at the same time. A tire pump is integrated with this station.

Timber decking is used for the ground of the workstand, to define the work space through subtle change in materiality.

> FIGURE 04-100 - *FixHere Logo*

>> FIGURE 04-101 - *FixHere Station, 1200mm x 3*

< **FIGURE 04-102** - *Base of the Workstand*
 ^ **FIGURE 04-103** - *Orange LED Integrated with the Workstand for Safety*

This FixHere station has a vending machine design next to the workstand. It expands upon the idea presented in the Bike Fixtation in the precedent study.

The vending machine sells tubes and tires and provides tool rental. Swipe card or credit card access combined with proximity sensors facilitate payment collection and prevent theft.

The FixHere station will benefit commuters as well as sports orientated cyclists.

- FIGURE 04-104 - *FixHere Logo*
- > FIGURE 04-105 - *FixHere Station, 1200mm x 3*
- >> FIGURE 04-106 - *Large FixHere Station, 1200mm x 4*

◀ FIGURE 04-107 - Logo Integration with Modules

▲ FIGURE 04-108 - Orange LED Safety lights at Base of Tracks

└ FIGURE 04-109 - Back View of LockHere Station

The *LockHere* Station provides medium term bike locking to cyclists.

The front of the station has four vertical docking stations, which use the same geometry as the *RentHere* Station, and the back has standard angle docks.

LED safety lighting is incorporated into the tracks of the docking stand, and the metal rings for locking bicycle are designed with orange accents.

> **FIGURE 04-110** - *LockHere Logo*

>> **FIGURE 04-111** - *LockHere Station, 1200mm x 4*

◀ FIGURE 04-112 - Logo Integration with the Concrete Base

▲ FIGURE 04-113 - Detail of Bench

▮ FIGURE 04-114 - Back View of SitHere Station

The *SitHere* combines public seating with short term bicycle storage. It expands upon the idea presented by the Piano in the precedent study.

Cyclists will have the ability to dock their bikes at the bench while waiting for friends. No secure locking rings are provided as the intended storage period for this station is up to 45 minutes. Timber decking is used to differentiate the spaces.

This station is designed as an attachment module for other stations.

- └ FIGURE 04-115 - *SitHere Logo*
- FIGURE 04-116 - *Standard Flat Canopy Connection Module*
- FIGURE 04-117 - *SitHere Station*

◀ **FIGURE 04-118** - Front View of the Toilet Module, Doors Closed

▲ **FIGURE 04-119** - Back View of the Toilet Module

Public toilets can be designed as a part of cycling infrastructure by providing shower and changing room facilities.

The toilet mechanisms are modified version of the automatic toilet WC Tronic 402 for Ströer Out-of-Home-Media, Germany. It has disabled-access unisex toilet, swipe card activated shower, clothes storage on one side, and two urinals on the other. The whole unit is automated for cleaning and sanitisation.

FIGURE 04-120 - Toilet Module Logos
 FIGURE 04-121 - Toilet Module, Doors Opened
 1200mm x 7

<< FIGURE 04-122 - Toilet Bowl 01
 < FIGURE 04-123 - Cleaning Mode
 > FIGURE 04-124 - Toilet Bowl 02

Two toilet bowls were designed for the toilet unit for hygiene reasons. After use, one would flip away for cleaning and the other would flip out for use.

Building upon the original German design, a shower unit is designed into the toilet module. It is swipe card accessed, and on a 15 minute timer. Cabinets are designed into the walls of the module for storing clothes while the shower is in use. Large mirrors and generous basin top is located close to the entrance, away from the toilet and shower.

When the shower is activated, the two toilet bowls will fold away automatically, and the orange ring around the large metal button would turn green to indicate that the shower is ready to be used.

➤ **FIGURE 04-125** - Toilet Module in Shower Mode, Note the Green Light around the Button

Interior of the urinal is finished in the same aesthetics as the toilet and shower unit. Two wall mounted stainless steel urinal bowls are divided by the sheet of 7mm frosted white polycarbonate sheet.

Smaller basin and mirror are located at the far corner against the back wall.

> **FIGURE 04-126** - *Sliding Door Entry for Urinal*
 >> **FIGURE 04-127** - *Detail of Urinal*

This cafe module is design with the same aesthetics treatment as the smaller modules from the BikeHere brand. It provide a transition space between the different modes of travel.

This cafe module can be connected to other module to form a cultural and social destination for cyclists. Note the flip out window for a bike through coffee window.

Decisions for using this module will need to be based on site location and the surrounding business culture.

FIGURE 04-128 - *BikeHere Wellington Logo*

FIGURE 04-129 - *Cafe Module*

The Bike Service Shop will have professional bike mechanics working inside to maintain the fleet of bikes from the RentHere stations, but they can also fix and service private bicycles. The logo for the shop is the same as the FixHere station.

Floor to ceiling glass walls are designed to give the Bike Service Shop maximum display area.

There is a FixHere workstand located outside the shop, and when the cyclist fails to fix their own bike, they can seek professional advice inside.

- ┐ **FIGURE 04-130** - *Bike Service Shop Logo*
- **FIGURE 04-131** - *Front View of Bike Service Shop*

The *StoreHere* facility is the largest building designed for the cycling infrastructure in Wellington. It offers 60 longer term indoor bicycle storage, six toilet and shower units plus 26 paid lockers within the facility.

The bicycle storage units are Spacepods designed by a British company called Cyclepods. It uses the same vertical docking action as the RentHere and LockHere station. The 60 storage spaces are divided into three rows of 20 spaces.

The toilet and shower units share the same design features as the Toilet Module, but condensed.

The lockers are located on the outside of the building, they are paid for via cash or swipe cards.

Swipe card access and pay stations are located at the entrance of StoreHere; the system requires the user to swipe in and swipe out. A pedestrian only entrance is located next to the bicycle entrance.

The building uses the same construction techniques as the base module, and the mass of the roof is supported by gravity only columns. The entire structure is torsionally anchored by the toilet and shower structure.

- FIGURE 04-132 - *StoreHere Logo*
- FIGURE 04-133 - *Night View of StoreHere Facility Showing Lighting Quality*

The elevation treatment for StoreHere retains the same BikeHere minimalist aesthetic features, but at a much larger scale.

The bicycle storage area is designed with natural surveillance in mind by encasing 3 sides of the building with 10 millimetre floor to ceiling clear polycarbonate panels. The roof has two degrees of fall and provides 1500 millimetres of eaves around the entire building. The interior is naturally ventilated, and therefore it retains exterior material finishes, but the toilet and shower units are self-contained modules in terms of weather tightness.

< **FIGURE 04-134** - Elevations of the StoreHere Facility

> **FIGURE 04-135** - Plan of the StoreHere Facility

SCALE : 1 : 200 @ A4

< **FIGURE 04-136** - Toilet and Shower Walkway
 > **FIGURE 04-137** - Connection Detail for Polycarbonate Walls. Note the Integration of Drainage

Large skylights provide natural lighting during the day and diagonally patterned fluorescent tubes provide artificial lighting at night.

The same concrete tiles from the base modules are used for the ground of the bicycle locking area. Lighter coloured polished concrete topping differentiates the walking zones from the storage zone.

➤ **FIGURE 04-138** - *Interior Perspective of the StoreHere facility*

This table names and shows all the BikeHere modules and their related configurations.

To insert these modules on site would require this table and a planning grid.

Note the base modules are completed with connection modules from M07. These connection modules can also link together different base modules to form larger facilities.

Further facilities can be designed based on requirements; however the diversity of this table is satisfactory for the purpose of this design.

➤ **TABLE 04-006** - *Table of BikeHere Modules*

BIKEHERE MODULES

		M00	M01	M02	M03	M04	M05	M06
CONFIGURATIONS	A
	B
	C
	D

CONNECTIONS	M07
		A	B	C	D	E	F	G

>> 04 DESIGN OUTCOME SITE INSERTION

This section documents the site insertion design process for the BikeHere modules.

Three different sites were chosen to show the diversity of the BikeHere products. All sites are located along the BikeHere cycle network.

The size and the complexity of the programs increase as this section progresses; it will cover urban furniture intervention to the redesign of the landscape and architecture of the Wellington Railway Station Park.

➤ **FIGURE 04-139** - *Map Indicating the Location of the Chosen Sites in Relation to the Cycle Network*

MAJOR HUB
ALL ASPECT OF CYCLING

WELLINGTON RAILWAY STATION

CONNECTING
NODE WITHIN
NETWORK

TE ARO PARK

SATELLITE
PODS

146 CUBA STREET CARPARK

Most of Cuba Street is pedestrian-only with boutique retail stores and little bars and cafes on both sides of the street.

The carpark at lower Cuba Street provided opportunities to advertise cycling to motorists and pedestrians alike.

The cyclist group targeted for this site is the casual user group, with some overlap into the commuter group. Therefore bike sharing, bike storage, and urban furniture are the key design activators for this site.

FIGURE 04-140 - Photo of Existing Site
 FIGURE 04-141 - Cafe Beside the Carpark
 FIGURE 04-142 - Current Pay Here Station

➤ **FIGURE 04-143** - Site and its Relative Location of the Design Framework

FIGURE 04-144 - Site Plan of 146 Cuba Street
 FIGURE 04-145 - Highlighted Area for Design Intervention

The PayHere station in conjunction with the RentHere station will replace the existing parking meter.

The street traffic around the site is relatively calm, which creates a naturally comfortable cycling environment.

This design intervention will utilise one carpark space and the existing parking meter area.

FIGURE 04-146 - Planning Grid Showing Module Configurations

FIGURE 04-147 - Composite Render Showing the Design Intervention of Site

Te Aro Park was the site for the first design; this design however aims to provide a medium density facility for casual and commuting groups.

This is achieved by providing RentHere Stations at the entrance to both Eva Street and Opera House Lane. SitHere and LockHere station are planned for bicycle storage and the inclusion of Toilet Module and FixHere Station will further reinforce the commuter cyclist community.

- FIGURE 04-148 - Photo of Existing Site
- FIGURE 04-149 - Public Toilets at the Park
- FIGURE 04-150 - Water Feature at the Park`

➤ **FIGURE 04-151** - Site and its Relative Location of the Design Framework

Dixon StreetManners StreetOpera House LaneEve

➤ **FIGURE 04-154** - *Perspective Render of thoroughfare through the Te Aro Facility*

✓ **FIGURE 04-155** - *Exterior Perspective of the Te Aro Cycling Facility. Note the Landscape Development is Important*

FIGURE 04-156 - The Park in Front of the Railway Station

FIGURE 04-157 - Cycle Lane Next to the Park

FIGURE 04-158 - Vehicle Access for the Railway Station

FIGURE 04-159 - Site and its Relative Location of the Design Framework

The major cycling hub at the Wellington Railway Station will include all aspects of cycling design typology. This site will need to facilitate all three groups of cyclists, but with an emphasis on commuter cyclists.

The design of this cycling hub can be split into three phases. The first phase will implement the RentHere and the SitHere stations to activate casual cycling. Phase two will provide Toilet Modules and FixHere station in conjunction with RentHere and SitHere stations to service sports and commuting orientated cyclists. Finally, phase three will introduce StoreHere and other large architectural products along with the redesign of the landscape.

In order to turn the site into a cycling safe environment, continuous cycle lanes are planned around the Wellington Railway Station. Five major pedestrian crossings are identified, and traffic calming strategies will need to be implemented.

Based on space syntax information, the design of the landscape redraws the pedestrian walkway to link pedestrian crossing number 2 to the entrance of the railway station. Visual links were drawn from the walkway to the railway station with the design of the ground texture, whereas the lines on the walkway are drawn from the columns of the railway station. RentHere and SitHere stations will focus along the sides of the walkway.

The northern area of the site is designed to include leisure activities, and the southern area will contain Toilet Modules and FixHere stations.

This design will focus on the centre area where the large bike storage facility is.

➤ *FIGURE 04-160 - Site Plan of Wellington Railway Station*

SCALE : 1 : 2000

The cycling hub is designed around the eight existing pohutukawa trees on the site.

At the entrance of the vehicle access, a vehicle and bicycle shared road is marked in orange and ground texture is differentiated with raised orange speed strips. The pickup and drop off area is designed on the left lane, and vehicle parking spaces are available on the southern end of the site.

Two large storage facilities provide 120 secure indoor bicycle storage, and 12 toilet and shower units plus lockers. The cafe and the bike service shop is also designed on the site. These architectural facilities frame the central area from the streets and are designed into a mixed use leisure park.

Different ground textures are used to define the movement and the rhythm of the landscape, while seating benches and smaller planting are used to further divide the spaces.

➤ **FIGURE 04-161** - Site Plan of the Wellington Railway Station Park

Seating areas are incorporated with the walkway zone is design in front of the shop and cafe. Behind the seats is the raised seating platform which is orientated for maximum sun exposure.

The leisure area has clear line of sight to the shops, cafe, bike storage and the lockers.

- FIGURE 04-162 - Detail of Raised Seating Platform
- FIGURE 04-163 - Detailed Perspective of the Cafe Window
- FIGURE 04-164 - Exterior Perspective of the Walkway, Shared Cycle Lane and the Raised Central Leisure Seating Area

Large horizontal bi-fold doors can be shut to provide better security for the locked bicycles. The facility is illuminated at night for safety and for brand advertising.

FIGURE 04-165 - StoreHere Entrance During Daytime

FIGURE 04-166 - StoreHere Entrance During Nighttime, Note the Horizontal Bi-fold Doors and the Lighting

FIGURE 04-167 - Exterior Perspective of the Cycling Hub

This map indicates the aesthetic continuity that can be expected from the BikeHere brand in Wellington.

The RentHere Station will be the dominant feature of the BikeHere brand, and support facilities such as the one at Te Aro Park and the Wellington Railway Station will be designed with the cohesive aesthetic language of the brand.

➤ **FIGURE 04-168** - *Map Indicating the Range of BikeHere Components at Different Locations Throughout Wellington*

WELLINGTON RAILWAY STATION

TE ARO PARK

146 CUBA STREET CARPARK

>> 04 DESIGN SUMMARY

CONCISE SUMMARY

The refinements made in the design framework produced clearer and more flexible interpretations of the relationship between cycling facilities and the groups of cyclists, also the introduction of the BikeHere brand forms a cohesive design platform for the products of cycling facility to follow. The resulting design outcome was comprehensive and cohesive in comparison with earlier designs.

The outcome of this design was satisfactory. It included elements of graphic design, industrial design, interior design, architecture, landscape and urban planning into the design of cycling infrastructure, and by utilising the appropriate marketing and branding strategy, these design elements were able to be structured and organised.

Some earlier urban planning research was utilised from previous designs, however the strategies for conducting this design are new.

It is important to note that the flexibility built into the design framework allowed for addition of other cycling facilities or user groups, and also that this design framework can be adapted to suit other cities.

The semiotic connections within the cycling infrastructure were considered with every design decision, and because of the branding strategy applied here, the design of the semiotic relationship presented itself naturally.

To conclude, this design can be viewed as the start to a viable mode of urban transport in Wellington.

CONCLUSION

CONCLUSION

05

This research aimed to first explore the workflow and methodology for planning and designing cycling infrastructure in a city, then utilise research through design to discover planning and design strategies.

The literature review gave insights into the barriers and issues of cycling. While some of these issues are not directly related to planning or design they do explore the complexity of multiple stakeholders and how that would prevent good design from happening. The review of precedents identified the diversity of design scale and disciplines that are necessary for the success of cycling in a city, from both an urban planning and design context. The participatory design process also helped to understand the cycling culture, the issues of cycling and the danger of cycling in Wellington from a personal level. These findings combined with the knowledge gained from the literature review guided the direction of this research.

	Casual (Bicycle Share)	Commuting	Sports/Exercise	
Infrastructure	<div></div>			Traditional Roads
				Bike Path
				Laneways
				Bicycle Priority Lane
				Footpath
				Signage
Public Facilities	<div></div>			Shower/Changing Room
				Toilet
				Spare Parts Vending
				Bicycle Workstand
				Locking Stand
				Secure Parking
				Goods Storage
				Public Bicycle Sharing
Private Facilities	<div></div>			Bicycle Service Station
				Bicycle Retail
				Cafe
				Meeting Space
				Education Space
				Bike-Sharing Office

▲ FIGURE 05-001 - Cohesive Workflow Diagram
 ▼ TABLE 05-001 - Framework for Planning & Designing Cycling Infrastructure

FINDINGS FROM RESEARCH

This research found that the planning and design for cycling infrastructure was difficult to understand and to participate in. The planning and design workflow and framework developed through this research facilitated the design of different cycling components within cycling infrastructure in Wellington.

[SEE FIGURE 05-001 & TABLE 05-001]

To further improve the cohesiveness of the cycling infrastructure, design of cycling identity and brand was also introduced (Masten 2003). The effects of the framework and branding were shown through the final design, in which the cycling infrastructure contained a comprehensive range of facilities while maintaining a consistent design language.

Researching, planning and designing different cycling design components are time consuming and the planners, designers and architects need of a tool which can consolidate and direct the content of cycling research.

The development of the design framework addressed this problem by providing the necessary structure for research and design. The design workflow then created branches in the design framework to address the individual design problems. Since these design solutions were based on the same design framework, the design outcomes had a sense of cohesion which otherwise would have been difficult to obtain.

◀ **FIGURE 05-002** - *Design 01*

◀ **FIGURE 05-003** - *Design 02*

◀ **FIGURE 05-004** - *Bike-Sharing Component of Design 03*

◀ **FIGURE 05-005** - *Cycle Hub Component of Design 03*

DIFFICULTIES IN DESIGN

The design processes of the first three designs were difficult. New problems were raised at every stage of design that impacted on other parts of the design, additional research was conducted during the design period to address emerging issues, and it was a challenge managing the creeping scope of the cycling infrastructure. Although these difficulties constrained the design process, nevertheless the outcome of third design was relatively comprehensive in terms of cycling infrastructural content.

CONVENIENT
DYNAMIC
FUN
TECHIE

RentHere

StoreHere

SitHere

LockHere

FixHere

PayHere

FIGURE 05-006 - Cycling Brand for Wellington
FIGURE 05-007 - Logos for Cycling Facilities in Wellington

REFINE THE DESIGN METHODOLOGY

The results from the first three designs suggested that developing methods for structuring the design components and exploring better semiotic relationships between them can address the difficulties of planning and designing cycling infrastructure.

In order to facilitate the planning and design process, and reduce the research complexity, the final design started by developing a design framework. This framework was used to list design typologies which would be designed to influence cyclists and graphically show how each design typology would affect different groups of cyclists. This is particularly useful as from the beginning of the design stage, all design facilities were evaluated and presented to the designer, ruling out any uncertainty in terms of what the cycling infrastructure would require. Furthermore, the design research could be conducted in a collective manner, as the list of design typologies were established before the conceptual stages of design.

More cohesive designs within the cycling infrastructure improve the legibility, marketability, and imageability of the transport system, and ultimately improve the experience of cycling in a city (Lynch 1960). Difficulties to providing this cohesive design language were evident in the first three designs, therefore in the final design a fresh approach to structuring the cycling infrastructure was needed.

The design of the cycling identity and brand was introduced to provide this structure. This identity or brand structuring represented and influenced the design of all cycling infrastructural products, services and properties.

[SEE FIGURE 05-006 & FIGURE 05-007]

The development of the design framework and the cycling brand provided the design stage with direction and guidelines, which resulted in a relatively simple, directive and objective design development process. Design decisions such as the modular structure, aesthetic form of the base module and the development of landscape were implemented with consideration to the wider context of

		MODULES						
		M00	M01	M02	M03	M04	M05	M06
CONFIGURATIONS	A
	B
	C
	D
CONNECTIONS		M07						
		A	B	C	D	E	F	G

< TABLE 05-002 - Table of BikeHere Modules
 > FIGURE 05-008 - Map Indicating the Range of BikeHere Components at Different Locations Throughout Wellington

cycling infrastructure, which had been difficult to establish in previous designs. The design outcomes from the cycling brand produced a cohesive design language which provided a semiotic link between design facilities within the cycling infrastructure.

[SEE TABLE 05-002]

The design framework was utilised again to guide the decision on what type of facilities would be needed at a particular site. The three site insertions demonstrated that the design framework was able to respond to different site requirements and provide a set of recommendations based on the input from the designer. The results from the site insertion produced successful designs that vary in scale, scope and complexity but are grouped by the design language of the cycling brand.

[SEE FIGURE 05-008]

The development of this design would not have been successful without the contribution of the first three designs. By learning from the shortcomings of the earlier design processes, the final design was able to introduce the design framework and branding to the design of cycling infrastructure. As a result, the products from this cycling brand contained a level of cohesion that was unattainable in the first three designs.

CONCLUSION

It was evident from the literature reviews that the design of cycling infrastructure is only a part of a wide range of transportation problems which need to be addressed. Banister noted that transport policy formed the greatest barrier for planning and designing cycling infrastructure (Banister 2005), and the lack of vision, leadership and recognition for cycling made planning and design cycling infrastructure in New Zealand difficult (Preval, Hulme-Moir et al. 2010).

This research explored methods to design better cycling infrastructure in cities, assuming a pro-cycling environment. The findings from the first three designs functioned as a learning curve for the development of the planning and design workflow and framework in the final design. The final design outcomes were based on the design framework, and a cycling brand was explored to provide the cycling infrastructure with semiotic structure. The considerations for semiotic relationships between designs within the brand concluded in positive design outcomes, which ultimately

lead to improvements of the cohesion of design language and the legibility of the cycling transport system.

Through this design research, the relationship between the cycling infrastructure and the existing built environment was constantly tested; the impacts of the resulting comprehensive and cohesive cycling package for cities has far exceeded the initial expectations. By providing insights into the issues of cycling infrastructure from a design and architectural perspective, this research was able to reach beyond the political, policy and funding barriers to produce a vision that places the planning and design solutions of infrastructure within the wider context of cycling. This ultimately would provoke further research on the relationship of cycling and the urban form within the fields of design and architecture in order to create higher quality bicycle-friendly cities around the world.

DISCUSSION

DISCUSSION

06

OVERVIEW

This research investigated how to cohesively plan and design infrastructure for cyclists.

This chapter first discusses the planning and design methodologies of cycling infrastructure reflected in current trends, and compare these methodological trends to this research. The importance of this research in the current environment is explored, and then finally the chapter considers the effect of these research findings on the practice of urban cycling.

The limitations of this research are examined; three major limitations were noted, discussed and elaborated on.

Some recommendations are made in order to improve the research, suggest areas of future research and discuss how these suggestions would further the planning and designing of cycling infrastructure.

This chapter concludes with broad reflections on the initiation of this research, the design process and the design outcome. These reflections are linked to the architectural profession, and a few notes are made regarding the changing role of architects in the context of transport planning for cycling throughout this research.

DISCUSSION

The literature review chapter looked into the decision-making process for implementing cycling infrastructure from a policy point of view; the review of precedents chapter offered examples of design typologies which respond to the needs of cycling.

The transport policies in New Zealand have an underlying focus on sustainable transport and urban form, and policy-makers are beginning to recognise cycling as a form of transport that could influence road infrastructure development (Hurn 2010; Preval, Hulme-Moir et al. 2010). Cities such as Paris, San Francisco and Sydney have already established their pro-cycling policies; as a result designs have been implemented to improve the cycling experience in the respective cities. A cycle lane network is usually the most identifiable element of any cycling infrastructure due to its scale. Other elements include large cycling facilities designed to represent the image of cycling, and smaller industrial design elements implemented to assist the functions of the wider infrastructure. However, the relationship between these elements is usually not addressed. In Paris, the designs of the Vélib system have

a vague semiotic interaction with the design of other cycling facilities in the city. What this indicates is that cities usually consider the design of each cycling infrastructural typology individually, which results in cycling infrastructure that contains multiple design typologies and different design language across the different scales of designs within one city. This scatter and inconsistency in the structure of the design language for cycling infrastructure reduces legibility of cycling in cities, distracts the users from the continuity of the transport system and ultimately diminishes the attractiveness of cycling as a mode of transport in the city.

The design case study for Wellington is developed under the brand of BikeHere; the planning and design methodology utilised for Wellington produced a visually cohesive and functionally comprehensive transport system. This design methodology used in this research can be considered a success because it improves on the current working model by addressing the issues outlined in the previous section.

As the number of cities seeking to adopt and integrate cycling infrastructure within their existing road network increase, the pressure on transport and urban planning increases too. The impact of transport on urban form is a popular topic for modern research (Hickman and Banister 2005; Pucher and Buehler 2008). The utilisation of the existing planning and design model produces cycling infrastructure that contains limited cohesion and semiotic considerations. When this is implemented in cities, it introduces more designs to the already cluttered urban landscape. The results from this research refine the current workflow and eliminate design clutter by developing a design framework for planning cycling infrastructure, and then introducing branding to structure the designs of cycling design typologies across different design scales and disciplines.

If a city utilises the methodologies offered by this research, the planners and design can expect the research for cycling to be conducted in a collective manner based on the development of the design framework. Long term planning for cycling would then be considered in terms of transportation planning and urban form. The designs of each cycling

typology can be better managed and outsourced to the appropriate design professions and ultimately produce design products that communicate the same values as the cycling brand. At the implementation stages, the planners and designers take the lead, designing site specific cycling responses based on the suggestions provided by the design framework. By working with the methodologies offered by this research, the results from subsequent design research should present new perspectives on cycling planning and design in cities.

The ultimate goal for this research is to reduce car dependency by presenting cycling as a viable mode of transport. In order to achieve this goal, the aim was to plan and design cycling infrastructure in such a way that the result is easy to use and legible, so that cohesive and high quality designs can be produced and integrated to the existing road infrastructure and the city. This research does acknowledge that planning and designing of cycling infrastructure is only a fraction of the concerns for implementing cycling in a city; but nevertheless, the results show the possibilities of what cycling could look like in the city and offer an alternative perspective on

the workflow and planning and design methodologies. The research results could finally provide the means to reflect on the current state of cycling infrastructure, influence the changes transport policy, form business plans for investors, or just simply provide a vision for cyclists in their city.

LIMITATIONS

One of the biggest limitations of this planning and design methodology is that it would not integrate well with already established cycling identities within the cycling infrastructure.

This design methodology requires cycling and all of its affiliations to be recognised as one collective, and that a brand be designed to represent the entire infrastructure. In the case of Wellington, the city currently lacks any distinguishable cycling infrastructure. As a result, a design of this type can be integrated positively into Wellington City. If the design case city was Paris, where the distinctive Vélib bike sharing system already exists, then the planning and design methodology offered by this research could hinder the progress already made in that city.

Other limitations within this research can be traced back to the development of the design framework. The outcomes from the final design are informed by the suggestions provided by the design

framework; however, time and resource constraints limited the depth of the quantitative research which would have been necessary to justify the scope of such a framework. As a result, the statistical values were based on the best estimates that available at the time of the development. Nevertheless, the findings from the designs are still valid as the design and development processes followed the structure set out in the methodologies, and these assumptions were necessary to progress the research.

RECOMMENDATIONS

While this research is satisfactory in the current state, there are three main areas that should be improved on for this research to obtain higher quality results.

The first area that should be improved is the review of the precedents. While the examples chosen for the review reflected a wide range of cycling infrastructure, nevertheless, these precedents were studied based on second hand information. It would be ideal if first hand research could be done on three cities, in different continents, analysing the different scales of infrastructure within each city and then comparing the findings. The ideal structure for the review of the precedents should be to study the cycle lane network, large facilities, and smaller industrial design elements in one city. However as the cycle lane network overshadows most cycling infrastructure in cities, it was difficult to obtain a good range of cycling infrastructure in one city. As the later stages of this research started to focus on the semiotic

relationships within the cycling infrastructure and branding strategies for one city, it became apparent that three cities is the best sample size for studying cycle infrastructure. Location studies of the three cities should be considered in order to comprehend the cycling experience and then explore the design responses at different scales for each city.

As pointed out in the limitations, the quantitative research required to support the design framework was not based on official statistical information. Therefore, before initiating any planning and design developments, more comprehensive quantitative research needs to take place. More up to date statistical data on the division of the groups of cyclists, and mass surveys on the relationship between cyclists and each design typology, could provide a more realistic framework.

The final recommendation would be to increase the level of inter-disciplinary collaboration for the planning and designing stages of this research. The workflow chart [Insert workflow Chart] identified the main areas of research for implementing cycling. During the course of this

research, feedback was given by people from various disciplines at key stages of the design; however no scheduled planning and design collaborations were made during the actual design process. The opportunities for involving other professions should be considered, but care must be taken to manage the overall research. In retrospect, the feedback processes functioned well in the research environment, but in the future context of real world application, the various elements would be outsourced to their respective professionals. The role of the researcher in a real world application would be the expert consultant who works in between the authorities, the communities and the professionals and manages these different cycling elements to reach a comprehensive, cohesive and desirable outcome.

LOOKING FORWARD

The opportunities for real world collaboration would push this research to new heights. The design outcome of this research was based on the interpretation of the researcher at the time of design. By working with the authorities, the communities and the professionals, this research would provide a more comprehensive critique on the existing planning and design of cycling infrastructure.

The planning and designing of cycling infrastructure could be considered as a tool to influence and drive changes. The BikeHere brand presented in the final design represents the recognition of cycling as a mode of transport, a business and an integral part of the city.

Advocating for cycling is a slow processes (Shepard 2011), but BikeHere has the potential to speed up this process. Cycling advocates often critique the existing cycling infrastructure, pointing out what it is lacking and why it is bad; however BikeHere goes further, critiquing existing problems by presenting alternative design solutions on how these problems can be addressed in the

form of visual images for people to relate to. These alternative solutions from the BikeHere brand could be presented at a public forum, and gather public interest and participation on the future development. As a result, this cycling brand could translate to a winning campaign.

From a business point of view, BikeHere is able to provide diverse business opportunities within the cycling infrastructure, from bike sharing systems to storage units. By developing the entire cycling infrastructure into a brand, it shows confidence to the potential businesses and investors that BikeHere has the vision and the structure to develop cycling to what it could be in a city. If BikeHere is able to create a healthy investment environment for businesses and private investors, then the funding pressure from authorities would be eased.

If the design alternatives from BikeHere are positively received and the funding opportunities are present, then authorities could begin to consider the changes needed for BikeHere to happen. This perhaps could be in the form of recognition in transport

policy, new departments in local government for cycling management, or funding restructuring. Nevertheless, BikeHere presents the opportunities to ask challenging questions.

SUMMARY

This chapter takes a step back and considers the content of this research in a wider context. The discussions provide a concise overview of the planning and design methodologies for cycling infrastructure, and outlined the alternative working model offered by this research.

A Description of each limitation was given, and issues with integration with existing cycling infrastructure, monopolising the cycling transportation in cities and the lack of quantitative research development were noted and explored.

Recommendations were discussed for improvements on the research, and the findings were considered in the context of real world applications. Finally, this research is offered as an opportunity to challenge the current cycling issues by considering the wider context.

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