Improving the aesthetic and other experiential design aspects of bicycle paths in Western Australia

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This thesis is presented in fulfilment of the requirements for the degree of

Doctor of Philosophy (Geography & Environmental Planning)

School of Communications and Arts
Edith Cowan University
Western Australia

October 2010

USE OF THESIS

Abstract

Governments around Australia are in the process of promoting cycling as both a sustainable form of transport that can be a viable alternative to the motor vehicle, particularly for shorter trips, and as a healthy recreational pursuit that can play an important role in addressing the growing problem of obesity and illnesses associated with a sedentary lifestyle in the community. As part of this initiative, the development of effective and efficient infrastructure for bicycles is seen as a vital step for achieving higher participation rates.

A major component of the nation's bicycle infrastructure is the growing networks of paved paths and natural surface trails located in both urban and regional areas. A well-designed path or trail must meet agreed standards related to safety and function and, in order to achieve maximum usage, it must also create a desirable riding experience. While requirements for safety and function are well understood by path and trail planners, little empirical information has been produced to enable these planning professionals to understand the elements that impact upon an individual's riding experience and to then incorporate them into the design process.

Accordingly, the overall aim of this research was to investigate how the aesthetic, cultural and other experiential design aspects of bicycle paths and trails can enhance the perceived riding experience. A secondary objective of the project involved a determination of the procedural factors guiding the local path and trail design protocols and process. A third objective was to gain an insight into the most effective method of communicating the benefits of these riding environments to important target groups.

Following the establishment of a theoretical framework incorporating the psychophysical nature of cycling, the effect of landscape and current design practices, the research progressed through several stages beginning with an autoethnography examining the researcher's extensive experience in the promotion of cycling in Western Australia, augmented by in-depth discussions with leading key informants. This was followed by a mix of quantitative and qualitative methodology to gauge perception of various elements of in-situ and photo-surrogate path-riding environments among the general population in Perth, Western Australia.

The findings indicate that there are specific experiential design aspects related to the riding environment, surrounding landscape or associated features that can directly influence a person's decision to use a particular path, trail or route. The research also identified preferred communication strategies and found deficiencies in the current design process that if addressed, could lead to the development of better received and patronised riding environments.

It is intended that the outcome of this research will be to provide a design framework to guide path and trail planners in the development of facilities that enhance the overall riding experience. A number of agencies responsible for developing bicycle infrastructure, or design standards, have indicated a desire to access parts of this research project for use in the decision-making process, thus achieving a better balance between safety, functional and experiential aspects.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

(i) Incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution or higher education;

(ii) Contains any material previously published or written by another person except where due reference is made in the text; or

(iii) Contain any defamatory material.

I also grant permission for the library at Edith Cowan University to make duplicate copies of my thesis as required.

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Date: 5/11/2010

Acknowledgements

This project could not have been completed without the support given and valued contribution made by a number of individuals.

Firstly, I would like to offer the sincerest thanks to my principal supervisor Associate Professor Rod Giblett, for his tireless expert guidance, advice and encouragement throughout the entire duration of the research. His approachable manner, broad knowledge base and seemingly endless ability to provide meaningful insight on a vast range of topics have played a central role in my success.

I would also like to acknowledge the ongoing support and professionalism of other Edith Cowan University staff members including my associate supervisor Dr Stuart Medley, the faculty research consultant Dr Danielle Brady and the graduate studies administration team.

Similarly, thanks must be extended to my colleagues at the Western Australian Department of Transport for assisting to identify important issues that shaped the project and to the key informants from other organisations around Australia and internationally who gave their valuable time to provide me with the benefit of their knowledge and experience.

Particular mention should be made of my gratitude to the many keen participants in the various stages of my research project who were sourced from among the local cycling fraternity, ride groups and the wider community.

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Chapter 1 Introduction

Cycling is one of the leisure activities and alternative forms of transport identified by all levels of government in Australia as being a key component in the fight against the major community concerns of obesity, climate change and traffic congestion. Accordingly, the ongoing development of appropriate infrastructure such as shared paths, bicycle lanes, mountain-bike trails and end-of-trip facilities is being funded by state and local authorities across the nation.

As a principal objective, this research project seeks to make an original contribution to knowledge by gaining an understanding of how the experiential design aspects of path-based cycling infrastructure, which are not directly related to safety and functionality, can influence rider route choice within a Western Australian context. While the potential importance of these aspects in the design process is acknowledged by relevant authorities, this study represents the first attempt to investigate the topic and reach meaningful conclusions.

The following introductory chapter provides an overview of the historical background and current state of cycling in Australia, with particular attention given to the types of existing path infrastructure and their respective attributes. It also identifies key research questions, examines the significance of the study, outlines its organisational structure and acknowledges any limitations.

1.1 Story of cycling in Australia

1.1.1 Historical perspective

Over a period of almost 150 years, the bicycle has played a significant role in many aspects of Australian life. Although it is beyond the scope of this research project to detail the entire story of this role, the following is a brief overview of that contribution.

The first commercially produced bicycles appeared in Europe during the early 1860s and were dubbed velocipedes by their owners. These machines were heavy, often weighing 25 kilograms or more and, due to the use of all-metal wheels, provided the rider with a bone-jarring experience over even the smoothest surface (Fitzpatrick, 1980).

Inventors quickly determined that an effective way of improving ride quality and speed was to increase the diameter of the driving wheel. This new design incorporating a large front wheel and much smaller rear wheel and became known as the ‘ordinary bicycle’ or more affectionately as the penny-farthing (Figure 1.1).

The first Australian velocipede was imported into Melbourne in 1868 and the first ordinary bicycle in 1875. Over the next decade, a number of bicycle clubs for ‘ordinaries’ sprang up across the nation but were essentially restricted to a small privileged segment of society due in large part to their high initial purchase cost, challenging riding-technique and limited application outside of general recreation (Fitzpatrick).

Figure 1.1: Ordinary bicycle

A niche market for bicycles grew dramatically with the development of the so-called safety bike in the late-1880s. Appearing much like the modern bikes of today, the safety had the speed of the penny-farthing but was much more stable and comfortable to ride. As the 1890s progressed, a cycling craze swept Australia, assisted greatly by the reduction in purchase price brought about by mass-production techniques. This activity reached a peak in 1897 when there were more than 150 different local and imported brands available around the nation and a new bicycle could be bought for a liitle less than seven pounds (Fitzpatrick).

Bicycles quickly became an important form of transport, particularly in rural areas when and where drought made the use of horses difficult. This included specific roles such as messenger services and even station work where bikes were deployed successfully for boundary riding, mustering and checking windmills. An excellent early example of the machine's durability was its adoption in 1898 by the Melbourne General Post Office for collecting mail from pillar-boxes throughout the city (Fitzpatrick).

It is notable that the introduction of the safety bike had a particularly enduring legacy for women. Australian society in the Victorian era was one of rigidly defined gender roles with distinctly separate spheres of activity for males and females. Since its advent, cycling had been seen as a male pursuit due in large part to its inherent physicality, but the stable and functional nature of the new safety bike lent itself to a much broader usage. Once given the opportunity, women found it an easy contraption to master (The possibility of mobility, n.d.).

Bicycles allowed women to move into new spaces, literally and figuratively. A major part of their emancipation at the turn of the twentieth century involved the move away from impractical clothing styles to less restrictive garments, such as bloomers, that were clinched at the knee. This initially provoked the wrath of conservative males but the very nature of cycling meant the change in fashion was a necessity and therefore widely accepted.

During the early 1900s, the bicycle was consistently promoted by women's groups as a tool for increased freedom. This can be seen in feminist photographs and artwork used at the time for spreading the concept of suffrage. Such was its impact, some men saw the bike as a threat to the social fabric and argued that if left unchecked, could disrupt the family unit by allowing women to travel beyond their previous limits and cause a lapse in the morals of youngsters by allowing them to stray farther afield with members of the opposite sex during courtship (The possibility of mobility). Interestingly, the levelling social effect brought about by the bicycle was not initially reinforced by the introduction of the automobile because, due to its much greater expense and resultant lack of accessibility, it was almost exclusively the province of men.

As cycling became more popular, so did the demand for suitable infrastructure. The first bicycle paths were constructed around the turn of the century in the goldfields of Victoria and Western Australia where the need for effective personal transport over distances was most evident (Fitzpatrick).

Cycling maintained much of its popularity around the world during the 1920s and 30s, although failing to experience the peak of earlier years. In the decades following World War Two, adult involvement in cycling began to wane as motor vehicles became cheaper and more accessible to working class Australians. New bicycle designs incorporating wider tyres, lower frames and a range of matching accessories helped to temporarily boost the popularity of cycling with children during the 1960s and 1970s.

In Australia, the bicycle began a major resurgence among adults in the 1980s with the emergence of greater community awareness about health and fitness issues. More recreation time enabled by flexible working hours and the introduction of the new pursuit of mountain biking saw a dramatic rise in bike sales. This growth was largely uniform across all user groups with one notable exception. From the mid-1980s, there was a massive drop in the number of Australian children riding a bicycle to and from school. Research conducted by government authorities indicate that the major reason for this drop has been a perception of parents that their offspring face increased risks from road safety and personal safety perspectives (Cycling Promotion Fund, 1998) despite the fact that these perceptions are not supported by statistical evidence of actual increased risk of harm. This recent phenomenon has direct implications for this project because it suggests that the activity of cycling can be influenced to a significant extent by the real or imagined experiential perceptions of participants and stakeholders.

1.1.2 Cycling today

Today in many parts of the world, cycling is as popular as it has ever been. More than 1.2 million new bicycles are sold each year in Australia (Cycling Promotion Fund, 2009) and an estimated 130 million worldwide (Earth Policy Institute, 2007). The bicycle industry in Australia is worth almost AU$1 billion per annum and has tripled in size during the past ten years (Cycling Promotion Fund). There are an estimated 200,000 regular adult bicycle riders in Western Australia, with a similar number of children also riding on a regular basis.

Whereas cycling was once considered a novelty, it is now seen as a multi-purpose activity across Australia. Commuting by bicycle is considered a viable alternative to private vehicles, particularly for shorter trips. Leisure and social riding (often on weekends) remains popular, with cycling currently rated as having the fourth highest level of participation level among recreational activities, behind only walking, aerobics and swimming (Cycling Promotion Fund). In addition, bicycle-based tourism and adventure travel is rapidly expanding, and road, track, mountain-bike and bicycle motocross (BMX) racing have an established place in the sporting landscape. Emerging factors such as peak oil, climate change, traffic congestion and obesity are likely to ensure cycling participation rates continue to grow in the future.

Although more Australians than ever are riding a bicycle, some groups are under-represented in the participation statistics, most notably women aged 30 to 50 (Zappelli & Rounce, 2009). In Western Australia, the agency responsible for encouraging cycling throughout the community, Bikewest, has identified this particular demographic as a primary target for further promotional activities. It may also have important implications for this research project as there is evidence that females are the most responsive to aesthetic and experiential stimuli involving transport infrastructure. By establishing the desirable attributes of a particular riding environment, it may then be possible to attract more riders from this important target group.

1.1.3 Development of riding environments

Australia has three broad types of riding environment: roads; dedicated on-road lanes or shoulders; and bicycle paths or trails. Apart from freeways and some designated highways, all public roads across the nation are legally open to cyclists and often form part of established urban bicycle networks. Certain roads have been further adapted by authorities with the addition of lanes, bikeways or sealed shoulders that enable riders to complete their journey on the road surface but without directly interacting with motor traffic. The third type of environment using bicycle paths or trails extends this philosophy further by providing riders with a separate facility that does not rely on the road network. It is the design of this latter riding environment that forms the subject of this research project.

There are three distinct categories of bicycle path facility in Western Australia: major paths; suburban and regional paths; and natural surface trails. Each has specific attributes and forms of administration. The following is a summary of those categories.

Major paths

The highest quality type of bicycle paths in Australia belong to those major routes in large metropolitan centres that form the trunk of a larger network with many lesser paths branching away. These major paths are designed primarily as transport corridors and therefore gain most usage from bicycle commuters travelling between home and work or business centres. They also support significant patronage from recreational and family riders, particularly on weekends and public holidays (Figure 1.2).

In Western Australia, the major bicycle facilities are termed ‘principal shared paths’ and can generally be found alongside freeway or major highway reserves, and near railway corridors. This enables commuter cyclists to use scheduled train services for part of their journey if desired. As the name suggests, these paths are shared facilities for cyclists and pedestrians, though there has been a recent move toward the provision of separated lanes for these two types of user in locations of high usage.

Figure 1.2: Typical section of major path in Perth.

Administration of Western Australian principal shared paths is now the responsibility of the Department of Transport. This agency identifies potential routes and coordinates the design and construction of new facilities, often in conjunction with other government agencies including Main Roads Department and the Public Transport Authority. The major paths are built to a quality and standard that allows rapid travel by bicycle. For example, they are usually constructed of road base and bitumen because this removes the need to insert the regular expansion joints necessary when concrete is used, which in turn creates a smoother ride for bicycle tyres. They also tend to have many straight sections and when curves do occur, they are of a very large radius so that braking is often not necessary. In addition, principal shared paths are designed so that they do not cross driveways and other features that could potentially impinge upon the flow of path traffic and pose a danger to cyclists.

Many principal shared paths in Perth have automatic counting mechanisms attached that record traffic levels on a daily basis. This data is then used by authorities for ascertaining usage and facilitating future planning.

Suburban and regional paths

The bulk of bicycle paths in Australia are located throughout the suburbs of cities and in larger regional centres. They can be independent of other riding facilities, or form part of a network of interconnected routes that service a wide geographic area.

In Western Australia, these lesser or secondary paths are administered by local government authorities under the coordinating umbrella of the Department of Transport. Construction standards and techniques vary depending upon the budget, topography and developmental aims of the controlling authority, although most are formed using poured concrete and adhere to a recommended minimum width requirement of 2.0 metres (Figure 1.3). Paving bricks are sometimes used in situations where concrete would be aesthetically disadvantageous. As with principal shared paths, the suburban or regional paths throughout the state act as dual facilities for both cyclists and pedestrians.

Figure 1.3: Typical section of suburban path in Perth

Suburban and regional bicycle paths are used for commuting purposes and are often built with trip attractors or destinations, such as schools and shopping areas, in mind, but research has shown that the bulk of users are recreational, family or touring riders (Zappelli & Rounce, 2009). Accordingly, the paths are designed to be multipurpose and this is reflected in the development of routes that include a mix of straight sections, curves and undulations. Unlike principal paths, these secondary paths often traverse driveways, entrance roads and other features that have the potential to intermittently interrupt the flow of path traffic and pose a danger to riders.

Natural surface trails

A third type of bicycle path can be collectively termed ‘natural surface trails’. Unlike the previously mentioned major and minor paths, these facilities are not mechanically paved but rely on the existing soil structure to create an effective riding platform. Natural surface trails can provide anything from a hard compacted surface that is equivalent to bitumen, through to mud and soft sand (Figure 1.4).

Figure 1.4: Typical section of natural surface trail located on the outskirts of the Perth metropolitan area

In Western Australia, these trails are constructed and administered by either the Department of Environment and Conservation or the relevant local government authority. Design characteristics are generally more flexible than for paved paths, and designers can only refer to loose guidelines, rather than agreed standards, for construction and maintenance.

Natural surface trails are predominantly for recreation and tourist riding, although some rail trails near larger urban centres that have been built on abandoned railway reserves are used for commuting purposes because of their inherent point-to-point character.

Associated features of paths and trails

A number of features and attributes can be associated with paths and trails that contribute to the overall riding environment. These items can assist with safety or functional aspects while also providing some experiential value, or be solely related to the development of a riding experience.

The most visible and frequently seen of these associated features is signage. Although having an obvious functional role, signs can directly affect a rider's physical or emotional experience of a path, trail or route. Most paths in the state use a uniform signage system adhered to by the respective agency responsible for their administration. However, iconic routes such as the Munda Biddi Trail in Western Australia's south-west region incorporate signs that have been specifically designed for that particular facility.

Lookouts and viewing platforms that exploit or enhance available vistas are an example of facilities that can be incorporated into riding environments by designers purely for experiential reasons.

In Australia, public artwork is occasionally incorporated into the design of major paths and natural surface trails, but more often it is added as an afterthought rather than incorporated into the initial design process. This artwork is usually administered by the relevant local government authority and can be located at a distance from the path, immediately adjacent to the path or actually form part of the path itself.

Educational or culturally-based infrastructure which includes interactive exhibits is also occasionally used, particularly in conjunction with regional paths and higher-traffic natural surface trails.

Other cultural features that evoke immediate aesthetic interest for path or trail users, such as ruins, shipwrecks and historical architectural landmarks, such as lighthouses, may form part of a route. These features can be incidental or deliberately incorporated into the path environment and are usually administered by the relevant local government authority.

Finally, there are also infrastructure features such as bridges, underpasses and tunnels that primarily perform a specific engineering function that can also add to the overall riding experience of a path, trail or route by adding an aesthetic or cultural element to the path or trail environment.

1.2 Key research questions and objectives

This research project aims to answer the following major question relating to bicycle path design and promotion:

What aesthetic and experiential design aspects of bicycle paths and their surrounds, consistently enhance the perceived riding experience and influence route choice in a Western Australian context?

By attempting to answer the above principal question, the research will also seek at an observational level to gain a better understanding of:

- The nature of rider perception and the relationship of this experience to a cyclist’s natural and anthropogenic surroundings

- The most appropriate method of communicating the features and benefits of experiential aspects to important target groups.

- The local path and trail design process, and the factors guiding its progress.

1.3 Significance of the study

This research will have significance at a local, national and international level through the development of a better understanding of how experiential aspects of design can contribute to the production of rider preferences for particular riding environments.

The Western Australian government currently spends more than AU$20 million per annum on the construction of new bicycle facilities throughout the State, ranging from principal shared paths traversing major urban areas to remote mountain-bike recreational trails. This investment is seen as crucial for the development of sustainable transport networks and recreational infrastructure.

The United Kingdom charity Sustrans, used a methodology established by the British government for assessing the economic benefits of transport schemes and estimated that the provision of well-patronised bicycle infrastructure can give a 20:1 return on original outlay from health and traffic congestion economic savings alone. This is far in excess of the typical benefit to cost ratio for rail of 3:1 (Sustrans, n.d.).

Over the longer term, such public investment in bicycle infrastructure is seen as cost beneficial because it contributes to a reduction in preventative health costs, the requirement for less roads and improved air quality. Accordingly, there is an economic imperative to ensure value for money by building facilities that receive the maximum amount of usage.

The ‘build it and they will come’ philosophy that heavily prevailed in the period from the 1960s to 1990s, is no longer considered appropriate in modern infrastructure development. Increasingly, responsible agencies are seeking knowledge of the various factors that motivate people to use facilities such as bicycle paths and trails with the aim of building enticingly designed infrastructure and developing better targeted promotional strategies (Gehl, 1996). This new thinking could be described as ‘build it so they want to come’.

I would further contend that a prevailing focus on the safety-related and functional aspects of path and trail design is deficient because it ignores a third equally vital component – the experiential aspects. Put simply, the equation for a well-designed path could be reasonably stated as:

SAFETY + FUNCTION + RIDE EXPERIENCE = A SUCCESSFUL PATH

In this instance, success is defined as repeated usage by the maximum number of riders that can be comfortably accommodated. The equation applies to all forms of community-based cycling with the relative priority afforded to safety, functionality and experiential aspects varying between those forms. It owes much to the famous treatise of architecture composed by Ancient Roman engineer and theorist Vitruvius who stated that to achieve success, a building must possess the three characteristics of commodity, firmness and delight. In a modern context, commodity could be considered to be functionality, firmness equates to structural integrity or safety, and delight being the ability to enhance the human experience (Blum & Jana, 2005).

While technical design guidelines are available and well-established for the safety and functional transport aspects of path construction, almost no formal study has been conducted into the fundamental role and impact of bicycle paths and trails either within Australia or in any other part of the world. This void is amply demonstrated by the almost complete absence of historic or recent academic papers dealing directly with the topic of todology (the study of paths).

Even at a broader level, hodology, or the science of roads, paths and other thoroughfares, remains a largely unexplored field of academic endeavour meaning there is a substantial knowledge deficit. In particular, the relationship of aesthetic and cultural elements of paths to the engineering parameters of design is currently little understood. A review of the literature reveals that there is recognition of the importance that human perception and human feelings can play in the desirability to attempt a particular route. However, there is scant information available for path and trail planners to use in exploiting this. Parker (2004) acknowledges that broad visual design principles such as shapes and edges undoubtedly affect an individual's perception of a path or trail, but openly admits that he cannot explore this further due to a lack of relevant data.

Through a direct conversation with the abovementioned author, who is currently lead consultant with the Minnesota Department of Natural Resources in the United States, I have been able to ascertain that this lack of research and understanding is universal. As a consequence, there are currently no clear experiential-based guidelines for path and trail planners to follow when designing bicycle infrastructure.

Even the government agency responsible for the largest and most complex network of transport infrastructure in the world has acknowledged that this form of research has become a priority. The United States Department of Transportation's Environmental Research Program (USDOT) now identifies aesthetic design as an area in need of attention. The agency's website states the following:

> Although a significant body of literature exists in regard to bridge aesthetics, formal transportation research does not yet provide a working definition of 'successful' highway design in terms of aesthetic, social, and environmental characteristics. Anecdotal examples of such projects occasionally appear in journals, magazines, and newspapers with appealing photographs or drawings. Yet the narratives rarely offer sufficient information on the political and organizational nuts and bolts to guide transportation planners and designers, public officials, and interested citizens facing similar challenges. Nor is there any body of comparative analysis on this subject to provide broader insight on what works, why, and under which circumstances (Transportation Environmental Research Program, n.d.).

Further to this statement, my own enquiries with various sections of the USDOT have revealed that this lack of transport research also extends to bicycle infrastructure.

The Perth Bicycle Network is currently viewed internationally as a leading example of bicycle infrastructure. This reputation will be further enhanced by the formulation of new design parameters that lead to riding environments that encourage usage by the maximum number of people.

1.4 Organisational structure of the thesis

The thesis is divided into seven chapters, including this introductory section covering the scope, limitations, necessity and significance of the research. It also provides a contextual overview of cycling in Australia from its beginnings in the 1860s through to the present day. In particular, the development of new local riding environments is examined and related directly to the key research questions and objectives.

Reflecting the multidisciplinary nature of the project, Chapter 2 establishes a theoretical framework that details the evolution of various theories associated with human perception, cognition and aesthetics, riding culture and experience, landscape studies and bicycle path design. A comprehensive literature review is detailed in which ideas, findings and concepts are compared and contrasted so that a meaningful consensus about what constitutes a experientially successful riding environment can be reached.

The chosen methodology for the project is outlined and rationalised in Chapter 3. The philosophy underpinning the research process is stated and mention is made of the qualitative paradigm adopted for the data collection component. A multi-stage process is outlined and the results of an autoethnography and interviews with key informants are provided. There is also in-depth discussion of the demographic and experiential components of the qualitative and quantitative research mechanisms.

Chapter 4 details the data collection phase of the research, including instruments and locations used. Recruitment and personality-profiling of survey participants is also explained, along with the choice of research delivery method. In addition, strengths and weaknesses of the collection strategy and procedures are investigated.

A full discussion of how the data has been analysed is provided in Chapter 5. This includes the activities of coding and recording the data, ordering and integration, abstracting and comparing, and validation.

Chapter 6 presents the findings of the study project and relates these directly to the original research questions and the existing literature. In addition, general preferences and socio-economic differences are investigated.

Chapter 7 draws together the implications of the findings of the research. It begins with an overview of the major issues and offers a number of recommendations for further action. Particular attention is paid to how new information gained through the research could be integrated with existing path and trail design standards or guidelines used in Australia and New Zealand. Finally, remaining gaps in understanding of the topic and emerging themes are highlighted, along with the identification of potential areas of future research.

This body of the thesis is followed by a reference section which lists all references used in the development of the thesis. Appendices are provided on data collection instruments, consent forms and a glossary of terms.

1.5 Scope and limitations of the research

1.5.1 Scope and delimitations of the research

The development and construction of new bicycle paths is an expensive exercise, with even the most simple section built on ideal terrain costing about AU$100,000 per kilometre to build (Government of Western Australia, n.d.). Accordingly, the addition of very expensive design and aesthetic elements would almost certainly be resisted by decision-making authorities. Even if that aspect can be clearly shown to offer a positive cost benefit in the long run through reduced public health costs, environmental costs and deferred road-building requirements, it may not be given priority due to high initial capital investment. Therefore to ensure its relevancy, this research project focuses on elements that could be instituted by planners at a reasonable cost.

Apart from the economic perspective, the design of a paved path and, to a lesser extent, a natural surface trail, must also adhere to certain agreed standards relating to engineering, functionality and sustainability. It is therefore essential that the study focuses on experiential aspects that will fit within those standards. With regard to paved paths in particular, physical design aspects such as width, sightlines, surface smoothness, clearances, gradients, drainage and lighting must not be compromised.

There are currently no formal national standards for unpaved bicycle trails. However, the South Australian government has developed a guide for the design, construction and maintenance of off-road trails. There is also an Australian Standard for Walking Tracks (AS2156.2) published in 2001 that offers some engineering guidelines that are applicable to bicycle trails.

This study had been limited to paved paths and recreational natural surface trails. Mountain-biking trails designed specifically for advanced sport riding are not included as they are usually designed for the specific purpose of challenging a rider’s physical ability rather than creating a sensually rewarding riding experience.

The researcher acknowledges the significant role played by on-road riding facilities, such as bicycle lanes, in the development and function of cycling infrastructure networks, as both stand-alone routes and as links to and between paved and natural surface off-road facilities. However, for the purposes of this research project, on-road facilities have been excluded from the study.

This decision to exclude on-road cycling facilities has been taken by the researcher in order to maximise the overall efficacy and efficiency of the study. Facilities, such as bicycle lanes, form a dedicated part of a road reserve and their design is therefore restricted to the needs of the road network. There is no fundamental scope for the bike lane to vary in direction or structure from that of the associated road lanes. In short, a bicycle lane mirrors the adjacent road lane and there is little or no opportunity for a person designing them for bicycle use to introduce independent aesthetic or experiential elements or features. Bicycle paths that run alongside roads and streets have not been excluded from the study as their direction and structure can be varied to some extent and they are not entirely reliant on the design of an adjacent road.

The study focuses on the design aspects and elements that a path or trail planner could reasonably be expected to introduce to a new or existing route. Specific major fixed attractions, such as wineries and wildlife sanctuaries, which tend to automatically define an entire route, are therefore excluded.

Finally, for reasons of practicality the researcher has intentionally restricted the definition of experiential design aspects as referred to in this project to those produced by the riding environment itself. While it is duly acknowledged that cyclists' experience of riding environments can be influenced by interaction with other people they either ride with or encounter along the way, the path or trail designer has no control over this variable and it therefore falls outside the scope of the research.

Within the abovementioned parameters, there is considerable scope for this research project to contribute to the development of more cost-effective and user-friendly bicycle infrastructure in Western Australia and many other parts of the world.

1.5.2 Limitations of the research

The primary limitation placed on this research project arises from the logistical difficulty of accessing the widest possible range of in-situ riding environments for perceptual assessment purposes. In this instance, the real-time experiential aspects of the project have been restricted to the geographic boundaries of the Perth metropolitan area in Western Australia and the existing bicycle infrastructure or scenarios contained within it. Ideally, the assessment of in-situ riding environments would include both paved and natural surface routes in other parts of Australia and internationally. However, due to limited resources, the researcher has decided to focus on local bicycle routes and associated facilities.

Having made that concession, it needs to be noted that the Perth metropolitan area currently contains a wide variety of riding environments that incorporate a range of design elements and features. The researcher therefore considers the geographic restrictions placed on the study to be of minimal impact when considering the final outcomes and findings arising from the research.

A further limitation placed on this project is the lack of availability of professionally-recognised personality-profiling resources that could be used to ascertain the experiential openness of research participants. Although Edith Cowan University is in possession of profiling tests such as the Revised NEO Personality Inventory (NEO PI-R) and the Sixteen Personality Factor Questionnaire (16PF), I am unable to access these tests because they can only be made available to graduate students of psychology under strict supervision. Existing rules dictate that the content of these restricted-access tests cannot be made available to students in other fields of study, regardless of the academic level of that study. Accordingly, I have had to use a research instrument that is free from any access restrictions to investigate experiential openness and this may not meet the same professional standards as those mentioned above.

Chapter 2 Literature review

2.1 Overview of context

The nature of this project draws on source material and experience from a wide range of disciplines including civil engineering, landscape architecture, geography, environmental planning, urban design, sociology, cognitive design, environmental psychology, aesthetics, behavioural science and recreation management. This literature review develops a research structure that focuses on two key study areas: the riding experience; and the riding environment. The former includes cultural influences related to cycling and why people ride a bike, along with the physical and psychological elements of the activity and body movement in general. The latter includes the impact of landscape and design features on human perception and responsiveness with particular reference to paths, trails and similar environments.

There were three principal aims that guided development of the review. Firstly, it sought to provide a strong framework to inform the methodological, analytical and conceptual aspects of the ensuing research study. Secondly, the review sought to assist in the acquisition of a deep and broad conceptual understanding of the issues at the core of the research and how they can be addressed. Thirdly, it was pivotal in revealing areas of study where meaningful and important research is lacking or where a more thorough understanding of existing findings is required.

For ease of analysis, the content of this chapter has been divided into four key areas that outline an exploration of the topics relevant to the research questions and the main research studies and theories applicable to those topics. These key areas are:

1. Cycling and society;
2. Spatial and cognitive factors;
3. Landscape studies;
4. Path and trail design.

The first section includes an analysis of why people choose to ride a bicycle and the resulting culture associated with that activity. This analysis extends to the motivations, needs and aspirations of cyclists, and the societal view of cycling by planning authorities.

The second section deals with how human beings perceive the world and construct the space around them through sensory systems. It further explores how those perceptions are shaped by cognitive processes, with specific reference to aesthetics and the psychophysical attributes of the riding experience.

All cycling infrastructure inhabits a landscape and the third part of this chapter examines the nature and perception of this factor with particular attention paid to preference theories and current design practices.

The final section addresses the theoretical and practical aspects of bicycle path and trail design around the world. This area of the review will provide an insight into the various aspects, elements and features of these riding environments that could influence the riding experience.

2.2 Cycling and society

As mentioned in the introduction, bicycle riding has been a popular worldwide activity for well over a century. During that time, it has developed distinctive cultural attributes, meanings and structures that influence how and why the activity grows or subsides. The role of cycling, the needs of cyclists and the way they are viewed by decision-makers and the broader community all shape the growth of the activity and affects how relevant infrastructure is created. The following section explores this cycling culture in an Australian context from a user perspective, with particular emphasis on the critical aspects impacting on path and trail design.

2.2.1 Bicycle culture

A distinct bicycle culture began to develop from the moment the first velocipedes were introduced into Europe during the 1860s – a time when riding in a horse drawn carriage was only a pastime of the privileged few. Prior to the invention of the internal combustion engine and the subsequent rise of the motor car, the bicycle offered a rare degree of freedom to the working and middle classes.

Cycling had an immediate influence on the society it inhabited. It formed an important part of early feminism and was a key driver of change during the suffragette era (Petty, 1996). In particular, the development of the easy-to-ride safety bicycle during the 1890s gave women unprecedented mobility and almost certainly did as much or more for their emancipation than any other single factor (Smith, 1972).

In a period of very restrictive female fashions, women cyclists at the turn of the twentieth century were among the first activists to promote rational dress (such as bloomers) that did not impede movement. They no longer had to rely on a man for transportation, and many women not surprisingly referred to the bicycle as 'The Freedom Machine' (Smith, 1972). Even today, a similar experience of freedom is available to children who are afforded a degree of independence when given their first bicycle (Smith, 1972). It is clear that this physical and emotional relationship between rider and machine that has existed since its invention needs to be borne in mind when considering how to create a holistically meaningful riding experience.

Norcliffe (2001) extends this concept of gradual integration into society further by concluding that the bicycle was one of the first consumer products to include a wide range of accessories that actually had a sales importance equal to, or greater than, the original item. He notes that this anticipated, and possibly led to, the much later marketing strategy of accessorisation commonly used nowadays by the manufacturers of many consumer products.

At present in Australia it is difficult to identify a single well-defined bicycle culture. Unlike some other outdoor pursuits, such as surfing and snow-skiing which have a distinct culture incorporating fashion, language and lifestyle, cycling has grown into a loose collection of sub-groups that develop and maintain their own cultural values. The lycra-wearing road riders do not feel an intrinsic connection to the mud-splattered downhill mountain-bikers, or the Sunday morning path pedallers in search of coffee and cake, and vice versa. Instead they each have a tendency to stay within their sub-culture, only occasionally entering the others' world.

Although there is no definitive overarching local bicycle culture, all cyclists undeniably share similar aspects of the riding experience. The rapid road rider, muddy mountain-biker and Sunday path-pedaller are all participating in the one fundamental activity of bicycle riding. They are all exposed to a sensory extravaganza, the full vagaries of the weather, physicality and kinaesthesia. In addition, they are all required to adhere to the same legislation and policies, and importantly for this research project, they all prefer effective riding environments that meet their needs.

Despite these fundamental similarities, cycling has to be understood in the context of the societies in which it exists. China for example, has the most number of cyclists of any country, but particular types, such as the bicycle tourist, are rare. Contrast this to a nation such as Spain where, on weekends in particular, many people can be seen cycling out from urban areas on expensive machines and clothed in specialist gear, yet on weekdays commuter cyclists are largely missing.

Bicycle culture in countries such as Australia, Canada and the United States differs somewhat from those in other advanced countries where bicycle usage has become deeply entrenched at a societal level. Some of the highest cycling participation rates can be found in the European nations of Denmark, Belgium and the Netherlands. The cities of Amsterdam and Copenhagen have more than a quarter of all destination-based trips now conducted by bicycle, with many smaller towns boasting similar figures (Keates, 2007). It needs to be noted however, that despite having more kilometres of bicycle paths per head of population than Australia, these jurisdictions share the same design focus on safety and function. This is reflected in the absence of technical literature from Europe available in English that addresses the experiential aspects of cycling infrastructure.

Countries that have traditionally had a strong car culture, such as the United States, Canada and Australia, have significantly lower participation rates than most of Europe and Asia, particularly for commuter cycling.

The experience of walking has many things in common with that of riding a bicycle and in Western Australia most of the bike paths are also shared by people on foot. Therefore, for the purposes of this research project, a good deal of the research and discourse associated with the former is applicable to the latter. For example, the historical and anthropological examination of walking by Solnit (2000) in *Wanderlust: A History of Walking*, provides provocative pointers that can be used in this research project. Her assertion that walking is a form of meditation may apply equally so to cycling because of the innate rhythmical nature like strolling, of pedalling.

In addition, Solnit also asserts that the suburbanisation and automobilisation of our cities have not only changed the way the population lives, but how we now perceive, value and use our time, space and bodies in radically different ways than we did in the past. This is very relevant for cycling and, in particular, to the need to reclaim the perceptions and values of the landscape in order to increase participation.

Newman and Kenworthy (1999) also address this trend of the last half of the twentieth century toward urban planning being dominated by the needs of the automobile. They argue that this trend can be, and is, being averted through the introduction of carefully designed environments conducive to cycling and walking. In particular, they assert that it is rare to live in a city where it is possible to walk or cycle to everything, and that by integrating cycle ways with rail systems a genuine functional alternative to the road network can be achieved.

The recent rise of cycling in car-dominated countries, such as Australia, is not without its critics within the wider society. There are small, but vocal, groups of opponents to cycling that usually focus on one particular aspect of the activity that they find fault with. For example, cyclists who use roads for training purposes are thought by some to be a hindrance to traffic, particularly if they travel in packs.

According to Forester (2006), cycling in the United States has been repressed because cyclists were deemed incompetent outcasts. Similar sentiments have been expressed by cyclists in Australia, particularly by those who regularly use the road networks of larger urban areas. This repression may offer a partial explanation for the paucity of research into the functional design of bicycle infrastructure in car-dominated countries, but it does not explain the same lack of research in European jurisdictions.

In a large qualitative study of commuter cyclists in the city of Derby in the United Kingdom conducted by McKenna & Whatling (2007), participants reported being seen by other road users 'as an alien race in our own home town' and 'an obvious barrier that they could obliterate'. Although not explicit in the findings, well-designed paths offer a ready solution to many of these concerns as they separate riders from motorists.

A dominant car culture may not be the only force behind the apparent exclusion of cycling from the mainstream in countries such as Australia. Cox (2006) notes that even different groups of cyclists regard each other with widely variable attitudes, and hence tend to build their own value-hierarchies. Horton et al. (2007) conclude that even within a specific society at a particular time, there are likely to be major cycling inequalities. Both the participation levels of cycling and attitudes to the activity tend to vary, often significantly, according to age, gender, class, ethnicity and socio-economic standing. He offers the example of those societies with very high participation rates, such as Denmark and the Netherlands, in which as many women as men cycle and compares these to the United Kingdom which has a lower overall rate of participation and far more men than women riding bicycles.

In the United Kingdom, and anecdotally in Australia, cycling currently has the highest participation rate among people with the highest education levels and income levels, with the wealthiest fifth of the population riding more the twice as far as the poorest fifth (Government of the United Kingdom, 2007). Research also reveals that this aforementioned cohort has a strong awareness of the environmental and health benefits that riding a bicycle can offer. However, the greatest potential for increasing participation rates further lies in the lower socio-economic cohorts. These people have reported a lower awareness of the environmental and health benefits of cycling and may therefore place a greater emphasis on having fun or being stimulated. In this scenario, the riding experience becomes paramount if trying to motivate them to ride a bicycle.

At a more local level, the latest available statistics for cycling participation in Western Australia (Zappelli et al., 2009) reported that 32% of the adult population had ridden a bicycle in the past six months and therefore could be considered to have formally embraced the activity. A further 52% of adults were considered ‘positive persuaders’ under Sheth and Frazier’s model of attitude and behaviour segmentation (Sheth & Frazier, 1982). This meant that although these individuals had not ridden in the past six months, they had displayed a favourable attitude to cycling that made them potential riders at some time in the future. Only 16% of adult Western Australians reported that they rejected the idea of cycling and would definitely not consider riding a bicycle (Figure 2.1). With approximately four out of five adult Western Australians either already riding or open to the idea of doing so if conditions were favourable, the potential local demand for suitable riding environments is obviously enormous.

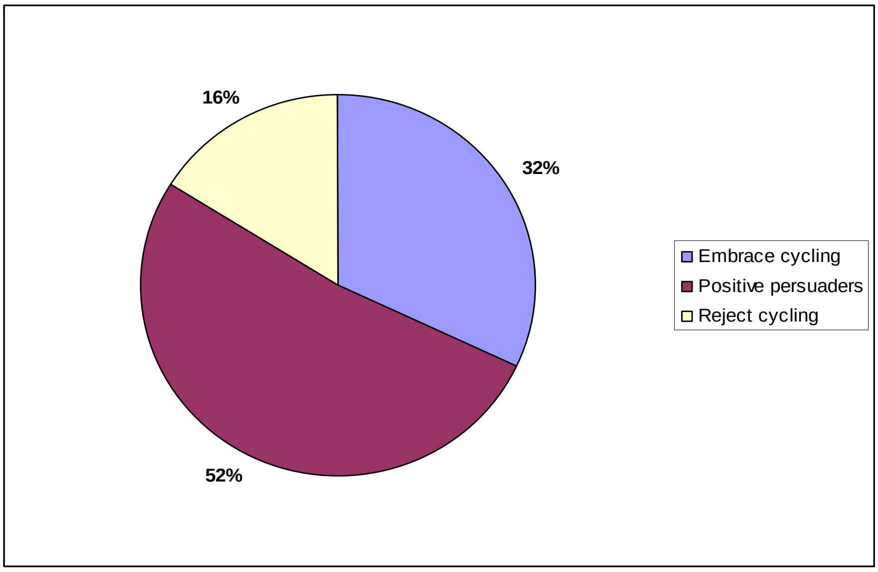


Figure 2.1: Attitudes to cycling of Western Australian adults (Zappelli et al., 2009)

An interesting finding arising from government attitudinal surveys conducted in Western Australia involves the community’s definition of a cyclist. It appears that many people who ride a bicycle for recreation or leisure do not actually identify with the term. Even those that ride regularly believe that ‘cyclists’ are those who wear lycra clothes, clip-in shoes and own an expensive bike (Zappelli et al., 2009; Greig, 2010). This lack of recognition has significant implications for the design of bicycle infrastructure as the self-titled ‘non-cyclist’ who simply pedal a bicycle have a tendency to become the silent majority who accept whatever facilities are provided to them, as opposed to the ‘cyclist’ who places considerable emphasis on improving infrastructure and knows how to make authorities aware of these concerns. They are the ‘squeaky wheel that received the oil’, but their loud squeaks are usually focussed on functional aspects.

2.2.2 Why people cycle

Historically, geographically, sociologically and culturally, cycling is a complex and diverse practice. Yet it is increasingly promoted by national governments across the first world as a simple, straightforward means of mobility (Horton et al., 2007). Cycling is able to fulfil many valuable human needs simultaneously, yet much of the marketing and promotion of the activity by authorities is narrowly focussed around physical activity or alternative transport programs. Horton contends that this marketing and promotion could be much more effective if the campaigners incorporated greater understanding of cycling’s complexity and diversity, even within a single society. He goes further to suggest that cycling-related policy ought to be based on the best available empirically-driven evidence of what is likely to be effective.

Just as buildings offer people a sense of place, infrastructure, such as roads, paths and trails, can offer us a sense of freedom which can be a very intense experience (Jackson, 1997). The following represent the major reasons why people decide to cycle.

Recreation

Pleasure appears to be one of the principal motivations for cycling, and one which remains remarkably durable across time and space (Horton et al., 2007). The United States National Highway Traffic Safety Administration found that 81% of cycling trips are for recreational purposes (United States

Department of Transportation, 2008). In Australia, research surveys also repeatedly show that recreation, leisure and social interaction are the major reasons why people choose to ride a bicycle (Zappelli et al., 2008).

According to the latest statistical analysis, a majority of Western Australian adults cycle purely for recreation (62%) and a further significant number (18%) ride for both recreation and transportation (Figure 2.2).

The nature of this riding appears to be both freeform and inherently experiential. For example, research conducted by the South Australian Physical Activity Council indicated that 47% of cyclists interviewed in that state reported that most often they were “just riding around” rather than following a particular route or cycling to a pre-determined destination (Government of South Australia, 2005). Such a high figure for freeform cycling strongly supports the need for riding environments that provide the user with a satisfying experience during the journey itself.

Leisure is not the only reason for recreational riding. The health benefits of cycling are now well established (Bicycle Victoria, 2005) and a growing number of Australians report fitness as an important function of their cycling activity, ether directly or as a by-product of general recreational riding.

Commuting / utility

An estimated one-fifth of Western Australians who ride a bicycle do so primarily as a form of transport (Figure 2.2). This may involve commuting to and from a place of work or study, or for other trips, such as shopping and running errands (Zappelli et al., 2008).

While hard-core cycle commuters are far fewer in number than those who ride for recreation or leisure purposes, as a segment of the cycling fraternity they are frequently the most vocal advocates for better facilities and more regular maintenance. Within this subset of cyclists there is also an environmentally-conscious group of riders who use a bicycle as their only form of transport.

There is evidence that a high percentage of commuter cyclists start out as recreational or leisure cyclists and graduate to it (Gardner, 1998). This presents a very strong argument for the development of infrastructure favoured by recreational riders, such as paths and trails that are aesthetically and experientially attractive. Through the provision of such facilities, relevant authorities can entice new recreational riders and introduce them to the benefits of cycling. The higher the participation in recreational riding, the greater the opportunity of achieving a flow-on of people willing to contemplate cycling as a legitimate and effective means of alternative transport.

For children who are too young to obtain a motor-vehicle driver's licence, a bicycle provides them with transport and an unparalleled measure of independence.

Tourism

Falling somewhere between the recreational and transport segments, but most often associated with the former, is the rapidly growing concept of bicycle tourism that, albeit locally, is coming off a small base. This form of tourism can commonly include organised events, independent self-riding tours or adventure excursions. Participants may choose cycling as means of moving between places of interest or for the activity itself (Sustrans, 1999). They are often experienced riders and travel in pairs or groups (Government of New Zealand, 2004).

The increasing popularity of cycle tourism may be due to a number of factors including renewed interest in personal health and fitness, an awareness of environmental issues and favourable media representations (Sustrans, 1999). A number of jurisdictions around the world are beginning to realise the latent, economic potential of bicycle tourism. In the Republic of Ireland for example, approximately 9% of all overseas visitors are considered to be cycle tourists. Similarly, in New Zealand it has been estimated that 3% of tourists to the South island use a bicycle for part of the time while sightseeing (Faulks et al., 2009).

With a sunny climate, flat terrain and natural assets, many regions in Australia are ideal for exploring by bicycle, but in many cases such activity is restrained or burdened by a lack of suitable infrastructure. This is particularly the case in regional areas where cycle links between recognised tourist destinations is non-existent and riders are forced to use busy roads or find alternative transport. Furthermore, this provision of an infrastructure of safe, convenient and attractive cycle routes for holiday cycling, centre-based cycling short breaks and cycle touring holidays with an emphasis on traffic free routes has been formally identified by policy makers as a key priority for the continuing development of tourism (Sustrans, 1999).

Individual businesses that rely on tourism for a substantial part of their revenue, such as wineries, galleries and craft factories, have begun to make provision for cyclists with secure bike-parking and free drinking water. In an effort to capture the economic benefits of cycling, government authorities throughout Australia are coming under increasing pressure to provide riding routes that mix specific destinations and stopovers with the experiential journey itself.

Sporting

The other significant group of cyclists that need to be acknowledged are the people who test their riding skills against other competitors or the clock.

Although the competitive riding fraternity exclusively conduct their activities at purposeful venues, such as velodromes (track cycling), circuits (bicycle motocross and downhill racing) or on roads closed to traffic (road racing and triathlon), and rarely use paths or trails, most of these participants would also be recreational or commuting riders at other times. Indeed anecdotally, it could be argued that a substantial number of sporting cyclists actually compete as a means of recreation rather than to satisfy a need for achievement.

Some of the larger competitive cycling clubs in Australia have acknowledged the growing demand from family riders by including more non-competitive rides in their schedule that can be completed by entire family groups.

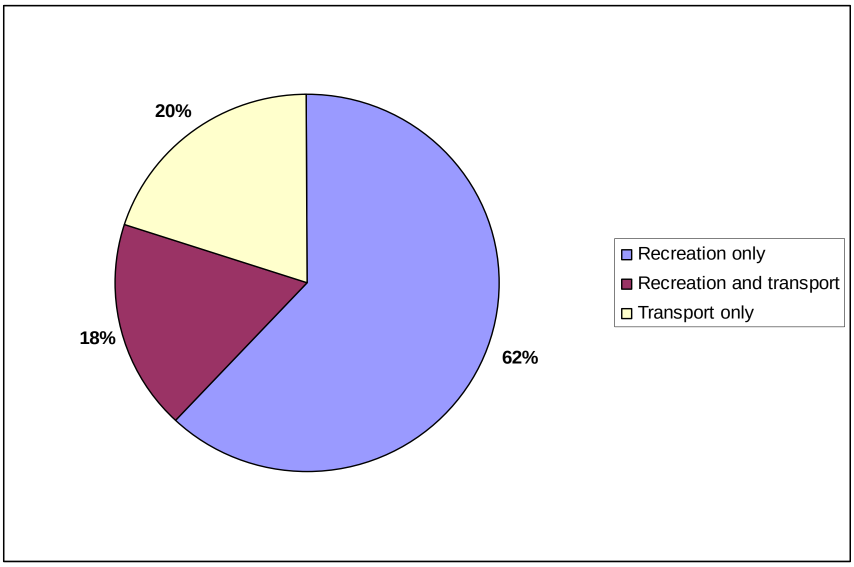


Figure 2.2: The main purposes of cycling in Western Australia (Zappelli et al., 2008)

In conclusion, cycling is a recreational pastime, an everyday mode of mobility, a sporting endeavour, a means of earning a living and a sub-cultural affiliation. The activity is simultaneously a novel, mundane, sensory, status-giving, gendered and occasionally marginalised practice (Horton et al., 2007).

2.2.3 What cyclists want

According to Lumsdon (2000), the appeal of recreational or leisure-based cycling lies in the provision of a riding experience which visitors desire, such as offering a challenge, ensuring safety or an overall feeling of relaxation and well-being. Various factors contribute to this and are outlined in the following pages.

In Western Australia, Bikewest conducts regular community stakeholder consultations and annual attitudinal surveys that provide an opportunity to garner feedback about the wants and needs of local cyclists. Among the key findings that have emerged from recent workshops and commissioned surveys are a preference for meandering rather than straight path alignments (Figure 2.3, Still et al., 2007) and a preference for paths over road-based riding environments (Zappelli et al., 2008). In contrast, Still et al. reported a stronger preference for on-road bike lanes than for bike paths, but this is likely to be due to a high proportion of the respondents being commuter cyclists. The Zappelli et al. sample was random and therefore included a high proportion of recreational riders.

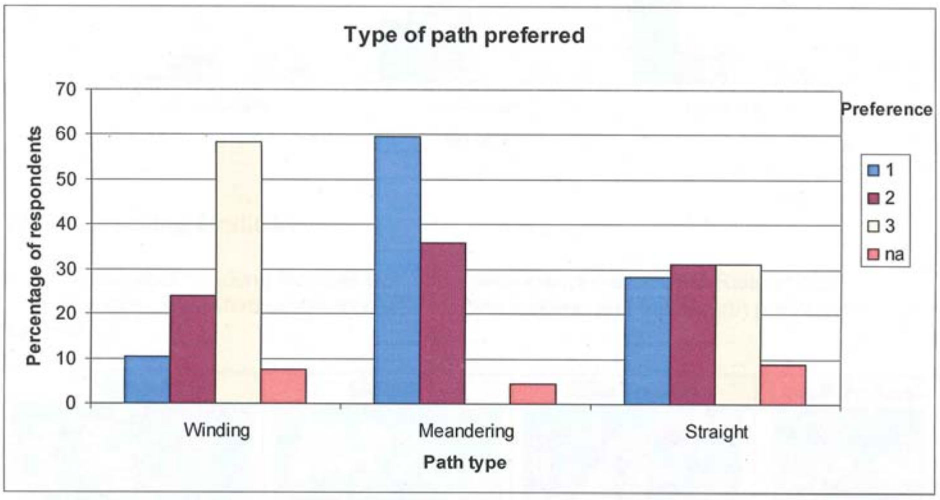


Figure 2.3: Preferred path alignment among Western Australian cyclists (Still et al., 2007). Note: Ranking used indicates most preferred as 1 and least preferred as 3

A survey of South Australian adults, who reported cycling activity ranging from daily excursions to not riding at all, also revealed that the provision of cycle paths was the major factor that would motivate a greater level of cycling (Government of South Australia, 2005). Importantly, this factor proved to be the most significant regardless of how often the respondent already cycled (Figure 2.4). These results indicate that appealing path and trail-based riding environments can potentially be significant motivators to increase cycling participation rates across the entire population.

There is similar empirical data from other parts of the world. For example, Everett (1990) used a crude regression model and found that separated paths probably played a role in high cycling participation rates in the United States. Hunt and Abraham (2007) found from a survey of Canadian cyclists, that all but the most experienced riders believed bike paths to be less onerous riding environments than roads. In a study of German cyclists, Bohle (2000) found a high preference for paths and recent surveys conducted in Australia have revealed a similar belief among local riders.

According to the Physical Activity Council Research Panel of South Australia (Government of South Australia, 2005, p.2):

> Cycling has been shown to be a popular pastime, and one that a lot of people do just for the enjoyment of it. It is clear, however, that an even greater number of people would like to cycle more, and that safer environments such as cycle-ways that are not on roads and cycling lanes on roads could enable this to happen. The popularity of cycling in other countries where cycle networks are common, such as the Netherlands, points to this being a successful strategy.

The other major concern of the cycling fraternity as a whole is that of legitimacy, or put simply, a right to do what they do and be where they are.

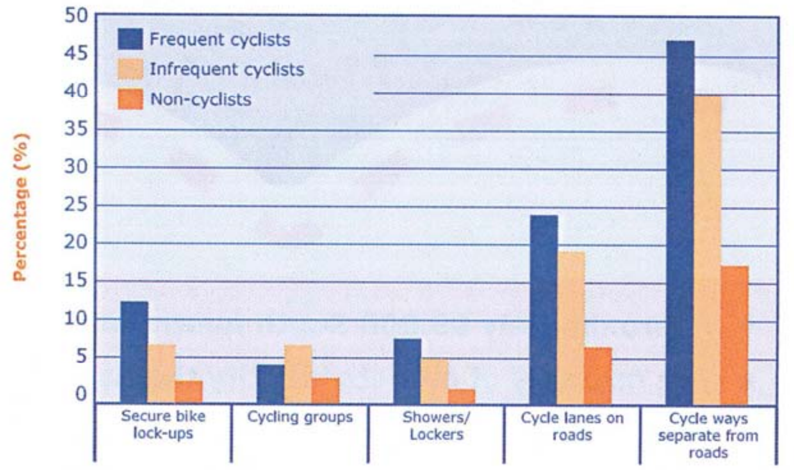


Figure 2.4: Factors that would motivate more cycling, by reported frequency of cycling (Government of South Australia, 2005)

Large bunches of riders on training rides can slow vehicular traffic. They are dubbed the 'lycra-army' by motorists because of their standard uniform of brightly coloured jerseys and knicks. These groups are often the target of motorist anger and feature in media reports about cycling.

Just as the presence of motor vehicles can make riding a bicycle on a road an uncomfortable experience, fast-moving cyclists can intimidate pedestrians in a similar way on shared paths (Zappelli et al., 2008).

Conflicts between users are much less of an issue with regard to natural surface trails where the lower level of activity reduces the likelihood of problem encounters. However, certain trails used by cyclists do have their opponents. In Western Australian for example, some land-owners adjacent to natural surface trails actively discourage riders by attempting to block the route or by interfering with directional signage (Government of Western Australia, 2010).

The end result is that cyclists can feel unwelcome riding on all forms of infrastructure, whether it be roads, paths or trails. This hostility has the tendency to act as a bonding force and lead to cyclists forming a closer knit camaraderie than other leisure activities, such as walking or horse-riding.

In a broad comparative study of cyclist environmental factors in Taiwan, Chang and Chang (2005) found that different rider groups share some preferences but diverge on others. For example, they concluded that aspects such as safety, signage and interpretation, tourism attraction and resting areas were preferred by both bicycle tourists using national scenic bikeways and recreational cyclists riding in local bike lanes. In addition they found that the recreational riders had a greater preference for paths with a high level of pavement quality than their tourist counterparts and the latter group placed a greater emphasis on enjoyment on challenging terrain.

A report on cycle tourism conducted by the Maine Department of Transportation in the United States (2001) concluded that bicycle tourists have strong preferences for different types of experiences, depending on their bicycling skill level and the composition of their travelling group.

This apparent divergence of riding environment preference between different types of user presents an obvious conundrum for the designers of cycling infrastructure. However, for the vast majority of the community, safe, functional and attractive bicycle paths are the key to increasing cycling participation rates across all demographic cohorts.

2.2.4 Planners' view of cycling

Civil engineers are largely responsible for the construction of bicycle paths and trails. However, the long-term planning and development of cycling infrastructure falls within the realm of urban and transport planners. The decisions made at this initial stage have implications for how new riding environments succeed.

An examination of the planning of non-competitive cycling in Australia and the infrastructure that supports it shows that it is conducted at three broad levels: big picture; middle ground; and local.

The global concerns of climate change, obesity and traffic congestion have seen an international recognition of the important role that cycling can play in creating a healthier environment and population.

It is at the local level that control over the largest portion of cycling path and trail infrastructure lies in Australia. Unfortunately, this is because, compared to federal, state and territory jurisdictions, the local government authorities tend to have the least access to skills and funding.

The Metropolitan Transport Strategy originally devised in the early 1990s as a core planning document for Perth (Government of Western Australia, 1995), still provides a base for policy decisions related to alternative transport modes, such as cycling and walking. Emerging from the Strategy at a practical level, cycling, along with walking, public transport, car pooling and teleporting (working from home or some other remote site), are identified as preferred modes of transport and have become the focus of the Western Australian Travelsmart program. This government initiative was originally developed in response to increasing concerns about problems, such as air quality and traffic congestion, that have arisen due to an overwhelming reliance on private motor vehicles for transport by the population of Perth. The concept has since been adopted by other Australian jurisdictions and is spreading internationally.

One potential shortcoming of the Travelsmart program is that it focuses on cycling purely as a mode of transport and fails to recognise that recreational or leisure riding is much more prevalent in the community. On one level that focus is understandable as the need to shift car-based trips to alternative modes is well-accepted. However, as already mentioned in the work of Gardner (1998), there is evidence that a person who begins to cycle for recreation or leisure, and then deems it as a positive experience, can be encouraged to consider riding as a commuter. It is therefore necessary to encourage and foster recreational riding in order to achieve a greater use of cycling for commuting purposes. Scheurer (2005) notes that Travelsmart campaigns have been predominantly targeted at residents of established suburbs and should be extended to outer areas where people are in the process of forming mobility patterns and new sustainable transport infrastructure can be more easily integrated into the overall urban design. While this is an important aim, the effectiveness of cycling infrastructure in the encouragement of riding a bicycle as a mode of transport may be more dependent on its ability to also encourage recreational riding.

Horton in Horton et al. (2007) notes that cycling as an activity is often the target of, or directly impacted by, the latest moral and/or political discourse. He asserts that as riding a bicycle has such a wide range of potentially beneficial outcomes for the rider and the world around them, the focus on cycling at any particular time and place means that people are encouraged to cycle for some reasons more than others.

A tourist taking in the sights, a bicycle messenger earning a living, a worker heading to the office and a person riding to lose weight have different priorities and experiences. However, they must all be accommodated by the one path, trail or lane.

The planning profession’s view of cycling does not appear to match the actual situation as represented by empirical studies. Instead, a case could be made to say that planning is based on policy decisions that are, in turn, emerging from deficient research.

Furthermore, the researcher contends that all cycling is richly experiential in nature yet little attention is given to the human element of the activity by those responsible for the fundamental direction of infrastructure planning. A growing number of independent policy commentators are encouraging a shift of attention from numbers to experiences. Popay et al. (1998) note a lack of explorations of the meanings associated with our daily travel choices. This conscious shift toward emotions, dynamics and meanings of the travel experience (Rothman, 2000) may offer a fresh perspective on how to better promote cycling.

The Western Australian Planning Commission's Liveable Neighbourhoods operational policy (Government of Western Australia, 2007, p.10) states that:

> Good cycling conditions and encouragement of cycling should be designed into the urban fabric. This includes such measures as: bike parking facilities; slower vehicle speeds and low traffic volumes; appropriate lane widths along local streets to allow cyclists to share travel lanes with cars; marked cycle lanes on busy streets; and shared paths and routes parallel to arterials with less traffic.

To effectively promote physical activity, policy-makers and researchers have advocated for greater use of environmental approaches, such as the construction of community paths and trails. However, research on the use of these facilities is limited (Troped et al., 2001).

Planners are faced with the challenge of developing cycling infrastructure that is popular and fully utilised by the community. Transit-oriented development (TOD), which is currently favoured by the decision-makers in Western Australia, has the aim of integrating transport corridors, such as railway lines and bus routes, within a new neighbourhood. These neighbourhoods include land-use elements, such as public open spaces, housing, shops, offices and services, centred around a transport hub and within cycling and walking distance of each other.

The urban development concept of a car-free city takes TOD to its logical conclusion and releases the residential landscape from the domination of road layouts (Weller, 2009). In doing so, it highlights the importance of incorporating alternative transport networks such as cycling and its respective infrastructure in the earliest stages of the planning process.

This section has examined why people ride a bicycle and what they are seeking from the activity. It is now necessary to examine the nature of the riding experience and the design of the riding environment.

2.2.5 Summary

This section highlights research indicating that recreation or leisure is overwhelmingly the most common reason Australians adults cite for choosing to ride a bicycle. Important South Australian research revealing that most riding is non-destinational is a clear indication that people perceive the experience of cycling as being paramount. Yet the bulk of these people who want to 'just ride around' are often overlooked when deciding to design and build new cycling infrastructure.

Despite being much smaller in terms of the total number of people participating, utility or commuter cycling, in which a bicycle is the chosen means of transport to reach a particular destination, is given priority over recreational riding by government authorities in policy-making and budget allocation because of its proven ability to reduce a current reliance on motor vehicles and the issues of air pollution and traffic congestion that such a reliance brings. While this emphasis on transport-based cycling is to some extent understandable, it does not take into account the fact that a very high proportion of regular utility/commuter cyclists graduate from being recreational riders. By fostering this important feeder-group through the development of riding environments that entice new riders by offering rich and meaningful experiences, an increase in the numbers of transport-based cyclists would be the likely outcome. This in turn provides even further impetus for this research project as it seeks to identify design aspects that encourage cycling for both recreation and transport.

The emergence of bicycle tourism further strengthens the need for this project. Touring by bicycle is a highly experiential activity and riding environments that cater for this aspect will maximise the number of potential visitors that, in turn, contribute to the local economy.

Statistics show that the activity of cycling in Australia is most popular among higher socio-economic groups. According to other research such as that conducted by Bikewest (Zappelli et al., 2008), there appears to be a large pool of potential participants in the lower socio-economic groups. Experience in the delivery of public education campaigns by Bikewest has shown that while motivational factors such as health and environmental benefits are important for people with high levels of income and educational attainment, they are much less powerful for other groups. Based on anecdotal evidence, these members of lower socio-economic groups may place a greater emphasis on enjoyment factors, such as having fun. Therefore, the development of bicycle paths and trails that offer aesthetically and experientially pleasing rides is likely to encourage participation from this untapped source.

Having clearly established the need for carefully designed cycling infrastructure that integrates safety, function and experiential factors, the following sections explore the nature of the riding experience in terms of both the riding environment and people's ability to perceive and assess it at a cognitive level.

2.3 Spatial and cognitive factors

In order to determine the most effective aesthetic and experiential design aspects of bicycle paths and trails, it is first necessary to gain some understanding of how and why humans perceive the environment or situation they inhabit through physical and psychological processes. This section explores the sensory, perceptual and cognitive aspects of existence, and then later relates these aspects to the activity of cycling. Additional attention is given to the nature of aesthetics and to the way people construct the space around them.

2.3.1 Human perception and sensory experience

The senses are our physiological method of perceiving external stimuli. They act as channels for perceived information to the brain for subsequent cognition (Hall & Page, 1999). However, there is currently no universal definition among neurologists and other related professions of what constitutes a human sense. The traditional five senses of sight, hearing, touch, smell and taste have been studied since antiquity and are the subject of substantial bodies of scientific research. In recent years, other methods of perception including balance, pain, kinaesthesia (movement), proprioception (body awareness or orientation), thermoception (receptivity to temperature change) and the sense of time have been generally accepted as playing an important role in human perception and are the subjects of academic study. More contentious methods, such as magnetoception (receptivity to magnetic fields) and precognition, have also been added to this list by some scholars.

Riding a bicycle is a psychophysical activity that calls on all of the traditional senses, except for taste. It also encompasses some of the lesser known factors of physiological perception including sense of time, balance, kinaesthesia and proprioception.

During daily activity, we may rely on certain senses more than others. Hammitt (1981) asserts that based on previous cognitive studies, sight probably influences preference response to environments more directly and with greater salience than do the alternative sensory systems. Arnheim (1969) suggests that vision plays an important role in familiarising individuals with an environment through the formation of mental images and cognitive representations.

For everyday human activities, such as cycling, vision often dominates the other sensory modalities so that not only does it tend to determine what a person perceives when a sensory conflict occurs, but it also has a tendency to distort the very experience of the object as given by the other sense or senses (Rock, 1975). It is therefore likely that this dominance will have a significant effect on people’s perception of environments such as cycling routes.

The human eye has an overall visual field of approximately 200 degrees, with a visual acuity or ability to resolve detail equivalent to 0.5 seconds of an arc, or the equivalent of one millimetre at a distance of one kilometre (Connolly, 1967). Such physiological parameters are relevant for this research project as the visual experience of cycling is by its very nature, accumulated while in motion. The ability of the human eye to discern fine detail in a moving object or in a stationary object while the viewer is moving is known as dynamic visual acuity (DVA). Studies (particularly by Connolly) have shown that under conditions of good illumination this ability begins to deteriorate at an angular speed of approximately 75 degrees/second (Table 2.1). This limitation directly affects the ability of a cyclist to perceive certain elements in a riding environment because what cannot be perceived cannot be experienced. According to the principles of DVA, a rider travelling at 10 mph or 16 km/h will be easily able to discern an object that is located at a distance of 20 feet or 6 metres. However, the same rider will start to struggle to perceive the object if they are travelling at 20 mph or 32 km/h.

Table 2.1: Angular speeds of objects for various speeds and distances (Connolly, 1967)

Mph	Ft/sec	Degrees /sec									
100	146	164° 24'	149° 22'	135° 20'	122° 34'	111° 24'	101° 10'	92° 24'	84° 46'	78° 6'	72° 16'
80	118	160° 46'	142° 34'	126° 6'	111° 4'	99° 26'	89° 2'	80° 16'	72° 50'	66° 30'	61° 6'
70	102	157° 10'	136° 24'	119° 6'	103° 8'	91° 8'	80° 44'	72° 10'	65° 2'	59° 6'	54° 4'
60	88	154° 24'	131° 8'	111° 26'	95° 28'	82° 42'	72° 32'	64° 18'	57° 38'	52° 8'	47° 30'
50	74	149° 6'	123° 14'	101° 16'	85° 34'	72° 62'	63° 20'	55° 44'	49° 40'	44° 42'	40° 38'
40	58	141° 18'	110° 50'	88° 4'	71° 14'	60° 14'	51° 36'	45° 2'	39° 52'	35° 44'	32° 22'
30	44	131° 8'	95° 28'	72° 32'	57° 38'	47° 30'	40° 18'	34° 54'	30° 46'	27° 30'	24° 50'
20	29	110° 50'	71° 44'	51° 36'	39° 12'	32° 22'	27° 12'	23° 24'	20° 34'	18° 18'	16° 32'
15	22	95° 28'	57° 38'	40° 18'	30° 46'	24° 50'	20° 48'	17° 52'	15° 40'	14°	12° 38'
10	15	73° 6'	41° 8'	28° 6'	21° 16'	17° 4'	14° 16'	12° 34'	10° 44'	9° 32'	8° 36'
8	12	61° 56'	33° 24'	22° 38'	17° 4'	13° 42'	11° 26'	9° 48'	8° 36'	7° 38'	6° 54'
5	7	38° 36'	19° 12'	13° 20'	10°	8° 2'	6° 42'	5° 50'	5° 2'	4° 28'	4° 2'
2	3	17° 4'	8° 36'	5° 4'	4° 18'	3° 26'	2° 52'	2° 28'	2° 10'	1° 56'	1° 44'
		10	20	30	40	50	60	70	80	90	100

Object distance from line of travel (ft.)

Connolly, through an ocular study of visual performance of highway motorists, suggests that transportation engineers need to consider human sensory and perceptual capabilities when designing infrastructure. He notes that the physiological and sensory capabilities of the human visual system were developed tens of thousands of years ago for an earth inhabitant environment where travel was restricted to walking or running pace. It was not until the past 150 years that human travel speed has increased significantly across the population with the benefit of technology.

Employing extensive trials, Connolly determined that a majority of motor vehicle occupants have an eye swing arc of 10 to 15 degrees to the left and up to 20 degrees to the right when using rural roads where the visual stimuli consists of such elements as terrain variation, vistas and groups of trees. It needs to be noted here that the relevant study was conducted in a country where people drive on the right-hand side of the road. He also found that in cases where visual stimuli is poor, such as along a major freeway, the recorded eye swing arc was reduced to about 5 to 10 degrees of lateral movement and almost no vertical movement. Based on these results, Connolly concludes that a varied road environment and landscape has definite benefits for the neuro-muscular visual system. He contrasts these so-called ‘free visual performances’ of rural roads with the much less aesthetically stimulating so-called ‘paced visual performances’ and determines that these latter performances have a tendency to deteriorate much sooner than free visual eye movement performances. There appears to be no valid reason why these findings could not be applied to riding environments. However, this cannot be confirmed because to date there has been no similar study measuring the eye swing of cyclists in selected riding environments.

The visual sensory system requires a certain length of exposure to stimuli in order to allow meaningful perception to occur. Recognising this fact, the Ministry of Transportation in the Canadian province of British Columbia has attempted to align the visibility of natural attractions with the speed and distance travelled by motorists using physiological testing (British Columbia Ministry of Transportation, 1991). This has resulted in the establishment of a proposed relationship between the average design speed of the road and the minimum distance that a fleeting glance (half a second) and a sustained aesthetically interesting view (5 seconds) would need to be visually available to the motorist (Table 2.2). Although this information relates specifically to motor vehicle travel speeds, the table could be expanded to include common cycling speeds such as 20 km/h and 30 km/h. Based on the existing formula, a cyclist travelling at 20 km/h would require constant exposure to visual stimuli for a distance of 2.80 metres in order to adequately perceive a fleeting view and 28 metres to perceive a panoramic scene. Similarly, the cyclist travelling at 30 km/h would require 4.15 metres and 41 metres respectively. If the prevailing alignment or structure of a riding environment prevents this ratio of exposure, the aesthetic experience will be diminished.

Table 2.2: Time and distance relationship for producing an idealised driving experience (British Columbia Ministry of Transportation, 1991)

Design speed	**Distance required for fleeting view (0.5 sec)**	**Distance required for panoramic view (5.0 sec)**
50 km/h	6.90 metres	69.0 metres
60 km/h	8.25 metres	82.5 metres
70 km/h	9.70 metres	97.0 metres
80 km/h	11.20 metres	112.0 metres
90 km/h	12.50 metres	125.0 metres
100 km/h	13.80 metres	138.0 metres

The upper limits of human visual perception are still not well-understood. After reviewing a number of experiments, Kaplan (1987) contends that people are capable of acquiring and assimilating visual information at a very rapid rate. This assertion points to the conclusion that even the most aesthetically complex riding environments can be successful, providing they are located so that they fall within the physical, perceptual capabilities of the eyes.

Although dominant, vision is not the only sensory system applicable to riding a bicycle. Unless they are hearing-impaired or wearing headphones, cyclists are constantly open to the sounds of the environment they are travelling through. Accordingly, it is likely that this auditory input can affect how they perceive and react to that environment.

Some limited empirical research has indicated that sounds can positively or negatively influence people's aesthetic and experiential preferences. Anderson et al. (1983) evaluated the impact that different sounds had on preferences for outdoor settings. The results of this study conducted in an urban botanical-garden setting concluded that the sounds of human activity, such as traffic and manual labour, were least preferred and those with a natural source, such as bird calls and wind noises, were most preferred (Figure 2.5). The type of environment appeared to directly affect the degree of preference, with sounds associated with human activity being considered more distracting in a natural setting than in an urban setting. In this instance, it is theorised that the presence of vegetation created a higher expectation of environmental quality so that sounds from human sources had a greater detracting effect.

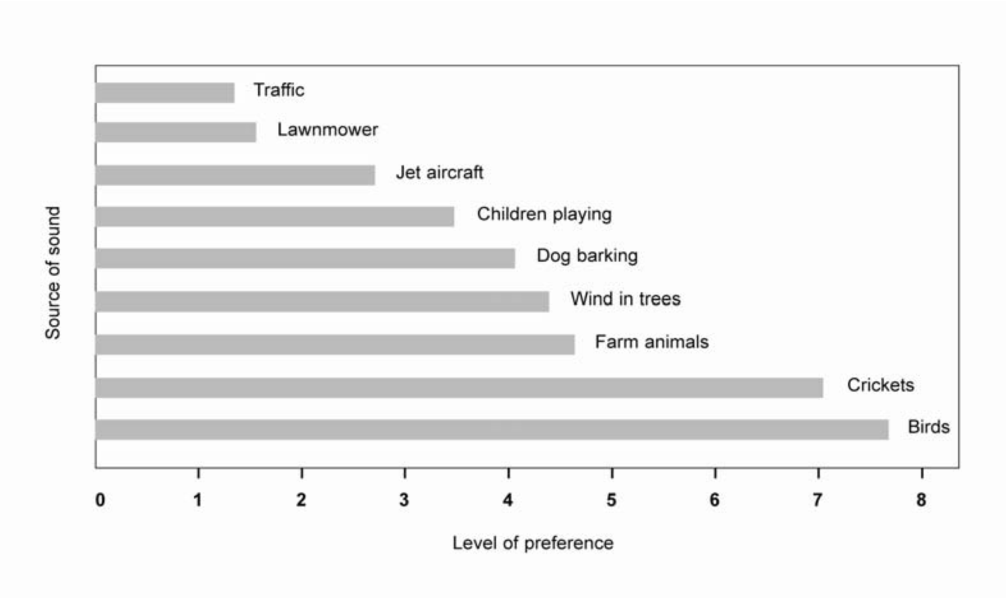


Figure 2.5: Impact of different sounds on environmental preference (Anderson et al., 1983)

In a Dutch study investigating the importance of quality indicators in rural areas for recreational cyclists, walkers, swimmers, anglers and boaters, the absence of traffic noise was highly preferred by cyclists (Goossen & Langers, 2000). This reported desire for tranquillity was of significantly higher importance for cyclists than for walkers.

Kroh and Gimblett (1992) found that the sound of birds chirping could be a contributing factor to the preference for types of landscape along a natural walk trail in Indiana. The high value of birdsong in both natural and urban landscapes was also confirmed by cyclists in ride experiments recently conducted by the New Zealand Land Transport Safety Authority (personal communication). Further strong support for the potential influence of certain sounds upon cyclists is provided by Gobster (1988), who reports the survey findings of riders using the North Branch Trail in the American city of Chicago that indicate that the sounds of nature were a significant experiential factor in their choice of route.

An individual’s purpose at the time of perception may also affect how environmental sounds are perceived. Naderi (2003) reports that researchers in a study of Texan walking environments found that participant responses to traffic noise varied considerably according to the stated purpose of their path activity. People who were walking for spiritual renewal or contemplation reported that ambient traffic noise was loud and distracting, while their counterparts who were walking for transport reasons found the same type of noise to be unobtrusive.

It should be noted that no research has been conducted to determine the effect upon cyclists of the sounds generated by their own activity such as the pedalling action and the noise of bicycle tyres on the path or trail surface. The results of such studies may offer designers an important insight into preferred path surface textures.

A number of other sensory systems invoked when riding a bicycle. Correct balance is an obvious necessity for cycling and at first glance it would appear to be a task that is difficult to achieve. However, due to the laws of physics, riding is a straightforward activity. When a spinning wheel moves in one direction around a central axis, it wants to continue moving in that direction. Centrifugal force acts on the bike and rider to counter the pull of gravity. Provided the wheels keep moving at sufficient speed and face the same direction, it is much easier for a rider to remain balanced than to use force to make it topple.

The human sense of balance or equilibrioception involves the interaction of several bodily systems and it enables an individual to maintain orientation. In order to achieve a correct level of balance, vision, the ear’s vestibular system and the body’s sense of its position in space need to be functioning together normally. This involves the brain processing visual signals about the body’s position relative to its surroundings that are then compared to information from the vestibular and skeletal systems (Qu & Nussbaum, 2009).

The human sense of time appears to have perceptual implications for those involved in the development of transport-based infrastructure. Empirical research indicates that the amount of sensory stimulation provided by an environment can affect the sense of time of someone experiencing that environment, both during and following exposure. In an investigation of spatial distance perception, Sadalla and Staplin (1980) compared participants' reaction to two routes of similar length but offering different levels of visual stimuli. The study found that following the completion of both routes, the one with a higher level of stimuli (shops, signs etc.) was recalled as being longer than the route with a comparatively low level of stimuli.

Following a more recent study of duration-perceptions of walking routes in urban shopping environments conducted by Ahn, Liu and Soman (2006), the researchers concluded that in rich environments providing substantial amounts of sensory stimulation, a person will take a lot of mental snapshots in a given objective duration. During this stimulation, time seems to pass quickly. However, during recall after the event the mind has to process all of the snapshots to recreate the experience. This processing results in the perception of greater estimated duration.

Although the perceived experiential richness of an environment has been shown to alter a person's sense of time, it is not clear whether this effect has any influence on decisions to seek out a particular environment or, in the case of a cyclist, the ultimate choice of whether or not to reuse a particular route.

Kinesthesia can be thought of as the brain's sense of movement or motion. It is one of the least understood of the sensory systems and may be the first to develop in the human embryo. Due to this early development, input into the kinesthetic neural mechanisms from other sensory systems, such as vision and touch, is compared and contrasted with these initial patterns (Zion, 1996). As an infant grows, they improve their ability to reach, grasp, crawl and walk. Kinesthesia becomes more fluid and effective as an increasing number of movement routines become available at an automatic level.

Furthermore, kinesthetic ability is necessary for humans to perform any kind of voluntary movement and involves the body's muscular system responding under the direction of the kinaesthetic system. Activities, such as swinging a golf club, catching a ball or riding a bicycle, all require a finely-tuned sense of the position of the joints. Kinesthetic responses need to become automatic through training so that the person is free to concentrate on other tasks such as locating objects or assessing environments for hazards (Zion).

Often confused with kinesthesia by the untrained, proprioception is the sense of static position or our ability to sense the position of one body part relative to another. An example is when a person attempts to touch their nose with both eyes closed. It is commonly believed that proprioceptive signals encode the angles of joints (van Beers et al., 1998) and this would have relevancy to cycling because of its repetitive leg action.

At a broad level, human perception involves the extraction of particular cues from a scene that may often contain many potentially confusing cues. Individualism is therefore important in the interpretation of information from an environment and that task is based on a range of probabilistic statements from many different settings. As there are numerous possible environments, judgements about any one environment cannot be done with certainty and must, by definition, be probabilistic-estimates. Some researchers have attempted to narrow these parameters and establish key aspects that are shared by the entire population.

Gifford (1987) outlines a perceptual model developed from the earlier work of environmental psychologist Egon Brunswick that describes how an individual perceives a scene and this concept is widely accepted today by landscape professionals. It is a reliable instrument that provides a graphical explanation of the interpretive role the individual plays in perceiving a particular scene using a process whereby scattered environmental stimuli are gathered together by the viewer in a similar manner to how a lens focuses light (Figure 2.6). It also deals with variables in categories (distant, near and subjective) and establishes relationships between each. A strength of the model is that it consistently organises data in order to derive conclusions from these connected findings. The lens model is particularly useful for this research project as it has the potential to reveal hidden relationships between environmental stimuli and psychophysical responses.

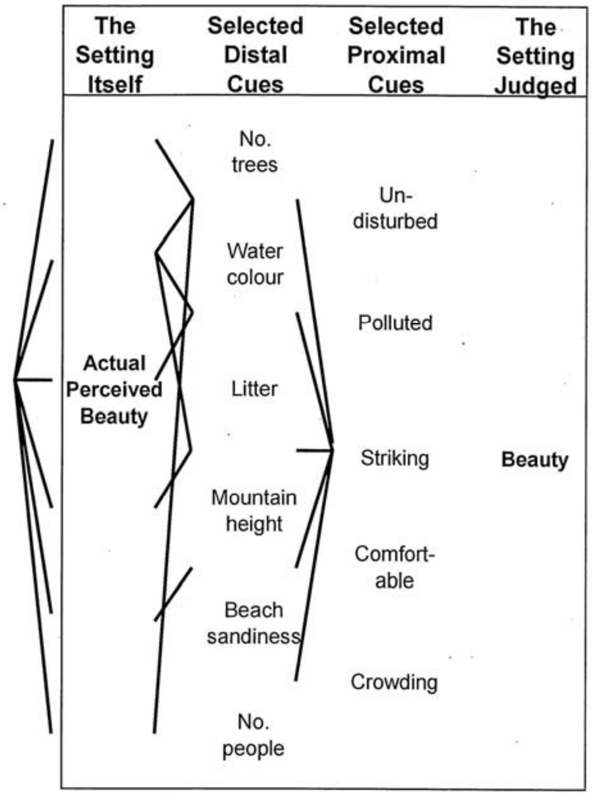


Figure 2.6: Gifford perceptual model (Gifford, 1987)

Another important perceptual model that has substantial empirical backing is the concept of information-processing proposed by Stephen and Rachel Kaplan (1982). This model is particularly applicable for the period of time between information being received by the senses and the person's response when that the information is identified, interpreted and compared with information in memory. A detailed exploration of information-processing is made in the next section that deals with landscape issues.

Cycling is a multi-sensory activity. An analysis of how the individual senses combine to create perception is explored in the upcoming section dealing with construction of space.

Gestalt psychology

Gestaltism is a theory of visual perception that was founded by Max Wertheimer and expanded upon by Kurt Koffka and Wolfgang Kohler in the early years of the twentieth century. It is based on the idea that the whole of an experience is more than the sum of its individual elements and that humans have a natural tendency to order an experience in a manner that is simple, regular, orderly and symmetric.

An important aspect of Gestalt theory is the concept of grouping and how a person interprets the various elements of a scene in a certain way (Kohler, 1947). These groupings can be based five factors: similarity; simplicity; symmetry; closure; and proximity. Similarity refers to how elements in a scene are grouped together conceptually, while simplicity is concerned with how elements are organised according to their external appearance. Symmetry refers to how images that are symmetrical tend to be viewed collectively even though they are situated well-apart. Closure refers to how elements are grouped together to form a pattern, and proximity is about how elements are grouped according to their spatial closeness. Recently the idea of 'common fate' has been included among the list of grouping factors. This refers to the perception of several objects moving in the same direction as being a single unit even though they have no obvious relationship to one another.

A further aspect of Gestalt theory is that the human mind actively organises the sensory information being received into a satisfying whole that is different from the sum of its individual parts (Sternberg, 2002). This theory stems from earlier work of German philosopher Immanuel Kant who concluded that people have an innate tendency to organise stimuli and events presented to them. There is some empirical basis for this theory with the proven ability of the mind to fill in gaps using reification – best demonstrated using illusory contour diagrams. For example in Figure 2.7, a triangle is perceived by most people even though the sides of the figure do not exist.

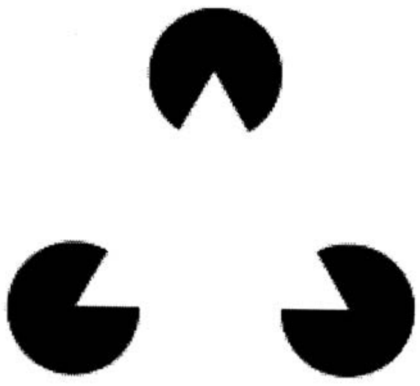


Figure 2.7: Demonstration of Gestalt principles: a triangle is perceived even though it is far from complete (Hoffman, 1998)

The Gestalt concept of automatic cognitive self-organisation has important implications for multi-sensory activities such as riding a bicycle. The rider experiences a constant stream of images and the way these are organised by the brain and sensory systems will determine how a riding environment is perceived and rated.

Furthermore, this Gestalt concept of wholes and parts is particularly relevant to landscapes and appears to be directly applicable to the modern landscape design principles of unity and variety discussed in detail in the section dealing with landscape theories. More specifically, Drottenborg (1999) contends that the principles upon which the concept is built may provide information about how individuals tend to recognise and organise objects or features and that this knowledge could be useful in the process of designing transport-based infrastructure.

Phenomenology

Phenomenology deals with the notion that perception is an ongoing subjective interchange between the body and the environment that surrounds it with any considerations of objective reality not being taken into account. The doctrine was first proposed by Austrian philosopher and mathematician Edmund Husserl in 1905 and has been subsequently built upon and amended by many others.

Current phenomenological theory focuses on the importance of reciprocity and how perception is a synchronization between the rhythms of the perceived and the rhythms of the things being perceived. Neither the perceiver nor the perceived is considered to be passive in this process and they each are able to influence each other. Langdridge (2006) uses the example of a person experiencing a tree to illustrate this concept of ongoing interchange. According to Langdridge, when a person touches the tree's bark, the texture of that bark returns a particular sensation to the perceiver's hand. If the same tree sways in the wind, the visual perceiver may feel that movement in their body. The resulting perceptual experience or encounter is reciprocal as both the perceiver and perceived are active.

Some modern phenomenologists believe that this relationship can not only involve natural objects such as plants and animals, but also inanimate objects, cultural icons, and even ideal elements, such as numbers or equations. They also contend that perception is a multi-sensory occurrence with the individual senses blending together into a synaesthetic-cognitive function.

Phenomenology offers an alternative concept of perception to that provided by the evolutionary-based objective theories such as information-processing. Instead of programmed responses and intrinsic preferences being the fundamental forces guiding human perception, phenomenology asserts that our individual experiences gleaned from previous encounters can shape perception of future experiences. Some early research involving identical twin subjects indicated that experiential history can significantly affect perceptive response to the same stimuli (Bloch, 1969). This subjective and individualistic aspect of perception may have crucial implications for those involved in the field of experiential design by making it impossible to develop stimuli that appeal equally to a group of people. As riding environments are aimed at a broad user profile, seeking a 'one-size fits all' design solution will be problematic.

2.3.2 Aesthetic theory

Aesthetics is the science or philosophy concerned with the quality of human visual and aural experience and sensory-emotional values applied through judgments of sentiment and taste. It is a broad study area that includes both the aesthetics of nature and the aesthetics of human creations. These two categories can be further divided into sub-sections including landscapes, natural science, the human form, objects and concepts.

Philosophers have been interested in the nature, source and scope of aesthetics since at least the time of Ancient Greece. Through the contributions of many thinkers across the years, with each building upon a predecessor, a rich philosophy of aesthetics has developed.

The renowned eighteenth century German philosopher Immanuel Kant believed the aesthetic was distinct from the useful, the pleasant and the good. To support this concept, he contended that the aesthetic quality of an object or work of art is not dependent on its practical usefulness, or even its congruence with conventional morality (Saw & Osborne, 1960; 1968). Kant suggested that aesthetic evaluation was based on the premise that the mind is not concerned with an object, but instead with the mind’s representation of the object. This subjectivist view of aesthetics, where judgement of taste rather than cognitive logic is the key factor, remains the dominant theory today.

Kant further argued that this focus results in a disinterest in, or lack of desire for, the object itself and allows the viewer to concentrate on the image. He believed this released the viewer to enjoy the aesthetics of the image without considering existential concerns that could influence appreciation (Saw & Osborne).

This theory of disinterest has since been rejected by some modern scholars who cite modernist art movements, such as expressionism and its relationship to community concerns, as a clear indication that the aesthetic is directly linked to other areas of life. French sociologist Pierre Bourdieu (1990) is a particularly vocal critic of Kant’s background, claiming that his membership of the upper class taints his overall experience of aesthetics and therefore any philosophical interpretations.

American psychologist John Dewey believed aesthetic experience was the product of an interaction of the objective and the subjective (Bourassa, 1991). Although not refuting Kant's basic premise, Dewey suggested that aesthetic experience was not entirely passive and required some form of involvement or engagement on the part of the viewer.

Later philosophers such as Cassirer and Langer have argued that symbolic representation or semiotics plays an important role in aesthetic judgement. Others have argued against this as an encompassing theory because they contend that natural objects cannot be truly symbolic and it therefore only applies to works of art (Saw & Osborne, 1960).

Of particular relevance to this research project is the field of environmental aesthetics. Nasar (1992) defines three distinct types: the sensory; the formal; and the symbolic. Sensory aesthetics is the pleasurableness of sensations received; formal aesthetics the perception and appreciation of quantifiable characteristics such as shape; and symbolic aesthetics the meanings of association that an environment conveys. When the environment includes artificial constructs, such as architecture, Nasar (1994) contends that an aesthetic response will also involve emotional judgements and affective appraisals arising from the connotative meanings that particular attributes of those artificial constructs convey.

Individual characteristics, such as personality and cultural background, have been suggested as potential factors that may influence aesthetic response to natural, artificial and mixed environments (Nasar, 1994). To date, no empirical studies have been published that demonstrate this theory, with some meta-analysis research finding little significant demographic differences between groups for environmental aesthetic response, apart from that between adults and children (Stamps, 1999). These are discussed in detail as part of an analysis of specific examples landscapes and transport infrastructure in following sections of this thesis.

The quality of visual experience depends partly upon the characteristics of the resources that stimulate that experience. It also depends on the nature of the viewers, their location, number, activity and values (United States Department of Transportation, 1990).

Today, various researchers are looking to evolutionary psychology, cognitive science and even mathematics in an effort to better understand the psychophysical nature of aesthetics. Schmidhuber (1997) for example suggests that an algorithmic solution can be used to determine the level of aesthetic beauty for a given experience by a given observer. He contends that an individual distinguishes between whether something is beautiful or whether it is interesting and that interestingness corresponds to the first derivative of subjectively perceived beauty.

Although a link between aesthetically-pleasing riding environments and a willingness to cycle more often has not been established in the research literature, aesthetics has been reported as being a significant factor in other forms of physical activity such as walking (Ball et al., 2001; Humpel et al., 2004). These studies provide an impetus to explore further and to pinpoint specific aesthetical design aspects that can be used to develop more attractive facilities for cyclists.

2.3.3 Psychophysical attributes of the riding experience

Social commentators such as Richard Louv identify the human need for outdoor experiences. Louv contends that as young people in particular spend less and less of their lives in direct contact with natural surroundings, their senses tend to narrow, both physiologically and psychologically, and this in turn reduces the richness of human experience (Louv, 2005). Activities such as walking and cycling offer a solution to this problem.

It is important to note that there has been no scientific studies aimed at describing the ways in which we specifically benefit from spending time in a natural environment. Louv himself acknowledges this lack of research and gives the reasoning in terms of economic outcomes by stating: What toy can we sell for natural play? (McKee, 2005).

Solnit (2000) believes there is something liberating in the mental state that walking produces, describing it as being: “Cool and withdrawn, with senses sharpened, a good state for anybody who needs to reflect or create.”

It is easy to imagine that cycling also can produce this liberation of the mind as it exposes the rider to similar environments at a moderate pace. Fournel (2003) contends that riding at a certain speed changes the perceived world of a cyclist, with a series of glimpses, instead of deep thought, being used to construct a new reality.

Spinney (2008; 2009) has attempted to explore the content of the movement by bicycle between points A and B. He contends that the study of cycling has been dominated by research investigating how riders complete a journey and little attention has been paid to the actual experience of that journey with specific reference to fleeting and ephemeral meanings. Rather than asking what cycling ‘could be’, Spinney argues that previous research has focussed on what cycling ‘should be’ and that it needs to give greater consideration of sensory, kinaesthetic, political and symbolic factors if the outcome is to provide a more realistic understanding of mobility and travel choices.

Spinney (In Horton et al., 2007) notes that cycling as a practice is embodied, sensorily open to the environment, technological, and free from much of the discipline that other forms of mobility are subjected to.

Furthermore, he contends that a cyclist’s perception of the environment is informed by the goals, skills and technologies available at that given moment. The bicycle itself influences environmental perception and it could be contended that a significant proportion of the cycling experience is absorbed at a sub-conscious level. Therefore, a person’s opinions of a riding environment may not be an entirely accurate measure of the actual impact. Alexander (1979) asserts that feelings can be a very powerful design tool. In doing so, he highlights the important difference between opinions and feelings.

Spinney also acknowledges that there is a lack of vocabulary available that enables people to adequately express their experiences of senses other than vision. Pow (2000) contends that this barrier to expression makes it difficult for researchers studying the embodied aspects of cycling to accurately assess the quality, nature and extent of tactile, auditory and olfactory experiences. Spinney also notes how other sensations, such as balance, are often fleeting and therefore do not lend themselves to expression or capture in the same way that visual stimuli does. This aspect is an important consideration when choosing an experiential research methodology that can be used to obtain meaningful results.

Spinney asserts that his ethnographic research of London cyclists has demonstrated that riders are able to control their experience of place by manipulating the kinaesthetic sensations within their own bodies (Horton et al., 2007). He also suggests the research indicates that a cyclist's notion of place is less reliant on visual stimuli than had previously been assumed. His findings show that vision is re-embodied alongside the other senses, producing a multi-sensory construction of the experiences and meanings of place. This assertion is supported by the crossmodal links promoted by Driver and Spence (1998) and discussed further in the next section dealing with construction of space.

Recreational or commuter cycling shares many similarities to other human-powered movement-based activities, including canoeing, hiking, surfing and snow skiing. However, a cyclist's experience of a shared path environment is somewhat different from those of a walker, due in part to the speed they are moving through that environment. A cyclist will tend to have more fleeting stimulus. French anthropologist Marc Auge, who coined the phrase 'non-places', suggests that such very short-term transitory experiences have no significance (Auge, 1995). An opposing view is provided by Evans (2004) who contends that even very temporary experiences have meaning and that significant transit experiences and understandings occur outside of the visual sense.

People do not usually experience the visual environment one object, element or feature at a time. Instead, this experience most often occurs as an integrated whole (United States Department of Transportation, 1990). Studies in the field of phenomenology appear to confirm this assumption.

Building on the principles of Gestaltism, Chown et al. (1995) extend this concept by asserting that individuals moving through an environment construct their own overall perception of that environment from the serial experience produced by that movement and then by assembling a whole from the various parts.

Research indicates that the receptivity of different viewer groups to the visual environment and its elements is not equal (United States Department of Transportation, 1990). People cognitively overlay physical form with meanings or representations, integrating mediating information gathered from prior experiences and social learning (Wolf, 2003).

This variance is termed ‘viewer sensitivity’ and has been shown to be closely related to individual preference. It affects visual experience by modifying viewer activity and awareness, values, opinions and preconceptions. This characteristic presents important challenges for the planners and designers of functional public infrastructure. As previously stated in relation to phenomenology, public facilities, such as bicycle paths and trails, must be able to cater for a wide range of users, and therefore for a wide range of viewer sensitivities.

The apparent sensory dominance of vision in cycling needs to be carefully questioned. Stripling (1995) describes an experiment she conducted as a sighted person being blindfolded and riding a tandem bicycle. She speaks about an awareness of the terrain changing during a ride and how the bicycle bends to accommodate it. She also mentions the ability to feel the presence of trees, not simply by the rustle of leaves but by what she terms a ‘soft closeness’.

Others report the motion of the bicycle and the complex sensory feedback while riding. Kim Kilpatrick (2001), who has been blind since birth, remarks:

> In a car, a totally blind person is in a sort of cocoon not knowing what they are passing unless others tell them. On a bicycle I can hear people walking along the sidewalk, lawn mowers, kids playing, sprinklers, the wind in the trees, waterfalls, birds, little animals hopping off the path, dogs being walked, people in conversation, and many other sounds. I can smell flowers, trees, the ground, the smell of the wind, and any other aromas that happen to drift past my nose.

Michel de Certeau (2002) contends that cycling is a tactile action that subverts institutional strategy and the way in which we are coerced into behaving. He further asserts that when riding, his commute becomes a pleasurable sensory experience that he looks forward too, as opposed to a practical necessity.

Reeh (2004) argues that tactility may play are particularly important role in how we see our physical environment. As a cyclist is not in direct contact with the surface they are travelling upon, the sense of touch is activated by secondary stimuli. Kennedy et al. (1980) argue that we 'feel' the surface of the road or path when riding a bicycle as a *distal* stimulus. This is distinct from the handlebars and saddle, through which information about the road surface is obviously transmitted, and which feel *more proximal* than the road, but also are distal, in the sense of being external to us. The road's visual texture combines with haptic information and may assist externalisation.

Justine Spinney writes (in Horton, et al. 2007) that the experience of cycling is one in which 'meaning is created moment by moment through a series of fleeting and solitary embodied encounters.' He goes on to contend that previous social theories such as that proposed by Auge have prematurely labelled spaces of mobility as lacking meaning and therefore not worthy of being called ‘places’. He asserts that Auge has neglected the multi-sensory nature of place by focussing on roads which are dominated by cars which produce a restricted sensory experience. Spinney argues that cycling is a much more embodied way to move and that the spaces of mobility associated with cycling have a great deal of meaning and do therefore become places in their own right.

Spinney also reminds us that regardless of the inherent sensory nature of a particular activity, we live in a visually-dominated world and this bias extends into geographical enquiry. Accordingly, there is a substantial body of research based on visual perception. However, in comparison, little sustained research has been conducted into other sensory aspects of experience.

The results of Spinney’s London study of cyclists supports his premise that the visual aspects of the riding experience are not overwhelming and that other senses play a significant role in the multi-sensory construction of the experience and meanings of place.

Other forms of bias may be skewing cycling inquiry. Previous research investigating stated preference-based choice of route has shown that both time and safety are the greatest determinants (Bovy and Bradley, 1985;

Hopkinson and Wardman, 1996; Stinson and Bhat, 2003; Zappelli et al., 2008). However, there is an inherent weakness in this research that is also indicative of a wider ignorance about the importance of the actual riding experience. This weakness is the failure of researchers to include experiential choices in the data collection process.

Horton et al. (2007) note that little is known about how people experience cycling bodily, yet this knowledge is critical to understanding why and how people cycle. Spinney is one of the few to explore this topic.

Common forms of land transport, such as the motor car and the train carriage, require the passenger to be fully enclosed with the surrounding landscape being silent and untouchable (Wilson, 1991). Giblett (2004) contends that landscapes in national parks were often deliberately juxtaposed to rail or road and that the car in particular changed the relationship of subject to object by creating a more dynamic set of prospects. Riding a bicycle is a sensory engulfment, with the rider being in close proximity to the surrounding anthropogenic and natural environments (Smith, 1972). Instead of viewing the world from inside a glass case and metal box, the cyclist is fully exposed to a greater range of sensory inputs (Giblett, 2008). This riding experience is whole-of-body rather than simply visual and this in turn means an effective route for a cyclist may need to offer much greater sensory stimuli than that for a car occupant. It may even require a major shift in thinking for engineers and designers who too often consider bicycle paths to be what could be called ‘miniature roads’.

Although train passengers, car occupants and cyclists all view the world from a seated position, the latter mode differs from the other two because it requires action (pedalling, leaning and bouncing) by the participant. Accordingly, where railways and roads may be constructed with a passive participant involved, infrastructure for bicycle riders must accommodate this range of activity if it is to fully challenge the senses.

In common with the car, the bicycle can provide liberation from the home, office or factory, enabling the rider to enter the public sphere of the street (Giblett, 2008). However, the ability of drivers and passengers to communicate with other road users is limited by their confines. Cyclists are more visible to the rest of the world than car drivers and can use body language to achieve a more complex or subtle social experience.

The design of a bike route may involve such concepts as place and identity, enclosure, variety and mystery (Laurie, 1986). Studies conducted by Clemson University in 2005, point to a correlation between landscape design and measurable physiological response. Trial subjects exposed to certain types of landscape demonstrated changes in brain wave pattern (Chang et al., 2008). This response to sensory stimuli needs to be explored further in relation to cyclists and their riding environments.

Bonham (2006) asserts that car travel is inherently non-experiential because the travellers in that mode, both driver and passenger, are dominated by the need for efficiency. She makes the point that over the time since the introduction of the automobile, the body of the car traveller has been disciplined to be efficient and that car travel is the most economical way to move. It could therefore be concluded that car travel seeks to minimize human effort whereas cycling is a travel mode that explores and even celebrates it.

2.3.4 Construction of space

Driver and Spence (1998) conclude that the space around us is constructed by computations involving complex integration between the different senses. They recognise how these individual senses can each sample different regions of space doing so in different coordinates. For example, vision is initially retinotopic (the projection of an image received by the retina onto the brain that preserves its spatial relations); touch is somatotopic (activation of the cerebral cortex by receptors on the body), and hearing is at first tonotopic then becomes head-centred. A person’s perception of the location of external events largely depends on the manner in which the information gathered from all these senses is combined.

According to Driver and Spence: “A single modality alone, cannot provide a stable representation of external space.” Using a schematic diagram, they point to recent crossmodal attention studies that have revealed numerous links in spatial attention, and their relation to the internal construction of external space.

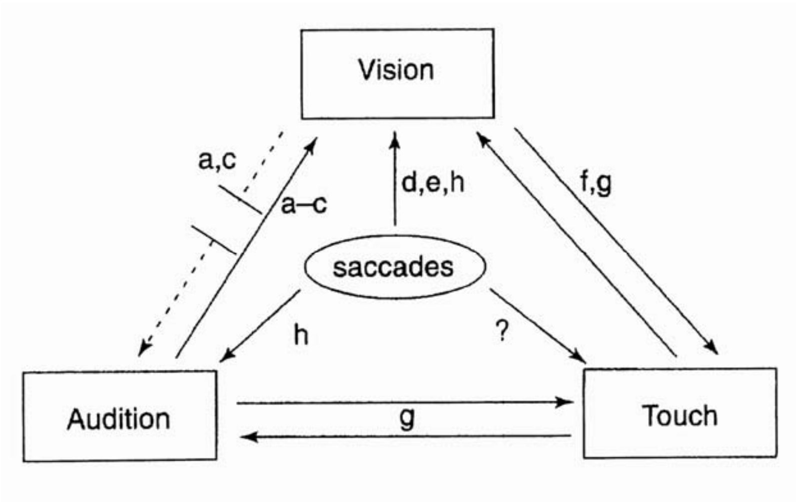


Figure 2.8: Representation of crossmodal links in exogeneous covert attention (Driver & Spence, 1998)

Figure 2.8 illustrates all of the known crossmodal spatial links. Solid arrows indicate that a link has been shown. Saccades are the rapid intermittent eye movements that occur when the eyes fix on one point after another in the visual field. In this instance, the term covert meaning that no overt receptor shifts such as eye-head-or hand movements were allowed

As previously discussed in the section dealing with sensory systems, a cyclist riding along a path or trail, assuming they are not deaf or wearing headphones, is constantly using multiple senses to construct the space around them.

Unwin (1975) asserts that we evaluate landscape or space in a very different way than static images such as paintings. He notes that this difference relates to a number of factors including the observer's position within a space, the comparative effects of peripheral or previous views, an orientation toward action and the prevailing meanings or atmosphere not visually expressed in the landscape.

This complexity presents practical difficulties. Computer game designers have long struggled with the problem of portraying effective outdoor spaces on a two-dimensional screen. It is difficult to create sweeping vistas or panoramas that feel real because the sensory input is so restricted. This limitation has important implications for how to communicate the benefits of a particular path, trail or route using standard forms of media.

Factors, such as visual angle, give a particular experience far less impact. In real-world spaces, the human eyes operate in an overlapping horizontal field-of-view of 120 degrees, whereas the angle for those viewing a screen is often less than 60 degrees.

French writer and planning theorist Henri Lefebvre suggested that there are several levels of space ranging from very basic natural or absolute space, through to complex versions of social space (Lefebvre, 1991). He argues that urban space is a social product, or a production of meanings which affect spatial practices and perceptions, and that all cultures produce their own spaces.

As previously mentioned in the section on bicycle culture, cycling is often misrepresented as a form of instrumental mobility in car-dominated societies. It has also been marginalised as a social and leisure activity in the urban landscape. The same reductionist logic that framed the bicycle as a vehicle has served to exclude it from public and pedestrian environments because it legally belongs on the road, and therefore must be too dangerous to safely mix with pedestrians. Spinney (2008) believes that despite such exclusions, many riders re-interpret the use of road and public spaces according to their experience as, unlike the car driver, the cyclist is anything but static in movement. In a car the sensory difference between driving up and downhill is neutral but on a bicycle it is only too obvious.

In a practical example, Spinney found that some London riders find kinaesthetic pleasure in the work of riding up inclines like Grosvenor Place, whilst others take great pleasure in coasting down Shooters Hill in Greenwich or heading south over Waterloo Bridge on the way home from work. The nature of cycling means that spaces otherwise rendered homogeneous when travelling by car have widely varying characteristics.

Spinney, echoing the words of Wilson (1991), further contends that by hiding in a glass and steel box, we have disconnected from each other and, to a large extent, from our surrounding environment. Exposing ourselves to the elements, such as weather and ambient noise, makes us interact with, as opposed to react to, our environment, and this in turn enables us to understand the space around us better.

Urban leisure cycling such as bicycle motocross (BMX) and trials riding in particular have capitalised upon the multi-sensory aspects of riding, particularly the kinaesthetic - the feeling of movement within the muscles and of the motion of the body through space. Such practices actively promote these pleasures as the central reasons to ride. Areas around South Bank's Shell Centre and Tate Modern are especially popular with riders who use ledges, verges, railings, benches and bollards to form an obstacle course to test their skill and balance. When ridden by a trials' rider, the 1.2 metre-high plinth of a statue is no longer just part of the artwork; it now provides a physical and mental challenge. Similarly, the armrest of a bench no longer only facilitates relaxation; when engaged by a trials' rider, it is a test of strength, balance and skill. Thus these design features take on a betweenness as their significance expands. At the same time as reinterpreting these elements of urban design on the micro scale, the performances of these riders fit well within the wider framing of the South Bank as a vibrant area of social interaction and street performances. Thus even though cycling may be not be part of Mather's South Bank master plan, unprogrammed activities can still proliferate and even enhance certain 'loose' spaces.

Spinney asserts that the concept of place has tended to revolve around notions of dwelling, sociality, and the visual qualities of place embodied in the term landscape. He contends that the spaces of mobility such as roads and paths have been largely theorised as relatively meaningless and relegated to simple conduits that enable movement from point A to point B. This could be construed as a manifestation of engineers considering routes as objects rather than spaces. Spinney further contends that this thinking is fundamentally flawed because even major trunk roads when experienced in a different way can actually be conceived of as place-like in character. This is particularly the case with bicycle paths and trails as user-research indicates that in Australia, both types of infrastructure are primarily used as a platform for experiences rather than movement between specific destinations.

Spinney also argues that destinations are not the only places where meaning is created and that it can is exist in non-places through an embodied and sensory engagement with place which does not rely solely on notions of landscape, dwelling or sociality. Creswell (2006) contends that spaces of mobility such as paths have traditionally been explained in terms of points or destinations and the push and pull factors relating to them. Spinney notes that the movement space that occupies an area between the point of departure and the destination has been ignored as a social practice generative of meaning itself.

Cresswell (2006) also asserts that movement is essentially the dynamic equivalent of location and that mobility is the dynamic equivalent of place. He notes that despite this apparent equivalence, geographers do not study mobilities to the same extent as place, territory and landscape. Cresswell argues that mobility is just as spatial and equally important to human experience of the world, and that moving from one point to another is the same as freedom, transgression and creativity.

Following completion of a large scale study of cyclists, Gardner (1998) asserts that significant differences exist between the image of leisure cycling and commuter cycling, with the former being thought of as a calm, peaceful and liberating activity while the latter being more demanding and stressful. However, leisure cycling is a significant factor in fostering the overall habit of riding a bicycle and is worth encouraging, with efforts needing to be made to develop the commuter journey by using the characteristics evident in the environment of leisure cycling journeys.

Haynes (1980) asserts that no two individuals will perceive a place in exactly the same way. He notes that their particular image of the environment is based on mental processing and that the result is a product of the sensory stimulus of a place combined with the individual's existing knowledge, memories, beliefs, values, attitudes and personality. Indeed, Haynes suggests that these latter factors may play a far more important role than the original information received through the senses.

Emotions and place

Seamon (1979) contends that humans are emotionally related to the environment, and this relationship ranges from momentary irritation felt when something is out of place, through to the profound sense of attachment for a place they consider sacred.

Gibson (1966) suggests that perception is not only a product of what we experience, but also how we experience. Our perception of a place is very much dependent upon how we are feeling in that place rather than simply how we organise sensory input.

Raymond et al. (2003) conducted studies that combined a simple visual locating task with an emotional evaluation task. Results indicated that emotional processes have a direct influence on attention and that a reciprocal relationship exists between attention and emotion. While neutral stimuli tend to produce little emotional response, both positive and negative stimuli trigger emotions. This research also found that attention and emotion may work in unison to prioritize processing and therefore influence the selection process for visual stimuli.

Chhetri et al. (2004) contend that visitor experiences in natural landscapes create emotional states and that these states are multidimensional and multi-sensory manifestations that can be exhibited in numerous forms. To test this contention, they conducted a study of the feelings and moods of hikers using a walking track located in the Grampians National Park of western Victoria that incorporates a diverse range of vegetation types, elevations, geomorphologic features and vistas. Findings indicated that natural landscapes influence on several experiential levels including desirable experience, impelling experience, apprehensive experience and social interaction during the journey. This study was limited by the fact that participants were drawn from a small and relatively homogenous group of university students. The researchers acknowledge that a sample more representative of the general population may have given a truer picture of visitor experience.

Lefebvre (1991) contends that certain spatial characteristics have an emotional function. For example, he cites the monumental, vertically-oriented structure and asserts that it signifies a plenitude of destructive force, partly due to the phallic nature of its spectacle. However, Lefebvre also claimed that the beach is the only place of enjoyment that the human species has discovered in nature. This is clearly short-sighted and ignores the many other natural environments that people find emotionally uplifting.

Australian social inventor David Engwicht developed the concept of ‘mental speed bumps’ after noticing that a child playing on the footpath can be more effective at slowing traffic than an engineering solution, such as a speed hump or chicane (Engwicht, 2005). He suggests that the speed of traffic along residential streets is largely governed by the degree to which residents have psychologically retreated from their street. Simply reversing this retreat creates mental speed bumps in the street that slow traffic to a safe speed. Engwicht’s suggestion has similar traffic-calming principles to the urban design concept known as ‘shared space’ which contains a core theme of integrated use of public spaces. It removes the traditional segregation of motor vehicles, cyclists and pedestrians in the streetscape (Keuning Institute, 2005).

2.3.5 Repetition and variety

From the perspective of landscape or environmental perception, variety can be achieved in two ways. Firstly, it can be achieved by having a constantly changing environment, e.g. natural or artificial bodies of water. Secondly, it can be achieved by having such a complex environment that something new is revealed each time as a rider cannot process everything in one visit.

A number of studies (Bornstein, 1989; Raymond et al., 2003; Zajonc, 2001) have concluded that a person’s emotional evaluation of particular stimuli can be significantly manipulated by means of repetition. Edensor (2003; 2007) offers an alternative view about the ability of seemingly mundane or boring landscapes to provide a rich sensory experience. He uses motorways in the United Kingdom as an example of how all car travel can be regarded as a means of redistributing sensual experience as cars and journeys contain their own sensual capacities.

Additionally, Edensor asserts that the motorway is continuously part of a complex series of flows and matrices connecting sensations, spaces, times and representations. He contends that users of the motorway do not suddenly become unreflexive creatures when they enter the on-ramp and that driving is an experience which combines temporal diversities through a series of experiences, such as immanence, nostalgia and anticipation. He also suggests that our concept of rich and poor experiential environments may need to be amended. He infers that motorways are not featureless spaces but possess their own special aesthetic and material qualities. The outwardly linear appearance of the roadway dissolves as monuments, signs and surprises create features and a web of associations. Edensor refers to this as ”a topography of possible sights and destinations that reference other spaces and times”. All journeys, regardless of the environments they traverse, are full of moments of brief co-presence as vehicles convey different bodies at different speeds, and include excursions of varying duration, distances, purposes and destinations.

Kent (1989) asserts that the results of a study into sensory preferences in built environments may reveal that the participant’s familiarity with the stimuli has an affect on attitudes.

The information-processing theory of landscape perception proposed by Kaplan and Kaplan (1989) and detailed more fully in the next section, can offer an important insight into the effect of familiarity on preference. A familiar environment is easy to make sense of but quickly becomes boring and demands less involvement, particularly if no prospective information can be safely afforded. On the other hand, a less familiar environment can be very involving but quickly becomes threatening and unpleasant if the prospective information cannot be easily processed and matched with the viewer’s existing cognitive maps. The attributes of novelty and intrigue characterise the level of exploratory behaviour response

Leading researcher in the field of positive psychology Mihaly Csikszentmihalyi, contends that humans enjoy an experience more if they are in a so-called ‘state of flow’. He defines this state of flow as being a complete absorption with an activity, environment or situation and derives the term from a comparison with a moving stream. This immersion is typically characterised by a state of intrinsic motivation in which temporal concerns or influences have little or no effect (Csikszentmihalyi, 1990). Achieving flow involves a fine balance of skill level and challenge where lower levels of both tend to produce feelings of apathy or boredom (Figure 2.9). This involvement of both skill and challenge can be directly applied to the activity of cycling.

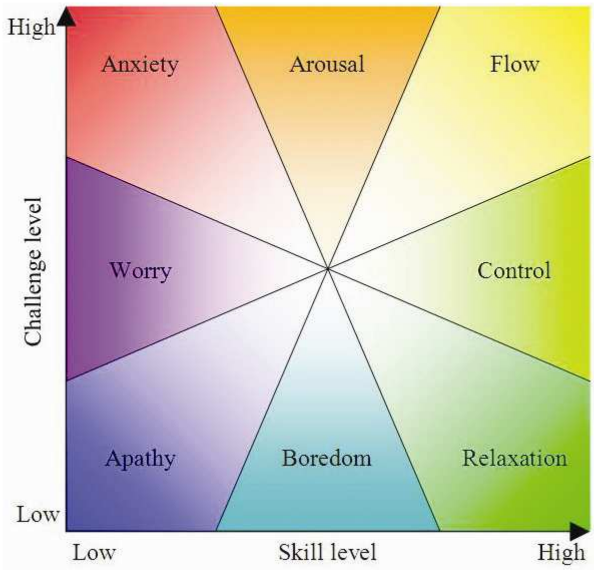


Figure 2.9: Flow measurement based on levels of skill and challenge (Czikszentmihalyi, 1997)

2.3.6 Summary

This section of the literature review has provided important insight into how humans perceive and make sense of the world around them. In doing so, it has enabled the researcher to gain a clearer understanding of what features, elements and aspects of designed environments, such as bicycle paths, trails and associated infrastructure, are likely or unlikely to be perceived and form part of spatial preference.

Although vision is undoubtedly the primary gathering-mechanism of environmental stimuli, psychophysical outdoor activities, such as cycling, appear to be multi-sensory perceptual and cognitively complex processes.

Successful riding environments are therefore more likely to appeal to some extent to a range of different traditional and more recently discovered senses.

The senses do have their limitations and any stimuli lying outside these perceptual boundaries, no matter how powerful, will be wasted. This is particularly relevant to visual aspects of a riding environment. Designers need to take into account proven factors such as dynamic visual acuity and the importance of crossmodal links between vision, audition and touch when deciding the nature, extent and location of potential stimuli.

The work of leading researchers such as the Kaplans (1987) with their information-processing theories and Czikszentmihalyi (1997), who contends that sensually-absorbing environments have an intrinsic flow developed by balancing skills and challenges, need to be acknowledged when assessing existing and new riding environments.

Other thought-provoking concepts emerging from the review are worth investigating and have the potential to contribute to path and trail design. Gestalt principles and the human sense of time could play a significant role in how riding environments of differing complexity are perceived by cyclists. In particular, factors that lead to perceptual grouping, such as similarity, simplicity, symmetry, closure and proximity, need to be carefully considered when designing routes that traverse varied terrain.

Spinney's (2007) analysis of the performative and kinaesthetic aspects of riding a bicycle has implications for the alignment and topography of satisfying paths and trails. In particular, his findings raise the need for designers to focus on the inherent physicality of cycling as opposed to other modes of transportation, such as motor vehicles. This is manifested in the apparent tendency for engineers to perceive mobility-based infrastructure such as roads and paths, as objects rather than spaces that promote movement.

The effects on aesthetic response may be dependent upon the observer and these are covered in greater detail in the following section.

2.4 Landscape influence

Cycling is an outdoor experience and all riding environments inhabit a landscape. It is therefore essential that any investigation of path and trail design include theories and practices related to that aspect.

There is limited published empirical evidence related to the features of the physical environment that influence physical activity (Pikora et al., 2003), though a few qualitative studies have explored how the environment influences patterns of such activity (Rutten et al., 2001; Corti et al., 1996; Bauman et al., 1996). In addition, no studies have investigated how landscape can affect cycling participation rates. However, there are several well-established theories about human preference for particular landscapes that offer direction and these are explored in the following section.

In this field of endeavour, there are two contrasting paradigms: an objectivist one which regards quality as inherent in the physical landscape; and a subjectivist one which regards quality as a product of the mind as seen through the eye of the beholder. These two paradigms underlie the surveys of the physical landscape and studies of observer preferences, with the latter now being favoured by the majority of modern-day scholars in the field.

2.4.1 Landscape preference theories and studies

The following represents an analysis of popular theories that attempt to explain why we prefer one landscape over another.

Prospect-refuge theory

Perhaps the most widely publicised and best known theory of landscape perception and evaluation has been the one associated with the idea of prospect, refuge and identification of hazards developed by British geographer Jay Appleton in the 1970s. This seminal concept is based on instinctive behaviour emerging from the hunter-gatherer stage of human evolution.

Appleton's prospect-refuge theory of human aesthetics asserts that visual taste is largely based on an acquired preference for particular methods of satisfying inherent desires and that these desires can be categorised as either an opportunity to see (prospect) or to hide (refuge). Appleton argues that humans are driven by a survival instinct and are therefore most attracted to environmental circumstances that potentially offer protection such as a canopy of trees, caves and water. He has further predicted that people should enjoy spaces or panoramas when we are located near the edge with our backs protected, and when we are partially covered, rather than entirely open to the sky (Appleton, 1996). According to his theory, convex surfaces suggest prospect while concave surfaces suggest refuge. Undulating surfaces are an alteration of both.

Appleton's theory was originally applied primarily to an examination of landscape paintings that emerged throughout the history of art, but other researchers, such as Hildebrand, have attempted to extend it to include the fundamental aspects of landscape architecture. Accordingly, the desire for prospect or refuge has been suggested as a factor in successful landscape design, with the use of certain techniques being said to increase viewer enjoyment. One of the most important of these for transport designers is the idea of suggesting locomotion in the imagination of the user. Appleton himself asserts that when we contemplate the pattern of communication in a particular landscape the eye tends to construct imaginary paths between its various parts. In common with Gestalt perceptual theory, Appleton contends that a road or path which dips or curves out of sight then reappears further along, suggests a continuous channel of movement even though absolute continuity cannot be perceived as the beholder's eye is led forward towards its destination.

The concept of prospects and refuges has some empirical support from de Jonge (1967) who describes an observational study of public recreation areas in the Netherlands. In this instance, researchers found that the border zones of a beach area and of a wooded area attracted greater densities of stationary visitors than the more central parts of these areas did. This phenomenon is labelled as 'edge effect' and may be explained by the need to have an unobstructed view over an open area combined with visual cover behind. Alternatively, de Jonge also proposes that the preference for edges or borders on at least two sides may arise from an unconscious desire to occupy a piece of ground that cannot be closed in by other people occupying adjacent parts of the area. The precise consequences of these findings for the design and maintenance of riding environments are not clear as there has been no comparable research involving moving cyclists.

Abello et al. (1986) found that participants, when showed a selection of scenes, had a preference for forest landscapes that demonstrated plant-fertile soil, plant vigour, some degree of pattern, and a structural legibility in winter defoliation. They concluded that these findings supported Appleton’s theory with the three former being signs of prospect and the latter indicating environmental hostility or hazard.

Among the critics of Appleton's prospect-refuge theory are those who question its behavioural foundation, particularly the emphasis on the role of hunting in the evolution of human landscape preferences. His psychobiological basis for aesthetic value has been challenged by some empirical studies. Nasar et al. (1983) examined preferences in an urban park environment and found that although females preferred an enclosed observation point to a more open one, males had a significant preference for open observation points. This finding of some participants preferring viewing points with less refuge is contrary to Appleton’s general theory and suggests that there may be other factors at work.

A few researchers have attempted to test for evidence of prospect and refuge in artistic interpretations. Heerwagen and Orians (1993) examined gender differences in declared preferences through the use of the landscape sketches and paintings of English landscape designer Humphrey Repton and iconic scenery artist John Constable. Accordingly, these findings appear to support the concept of prospects and refuges being an unconscious organising attribute.

Rod Giblett (2004) refers to elements of the prospect-refuge theory and builds on them by suggesting that the most powerful prospects have a tendency to make the land into something to be looked at by placing the subject in a position of mastery in space and time. With acknowledgement to the thoughts of Williams (1973), he contends that a sense of harmony can be achieved in the viewer when ‘working country’, such as agriculture and architecture, is combined with the natural landscape and that beauty combined with utility is a crucial desire, with the picturesque only a secondary consideration. This concept of harmony is addressed from a different perspective by Troy Parker in his influential theories of path and trail design (Parker, 2004). He describes this state as being when a path or trail seems to be part of the site and all its individual elements work together to provide that impression to a user.

Although not directly applicable to prospect and refuge theory, Giblett (1996, 2004) also addresses the topic of ruins and how they can be successful components of a visual landscape, whether they are culturally-based, such as derelict buildings, or natural, such as rocky outcrops and fallen trees. He notes the work of Malcolm Andrews (1990) who argues that ruins fascinate the viewer as they raise questions about the relationship between man and nature, the thoughts of Henri Lefebvre who asserts that the past and places leave their traces, and the work of Larzer Ziff who suggests that this fascination with ruins and fragments is the consequence of a yearning for lost wholeness. Willson and McIntosh (2007) further add to this concept by finding that heritage sites create an experiential space filled with emotional significance by enabling the viewer to use their imagination relevant to a context they are intimate with. Jones (2005) contends that when we employ imagination geographically, we rely largely on memories and that as these memories combine image and feeling, we remember reflexively the narrative of a particular event or perhaps remember emotionally when returning to past feelings.

Habitat-selection theory

Appleton and others have suggested a secondary evolutionary-based theory to explain the way in which an observer chooses to evaluate and conceptualise an environment. He hypothesises that the aesthetic satisfaction gained from a landscape stems from the spontaneous perception of features which, due to their colours, shapes, spatial arrangements and other visual aspects, act as sign-stimuli that indicate environmental conditions that are seemingly favourable to survival (Appleton, 1996).

Habitat-selection theory also includes the idea that humans have an inherent preference for landscapes that resemble the African savannah where the species is thought to have originally evolved and then migrated from. The evolution of our ancestors from tree-dwelling to ground-based is believed to have taken place near water sources in the zone between forest and open grassland (Kaplan & Kaplan, 1982). This zone could be best described as a savannah landscape and features particular tree shapes and a rich variety of animal species.

Similarly, habitat-selection theory predicts that elements occurring in environments that are rich in the resources necessary to sustain life, such as the tree shapes common to the African savannah, are particularly pleasing to humans as they signal a high quality habitat. Several studies have been conducted to test this hypothesis and consistently reported a preference for tree shapes that are spreading or globular rather than tall and conical. The former shape is reminiscent of the native tree species found in savannah environments (Orians, 1986; Sommer, 1997; Lohr, 2006).

According to the theory, good habitats should evoke positive responses and poor habitats should evoke negative responses (Appleton, 1996; Orians, 1986). Furthermore, Orians contends that emotions associated with aesthetical perception are a major component of how humans solve problems.

Information-processing theory

The cornerstone to this theory is the contention that humans will seek to both make sense of the environment and to be involved with it. The concept of information-processing arose in the middle of the twentieth century and is based around the idea that cognition is computational in nature, with the brain being the hardware and the mind being the software.

In the 1970s, American environmental psychology researchers Stephen and Rachel Kaplan began developing a model of landscape perception that drew on this initial evolutionary theory and extended its parameters to include human cognition. Kaplan and Kaplan (1982) suggest a landscape that successfully involves the viewer has four major attributes: coherence;

complexity; legibility; and mystery. These four attributes contribute to preference framework that is set in a temporal and spatial context.

They also contend that humans perceive their surrounding environment by rapidly extracting and processing information. In order to function properly and thrive, people attempt to make sense of that environment and seek involvement with it through the construction of cognitive maps (Purcell, 1992; Kaplan & Kaplan, 1989). These mental maps then directly influence how an individual interprets new encounters or experiences with the environment.

Research has consistently shown that people prefer landscapes that can be easily comprehended and also provide opportunities for involvement or the prospect of some involvement (Kaplan & Kaplan, 1989). Alternatively, landscapes that are ambiguous or overly complex are likely to be less preferred.

Specifically, the Kaplans identified two perceptual attributes (coherence and legibility) that help a person to understand a particular landscape and two additional attributes (complexity and mystery) that encourage its further exploration (Table 2.3).

Coherence refers to ease of organising details or elements of a scene to make sense of it. This might be referred to as the extent to which a scene ‘hangs together’. Mandler’s study involving recall of random word cards has shown that most people can retain up to five chunks of information about scenes in their working memory without adversely affecting coherence (Mandler, 1967).

Legibility is the ability to predict and maintain orientation within a landscape. It shares similarities with Appleton’s concept of refuge.

Complexity refers to a landscape’s ability to keep a person suitably stimulated. It is also commonly referred to as variety or richness. The Kaplans use the phrase ‘high fascination value’ to better describe this attribute.

Mystery or anticipation is the promise of more information being available to the person if they proceed further into the scene.

Among the major theories of landscape-influence, the Kaplan's information-processing idea appears to be the most supportable in terms of empirical evidence. The Kaplans themselves have conducted a range of experiments using both urban and rural landscapes as the stimuli to test the making of sense and involvement. Many of these have provided support for the premise, though it has to be noted that the nebulous nature of the concept means there is a significant amount of interpretation.

The theory has been successfully applied by other researchers in a range of studies. Strumse (1994) applied the perceptual attributes together with perception-based variables, such as openness, smoothness and ease of locomotion, and found the former attributes were the most effective predictors of preference. Herzog (1987) used the Kaplan model to analyse preferences for mountainous scenery with the addition of variables for spaciousness and texture and concluded that the couple's informational approach best accounted for the results.

Table 2.3: Kaplan information-processing variables (Kaplan, 1987)

	Understanding	*Exploration*
Immediate (the visual array in 2d space)	**Coherence** Makes sense now Orderly, hangs together Repeated elements	**Complexity** Provides involvement Rich and intricate Many elements
Inferred (future promise in 3d space)	**Legibility** Expectation of making sense in the future Distinctive	**Mystery** Expectation of involvement Promise of new information

Herzog & Smith (1988) investigated participant response to natural canyons and urban alleyways in an effort to re-examine Appleton's concept of hazard and how this related to the information-processing concept of mystery proposed by the Kaplans. They found that danger was a negative predictor and that mystery was a positive predictor.

Various sources have theorised a functional approach to landscape aesthetics. Gibson asserts that landscape perception not only deals with information about an environment, but also yields information about what possibilities that environment offers to the viewer. The Kaplans extend this concept of aesthetic functionality by defining the possibilities as two distinct purposes – making sense and involvement. Making sense refers to the inner need to comprehend, while involvement refers to the inner need to learn and be stimulated. They extend their discussion further to suggest that people prefer landscapes where there is an element of both mystery and legibility. The former does not necessarily imply novelty, or the presence of new information, but just the promise of it. According to Stephen Kaplan (1987), scenes high in mystery are usually characterised by continuity with a connection between what is seen and what is anticipated. In addition, he considers legibility to be another important aspect as it creates depth and defines a particular space, and more importantly, it involves the ability of a viewer to perceive a space as being divided up into sub-areas or regions – relating directly back to the inherent need to make sense of an environment.

Tripartite concept

Australian urban planner and academic Stephen Bourassa has attempted to bring the biological, cultural and personal aspects of landscape perception into one inclusive paradigm, theorising that all three play an important interconnected role in our overall perception of an environment. Drawing on the work of people including Russian psychologist Lev Vygotsky, Scottish philosopher David Hume and neurophysiologist Paul MacLean, Bourassa (1991) suggests that recent experiments, such as those conducted by Zajonc, have demonstrated that the primitive brain can respond to stimuli in the absence of cognitive awareness of those stimuli and that emotional response may occur separately from cognitive knowledge. He also argues that biological, cultural and personal modes of perception require a framework of aesthetic laws, rules and strategies. Gobster and Chenoweth (1989) also found that landscape preference was product of physical, artistic and psychological variables.

In an effort to establish an integrated framework, Bourassa has examined prevailing biological theories, such as prospect-refuge and information-processing, along with the cultural-stability-identity theory proposed by Costonis, and theories of creativity and its role in landscape perception. He contends that cultural and personal values are harder to measure and quantify than biologically-based preferences, resulting in a lack of understanding about how the other values contribute to the experiential interaction of the landscape and the perceiver.

Bourassa uses this tripartite framework to explain some of the findings from other researchers. For example, he suggests that the common preference found for natural environments compared to urban environments could be the result of the way these studies measure data. He contends that natural landscapes tend to be experienced predominantly in the biological mode while urban landscapes are more likely to be experienced in the cultural mode and therefore the overarching tendency for researchers to focus on the biological mode may skew any results.

While recognising the conceptual basis of the Bourassa framework, other theorists have questioned its applicability to the problem of landscape perception. Seamon (1993), for example, is critical of Bourassa on a number of counts, including a ‘bias against a formalist approach to landscape’, an ignorance of phenomenological research which is supportive of landscape contributing to the aesthetic experience, and his reduction of the aesthetic experience to the three standard dimensions of biology, culture, and the individual.

Affective theory

Affective theory considers that landscapes and natural settings can evoke emotional states of well-being in viewers and that these states can be readily detected through the use of psychological and neurophysiological measures. The major proponent of this theory has been American social geographer Roger Ulrich. Ulrich et al. (1991) asserts that immediate, unconsciously triggered and initiated emotional responses, as opposed to controlled cognitive responses, play an important role in the initial level of response to the natural environment. He equates emotional responses with affective responses and suggests a model of affective preference based on the premise that these responses to landscape occur prior to cognitive information-processing. This model contrasts markedly with the Kaplan theory of cognitive perspective.

Parsons (1991) has noted that despite a lack of empirical data supporting Ulrich's theory, the earlier sensory work conducted by LeDoux and Henry involving the effect of stress on endocrine response, provide evidence for the existence of sub-cortical hardware and processing function which, in turn, support the concept of affective response.

The Ulrich model also reverses the standard belief followed by cognitive psychology practitioners in the 1950s and 60s in which effects or emotions were regarded as being products of cognition, rather than the precursors. Using experimental evidence, Zajonc (1980) was among the first to demonstrate that individuals can make discriminations even in the complete absence of recognition memory. Following experimentation, Zajonc concluded that affect and cognition are controlled by separate and partially independent systems that constitute independent sources of effects in information-processing.

Pyramid of influences

In the 1990s, Canadian geographer Phillip Dearden (1989) developed a landscape preference model that closely parallels Bourassa's tripartite concept. Deardon has suggested a hierarchy where several variables influencing landscape preference are ranked according to their degree of potential social consensus. He theorises that all people are affected by innate evolutionary-based factors, while only particular societal groups may be influenced by certain cultural factors and individuals by specific socio-economic or demographic factors. He asserts that the choice of landscape assessment technique used by researchers needs to take into account these different levels of commonality. According to the hierarchical model, methods using a landscape-based technique are appropriate for assessing innate factors, while more subjective methods that address individual perceptions are best for assessing individual influences.

Theory of affordances

Other analysts, such as Gibson (1979), have theorised that our movement through an environment can be an important factor in how we perceive that environment, which may have particular relevance to viewers in regular motion, such as cyclists. As a person moves through a landscape, information about the surroundings flow around and past the viewer in a way that would enhance the spatial understanding of the environment (Bell, 2001). This has echoes of the state-of-flow concept proposed by Csikszentmihalyi (1990).

Gibson (1977) asserts that we do not perceive a landscape from a neutral perspective, but rather view it in terms of what information is afforded to us or what particular needs or desires it might fulfil. He calls this model a theory of affordances and suggests that environments provide different things to different people. A study of this model by Kaplan and Kaplan (1989) has extended the concept of an 'affordance' to include what the perceiver would like to do or achieve in a particular setting.

Although thought-provoking, it appears that more work needs to done to explore this concept of affordances before any valid conclusions can be reached and applied to riding environments.

Other concepts and analysis

Environmental perception involves a complex interaction of affective and cognitive responses to stimuli (Kaplan, 1987). These responses can be of a non-linguistic nature and therefore especially difficult to quantify (Osgood et al., 1957). This absence of any form of consensus among leading authorities in the field of landscape perception is problematic for transport infrastructure designers. There appears to be no formal theoretical base from which to make decisions about design aspects and those involved in the design process are forced to choose between often conflicting ideas. Aoki (1999) reviewed trends in the study of landscape evaluation during the past 60 years and found that despite no shortage of attention from researchers, there is still much debate about the most appropriate basic methodology. There is no clear definition of the concept of landscape and little progress in the development of scientific description of the associated experience. This lack of standardisation is caused by the ambiguity of the phenomenon of landscape, which originates from the developed analytical systems of the brain. Aoki advocates the development of a common and consistent scientific language for landscape appreciation, to assist comprehension and to facilitate more rigorous experimental opportunities.

As there is currently no unifying theory of landscape aesthetics, we are instead faced with a diverse range of concepts that tend to reflect the different approaches used by the various disciplines and professions involved in this field. (Zube et al., 1982). Though according to Porteous (1982), Appleton (1996) and Bourassa (1991), many of these concepts in the field of landscape aesthetic assessment are the result of strong empirical studies, they only offer limited theories to explain the research findings. Appleton in particular notes this void, urging caution when seeking to understand what fundamental factors lead people to prefer one landscape to another and suggests that a three-step approach be adopted involving the use of empirical techniques, the consideration of constraints inherent in the methodologies and the pursuit of an overall theoretical basis.

Apart from those already mentioned, there have been a number of other theories and concepts put forward regarding the perception of natural and artificial landscapes. Groat and Wang (2002), for example, argue that aesthetic experiences are part of the domain of reason, even though these experiences cannot be fully captured by formulas, words or other determinate models of communication.

Zube et al. (1982) developed a model of human-landscape interactions that offers a clearly defined framework. This model asserts that preferred landscapes:

- have a surrounding presence as they permit movement and exploration, through which the viewer can become a participant;

- are multimodal and provides information that is received and processed simultaneously through multiple senses;

- offer the viewer central and peripheral information that is received from all directions, not just where attention is focussed;

- offer the viewer information that can be incomplete, redundant, ambiguous, conflicting or contradictory;

- are not passive in that they provide the viewer with opportunities for action, control and manipulation;
- have an ambience as they are always encountered as part of an activity and have a definite aesthetic and systematic quality.

Some researchers have attempted to develop a tool for analysing landscape theory. For example, Russell (1980) has proposed a circumplex model that seeks to predict the likelihood that a person will be attracted to a particular landscape depending on the sensory information they derive from that situation (Figure 2.10). According to the model, the rate of sensory information and affective emotional response to that information determines if a person is likely to approach or avoid an environment with varying levels of pleasure. When the level of pleasure is high, a person is likely to respond to both highly arousing and tranquil environments, while the opposite is true for unpleasant environments.

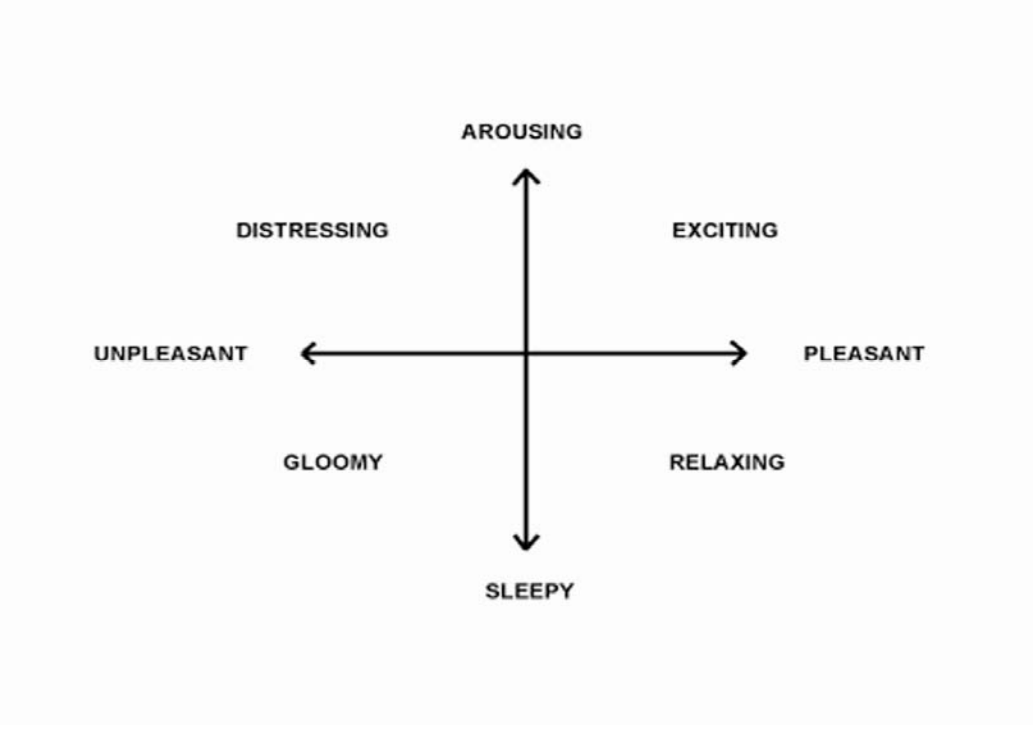


Figure 2.10: Circumplex model for predicting landscape response (Russell, 1980)

Drawing on Burke, Kant, Freud and others, Giblett (1996) proposes that our perception of landscape involves four different perspectives; the beautiful, the picturesque, the sublime and the uncanny, with each inhabiting different levels of consciousness (Figure 2.11). The beautiful refers to the small and pleasing objects within our immediate vicinity that are visual. The picturesque is also visual and refers to the mid-ground. The sublime rears in the distance and can be perceived using the eyes or ears. Rugged mountains are examples of the sublime and Giblett contends that this perspective is often the source of inspiration and a place from where new ideas emerge. The uncanny is the lesser known region behind our backs and beneath our feet which, unlike the other three perspectives, is not formally aestheticised as perception of it often relies on the non-visual senses such as smell, touch and taste. Swamps and wetlands are examples of features that evoke the uncanny. It could be reasonably assumed that many cycling routes enable riders to experience all four perspectives

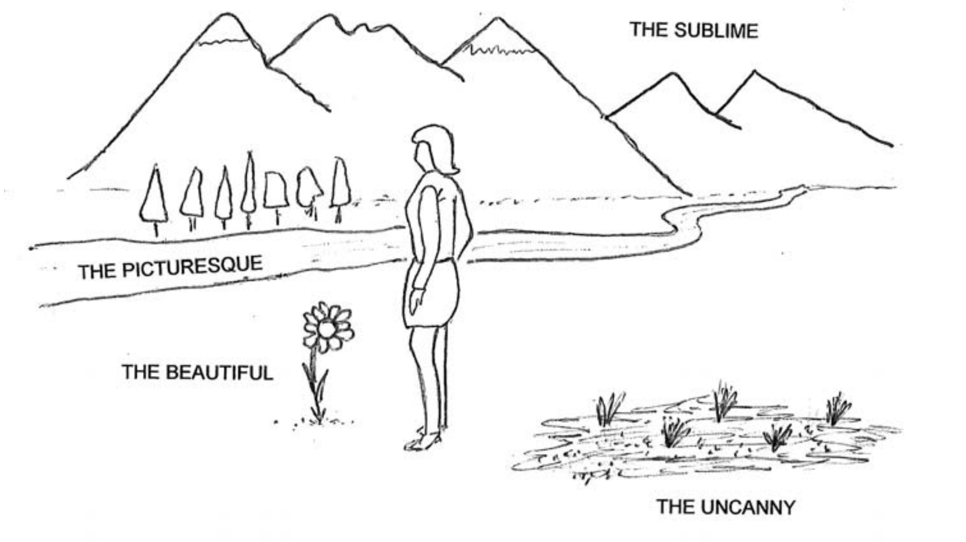


Figure 2.11: Giblett's four perspectives of landscape (Giblett, 1996)

Key preferences

A body of international research collected over time has shown that several aspects of landscape are consistently preferred by the majority of respondents. The most significant of these are discussed in the following section.

Preference for natural landscapes

Wilson (1984) coined the terms ‘biophilia’ and ‘biophobia’ to explain what he believes is an innate human affinity with, or fearfulness of, the natural world. Wilson’s theory contends that human identity and personal development is subsequently dependent upon our relationship with nature.

However, there is conflicting evidence as to whether people actually prefer sustainable natural landscapes. This has important implications for the designers of any infrastructure that inhabits a natural environment or includes a landscaping component.

Akbar et al. (2003) in a study of the assessment of aesthetic preferences of motorists in the United Kingdom determined that they overwhelmingly agree that the scenic beauty of roadside vegetation is a significant component of a satisfying road environment. This belief was particularly powerful if the vegetation consisted of a variety of species. In another study, Ulrich (1986) found that liking for highly urbanised scenes increased when trees and other vegetation were present.

Schroeder and Cannon (1987) suggest that street trees have a powerful impact on how people assess the aesthetic quality of a residential environment. Following a study of suburban tree placement, they contend that larger street trees are especially preferred by the majority of people and that street trees contribute the most to visual quality of an environment where there are few yard trees.

An earlier survey of motorists and cyclists using a road through the mountains and valleys of Washington State in the United States was conducted by Jones et al. (1976). The research indicated that specific natural elements, such as mountain peaks, cliffs, waterfalls, glaciers and evergreen forest, were rated the most highly. Less favoured were other natural elements, such as wetlands and scrubland, with anthropogenic elements such as buildings, outdoor advertising signs and railway lines being rated lowest. Although supporting the theory that people prefer natural scenes to artificial ones, this range of ratings also suggests that some natural elements have a greater positive influence on landscape preference than others. As many of the participants of this survey would be assumed to be local to the region, this finding has be taken in context with later research about familiarity with a landscape affecting overall perception.

The interesting question of what constitutes a natural scene among the general community was addressed by a study conducted in Australia by Lamb and Purcell (1990). They assessed perception of different types of natural vegetation in New South Wales and found that the height and density of vegetation influenced participants' judgement of naturalness, with the interaction of these two elements being particularly important. For example, landscapes with taller trees and dense foliage were judged to have a higher degree of naturalness compared to taller trees with a moderate cover of foliage. Open scrubland (low height and sparse cover) was not considered particularly natural even though it had been untouched by modern, industrial society. Fire damage was not found to affect perception of naturalness. However, respondents reported that even mild indications of grazing produced a significant negative effect. Lamb and Purcell concluded the study showed that ecological naturalness and perceived naturalness are not the same thing and that there are complex psychological factors which contribute to how we experience a landscape.

More recent research has contradicted this theory with findings suggesting that a large percentage of people often perceive natural ecosystems as unattractive and even scary to some extent. These individuals also show a preference for more manicured environments where the natural landscape has been deliberately redesigned (Nassauer, 1995). Riding environments can include both of types of landscape and these will be assessed as part of the research project.

A number of researchers have investigated the restorative function of natural environments. Even short exposures to parkland in urban areas, for example, can induce feelings of calmness and energy (Hull, 1992). Hartig (2005) asserts that all restoration occurs in the course of some form of activity and Hartig, Mang and Evans (1991) point to empirical studies that have shown that some of the most effective restorative outcomes are achieved when that activity is conducted in a natural environment. Cycling offers an excellent means of achieving that.

Shafer et al. (1969) used a nationwide survey of virtually presented environments in the United States to develop a formulaic model for predicting natural scenic preferences. The model (Figure 2.12) is based on a regression equation that includes the aspects of: (i) perimeter of close vegetation; (ii) area of intermediate vegetation; and (iii) perimeter of distant vegetation. From the results of the research, they concluded that four major factors invoke a positive influence on a person's perception of natural landscape. These are the:

1. Perimeters of near and intermediate vegetation;
2. Area of intermediate vegetation multiplied by the area of water;
3. Perimeter of distant vegetation multiplied by the area of water;
4. Area of intermediate vegetation multiplied by the area of distant vegetation.

Despite being relatively easy to understand and receiving wide academic support (Buhyoff et al., 1994; Real et al., 2000; Daniel, 2001) as a means of using statistical techniques to determine mathematical relationships between environmental components and the scenic preferences of observers, the Shafer model has not been widely adopted by landscape professionals for use in the fundamental design process. This may be due to the model lacking a causal link between the independent and dependent variables, or simply because it is too restrictive to be of practical value.

$$Y = 184.8 - 0.5436\,X_1 - 0.0929\,X_2 + 0.002069\,(X_1 . X_3) + 0.0005538\,(X_1 . X_4) - 0.002596\,(X_3 . X_5) + 0.001634\,(X_2 . X_5) - 0.008441\,(X_4 . X_6) - 0.0004131\,(X_4 . X_5) + 0.0006666\,X_1^{2} + 0.0001327\,X_5^{2}$$

Where: Y = preference
X_1 = perimeter of near vegetation
X_2 = perimeter of mid-distant vegetation
X_3 = perimeter of distant vegetation
X_4 = area of near vegetation
X_5 = area of visible water
X_6 = area of distant non-vegetation

The lower the value for Y, the more preferred the landscape.

Figure 2.12: Predictive model of Natural Landscape Preferences (Shafer et al., 1969)

Preference for water

A substantial number of landscape evaluation studies conducted during the past three decades have indicated that there is a strong correlation between preferred scenes and the presence of open bodies of water (Choker & Mene, 1992; Zube et al., 1982; and Herzog, 1985). This has important implications for any project seeking to understand which environments are most likely to have wide appeal.

Herzog (1985) assessed the preferences for various types of water bodies and determined that mountain waterscapes and large lakes were consistently rated highest, with structured ponds and smaller swampy areas rating significantly lower.

In an earlier survey, Hodgson and Thayer (1980) found that bodies of water that had been geographically labelled as anthropogenic (e.g. reservoir or weir) were given a slightly lower preference score than those with a natural label (e.g. lake). Nasar and Li (2004) found that a reflective surface of a water feature was more preferable than transparency. Yang and Brown (1992) determined that visible reflections of natural features such as trees and rocks on a body of water were especially preferred.

The continuous movement of water, such as flowing rivers and streams and waterfalls, has been found to be a particularly valued element when examining scene preference. Interestingly, Brown and Daniel (1991) used video depictions of a range of stream flow rates and found that participants' opinions of scenic beauty began to decrease for water courses that had very fast movement. The results indicated that the preference for water movement is finely balanced and diminishes significantly if the flow rate is too rapid (Figure 2.13).

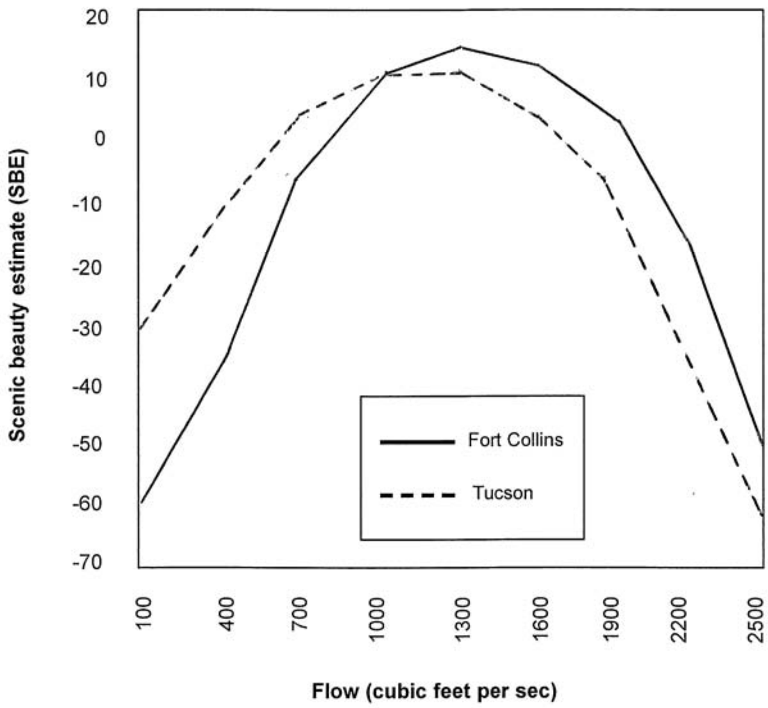


Figure 2.13: Influence of water movement on perceived scenic beauty (Brown & Daniel, 1991)

Hetherington, Daniel & Brown (1993) and Daniel (1990) concluded that experiences in natural landscapes were often multi-sensory and contextual. Specifically, they found that sound and motion appeared to be important factors in preferences, particularly when viewing riparian environments. Findings from a recent study of aesthetic responses to urban trail environments in two Texan cities suggest that the layout of these environments should be designed to take advantage of visual connections to water (Chon & Shafer, 2009).

The precise reasons for this importance of water in declared landscape preference are not well understood. Bourassa (1991) contends that humans have a biological need for fresh water and therefore have an innate preference to be close to supplies of it. Other analysts (Appleton, Gibson and Kaplan) also point to the survival enhancing qualities larger bodies of water as a source of sustenance. These contentions fail to explain why some scenes of obviously undrinkable seawater are rated almost as highly as fresh water lakes and rivers.

An alternative theory has been suggested about a general human affinity for water that has a psychoanalytic basis. Ryback and Yaw (1976) suggest that there is an unconscious desire for the pre-natal in-utero state of being surrounded by amniotic fluid and that this desire is carried through an entire lifetime. However, definitive empirical evidence for this latter theory is still lacking.

At a broader level, Kaplan & Kaplan (1989) have shown that both content and process are significant contributors to the development of preferences for certain landscapes. Kent (1993) also concludes that people travel scenic routes for what they expect to see, and for the effect the landscape has on the way they feel. Importantly, his findings point to the fact that people's preference for a particular route can be influenced by the descriptives of that route. A route that is publicised or officially designated as being scenic is then automatically considered to be scenic.

Furthermore, Kent asserts that little research has been conducted that focuses on how a driver and passengers experience the landscape. This lack of empirical analysis is even more obvious when considering the user experience of bicycle infrastructure. Kent is particularly critical of the assumptions underpinning those studies that have investigated user perception by asserting that they assume everyone sees landscape in the same way and that any preferences are uni-dimensional.

Kent conducted a study to determine the attributes and features of scenic driving routes which are most important and the reasons these roads are found to be enjoyable. Data was gathered by means of a verbal questionnaire that investigated desirable attributes, features and enjoyment, and the background of participants. He observed from this survey of transport experts and residents along scenic roads that natural features rated most highly, followed closely by cultural aspects.

In Kent's study the most important landscape feature was considered to be water (particularly open bodies of water), which supports the concept of key preferences outlined in the previous section. The other two highest rated aspects were topographic change and long views. Participants also placed considerable value on the variety resulting from a combination of natural and cultural features. Respondents indicated an ambivalence regarding single houses, but commercial establishments, signs and high-density housing were viewed as detractors to visual quality.

According to Kent, motivation for travel on scenic routes is multifaceted with motorists sometimes regarding scenic routes as an opportunity for involvement with the landscape, and at other times, as a release or detachment from normal activities. Although most of the identified features affecting driving pleasure where physical entities, participants did describe some psychological aspects of the experience such as coherence, smoothness and mystery. These have also been found to be good predictors of preference in other studies (Kaplan & Kaplan, 1989; Kent, 1989).

Kent also determined that although natural features and cultural features were rated highest in terms of overall preference, human modifications to the environment could, in certain circumstances, gain approval among participants. Examples of these approved modifications included isolated farmhouses, stone walls and landscaped gardens. Very few of these design aspects have been applied to the path or trail environment and even in the instances when they have, there has been no published research into their impact.

It should be noted that almost all of the landscape studies conducted around the world have focussed on the contribution made by specific elements or attributes to a person's preferences. While this reductionist approach is necessary to isolate and establish meaningful causal data, it fails to take into account the potential impact of two or more elements and attributes working together.

Demographic and social factors

If people's reactions to landscape are the result of active mental processing, as proposed by the Kaplan information-processing theory, then it follows that the characteristics of individual observers may potentially affect preferences (Kent, 1993). Through the use of large-scale research studies, there are social and demographic factors that have been shown or theorised to influence how landscape is perceived and evaluated. It has also been suggested that landscape preferences could be affected by moral and economic factors (Carlson, 2001) but any substantiation of that theory is currently lacking. For the purposes of this research project, the following demographic and social characteristics are considered:

Age

Several large-scale empirical studies have concluded that there are significant age-related differences in the preferences of landscapes and, that such preferences can be modified by experience over a period of time (Zube et al., 1983; Lyons, 1983; Bernaldez et al., 1987).

Bernaldez et al. in particular, conducted a study to test the responses of children to photographs depicting landscapes. They found that younger children showed less preference for poorly illuminated scenes or harsh scenes with aggressive forms than did older children. The same study examined preference for landscape diversity and revealed no significant differences between ages.

Lyons (1983) found that preference for vegetation was lower for children and elderly subjects than for college-aged and adult subjects. The coefficient of variation around the age group mean tended to decrease with age with young children being more enthusiastic and less consistent in landscape assessment than were older subjects. It should be noted, however, the differences may have resulted from the way that the various groups used the rating scale.

Familiarity

Some researchers have attempted to establish a connection between the perception of an environment and previous landscape experiences (Kaplan & Kaplan, 1989; Balling & Falk, 1982).

Lyons (1983) investigated the landscape preferences of boarding students who hailed from different natural environments, such as temperate deciduous forest, semi-desert, savannah, tropical rain forest and coniferous forest.

Results consistently revealed a higher preference for the most familiar environment.

Clawson (1966) contends that recollection of a particular environment is a major phase of recreational experiences. Hammitt (1981) suggests the existence of a tipping point of preference whereby past experiences and prior knowledge of an area may lead to heightened preference, but excessive familiarity may breed contempt and lead to a reduction of preference.

Gender

There is some evidence that gender may affect landscape preference and play a significant role in shaping a person's attitude to the natural world (Lyons, 1983; Dearden, 1984).

In contrast, Yu (1995) found in a study of participants that included Chinese sub-groups and Western professionals that gender was not a significant factor in landscape preference.

Hull and Stewart (1995) found that males and females focus on different parts or aspects of the environment around them when walking. Men were found to be more likely to view the surrounding topography and ephemeral objects than women. To date, there has been no similar study to investigate the potential differences in focus among male and female cyclists.

Education

A person's level of education may directly impact upon their perception of landscape. Yu (1995) found that a person's general education level, rather than accumulated landscape expertise can significantly influence preference, particularly if that general education has been accompanied by environmental experience.

Balling and Falk (1982) found that university students had more favourable attitudes to wild landscapes than did secondary school students, though age may have contributed to the degree of preference. Kent (1993), found in a study investigating the attributes, features and reasons for enjoyment of scenic routes that a respondent's level of formal education was a significant background variable for certain attributes. Those individuals with higher levels of education were more likely to rate scenes with anthropogenic content lower than were their less-educated counterparts.

Other researchers, such as de Jonge (1967), report a significant difference between the recreational environment preferences of white collar workers and manual workers. He notes a Dutch study of people visiting a section of open parkland that found manual workers were more likely to stay near entrances as opposed to white collar workers who had a greater tendency to wander around the entire area.

Cultural background

Some preliminary investigation has been conducted of how people from different cultural or ethnical backgrounds perceive the same landscape. Zube and Pitt (1981) for example, looked at cross-cultural differences among groups from several ethnic backgrounds.

Yu (1995) found that certain cultural factors could contribute to population variations in landscape preference.

The researcher contends that with Australia now being a multicultural society, the implications of this research for infrastructure designers are becoming more relevant.

Environmental awareness

The background of an individual may play a role in their overall attitude to natural and anthropogenic landscapes. Evidence exists indicating that professionals whose work in fields related to aesthetics and environmental, such as landscape architects, environmental scientists, biologists and park rangers, seem to weight the role and values of informational aspects of a given landscape differently from the layman and general public (Kaplan & Kaplan, 1989). For example, Nasar and Purcell (1990) found that architects' perceptions of what constituted an aesthetically-pleasing house differed from those of non-architects. In addition, Gifford et al. (1987) used the lens model

(Figure 2.5) for establishing the extent of differences between the aesthetic evaluation of buildings by architects and laypersons. Kent (1993, p.98) compared the responses to scenic driving routes of design experts and untrained local residents and found that “transport engineers and planners, evidently, did not consider experiential and cognitive aspects of driving scenic routes as important as other participants”.

The overall importance of demographic and social factors that determine landscape preference in the design of local bicycle infrastructure is debatable. On the one hand, public works such as bike paths must be built for a broad audience. All sectors of the community have paid for the facility and therefore all sectors have equal ownership rights. However, in a local context certain demographic cohorts, such as women, are underrepresented in cycling activity and targeting their specific environmental preferences during the design process in order to increase participation among the members could be seen as a worthwhile initiative.

2.4.2 Landscape design practice

Accordingly in guidelines established by the United States Department of Transportation, a landscape can be said to consist of four layers or components:

1. The underlying landform or topography;
2. The land cover itself;
3. The vegetation;
4. The manmade development.

Roads that run across the ‘grain’ of a landscape are particularly likely to cause aesthetic problems (United States Department of Transportation, 1990). This suggests that similar issues would result from bicycle paths and trails and that scoping should be conducted prior to the introduction of such infrastructure to ensure they do not clash with the existing landscape type.

Policymakers within the United States Department of Transportation have suggested that three factors contribute to the visual quality of a space:

vividness, intactness and unity. The agency has developed a simple equation based on this assumption to predict levels of visual quality for new projects (Figure 2.14).

$$\textbf{Visual quality} = \frac{\textbf{Vividness + Intactness + Unity}}{\textbf{3}}$$

Figure 2.14: Visual quality equation (United States Department of Transportation, 1990)

Each of these three factors is independent and intended to evaluate one aspect of visual quality. Vividness refers to the memorability of an impression received from contrasting landscape elements as they combine to form a distinctive visual pattern. Intactness refers to the integrity of visual order in the landscape and the extent to which it is free from visual encroachment. Unity refers to how the elements of a landscape combine to form a coherent visual pattern. It is similar to the concept of harmony raised by Parker (2004) in his analysis of trail design principles.

Use of design elements

Although there is no uniform consensus among practitioners, a high percentage of the membership of professions involved in the construction or assessment of landscape currently place particular value in five key design elements of line, form, texture, colour and scale.

Line

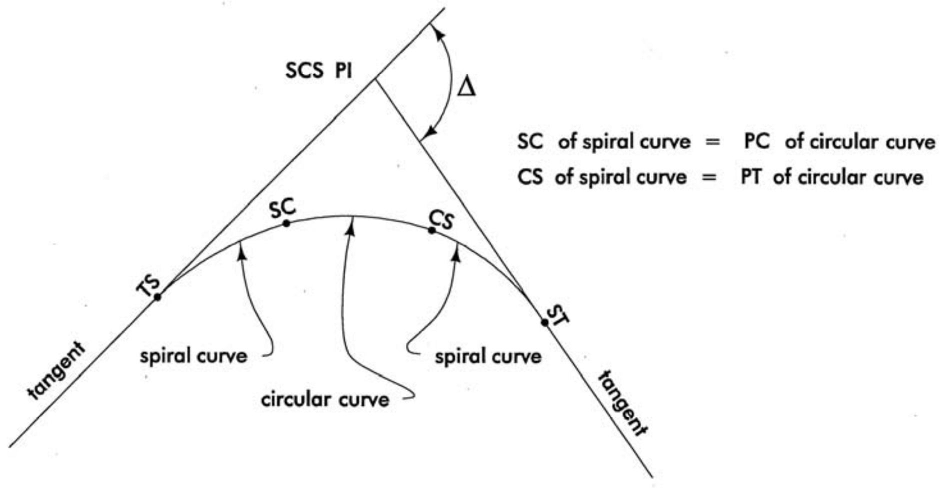
As a design element, line causes physical and/or visual movement by leading a viewer’s eye through the landscape or space (Texas A&M University, 2007). It creates order by directing sensory flow.

One method of achieving a sense of flow in a linear setting is the spiral curve. This shape was originally used in railway design during the late 1800s, eventually finding its way into the development of North American parkways (scenic highways) in the 1920s and 30s (Myers, 2004).

In the discipline of civil engineering, spiral curves (also called easement or transition curves) are used to move between a circular curve of a specific radius and degree of curvature, and a straight tangent (Figure 2.15). The radius and sharpness of a spiral curve increase uniformly along its length. In road design, the length and curvature of a spiral curve are based on anticipated traffic speed and the sharpness of the circular curve that the spiral must meet.

Spiral curves allowed faster-moving railway carriages to negotiate a simple curve without derailing. They ease the transition into the curve and help limit the full impact of centrifugal force. When employed in the constructed alignment of roads, spiral curves are thought to help make travellers feel connected with the landscape (Clarke, 1932).

Reverse spiral curves accommodate a rhythmic sequencing of views, and that stimulates driving interest and serves to keep drivers alert. Each spiral directs the driver’s attention and cone of vision to a different view. It becomes a ribbon that threads through and connects the surrounding landscape.



SCS PI = point of intersection of main tangents
Δ = total central angle of the circular curve from TS to ST
TS = point of change from tangent to spiral curve
SC = point of change from spiral curve to circular curve
CS = point of change from circular curve to spiral curve
ST = point of change from spiral curve to tangent
PC = point of curvature for the adjoining circular curve
PT = point of tangency for the adjoining circular curve

Figure 2.15: Spiral curves connecting a circular curve with tangents (Iowa Department of Transportation, 2000)

From an engineering perspective, the major disadvantage of using spiral curves is that their calculation is tedious and complicated (Zolomij, 1972). However, with the introduction of powerful computer software, this work has been greatly eased.

Certain well-established principles of landscape architecture, such as the use of spiral curves in the construction of scenic roads and parkways have been shown to demonstrate some significant influence on user experience (United States Department of Transportation, 2001).

Similarly, other long-held landscape design principles involving the use of colour, uniformity, balance, transition, proportion, emphasis, sequence and repetition are known to invoke reaction in static landscapes, such as gardens (Laurie, 1986), but have not been studied in the context of bicycle infrastructure and other flowing landscapes.

Line can also include other aspects of a riding environment, such as horizons, silhouettes, edges of areas and man-made development (United States Department of Transportation, 1990).

Form

Form and line are closely related. While line refers to the edges or outlines of an object, form relates to three-dimensional space and defines the structure and shape of an element, object or feature within a landscape. This can be the visual mass, bulk or shape of an object visible to a path-user (US Department of Transportation, 1990). A common example of form is the shape of a plant and the structure of its particular branching pattern, with the form of a tree being defined by its branching pattern and the form of a shrub by its growth pattern.

Thoughtful use of form in the area surrounding a riding environment can direct the eye to particularly pleasing features or away from less interesting elements, thereby assisting to create a better overall aesthetic experience or to construct a more meaningful space.

Texture

In design terms, texture refers to the surface quality of any feature or structure in a landscape, including natural vegetation. It can involve a physical tactile feeling, such as rough, smooth and soft, or be a perceptual response to visual differences. Unlike most of the other major design elements, texture is relative and can only be analysed by comparison between objects, by association of these objects with each other, or by distance (Texas A&M University, 2007).

For riding environments, the most obvious feature to consider in regard to texture is the path or trail surface. For maximum experiential impact, the tactile response received via the bicycle’s tyres should match the rider’s visual assessment of the surface being traversed. If only one of these factors is present (i.e. the ride is rough but the path appears smooth or the ride is smooth and the path appears rough), the riding environment will be considered to lack coherence in terms of the landscape theory of information-processing (Kaplan & Kaplan, 1982) and have the potential to be less preferred.

Colour

Light is the source of colour and the colours that people see are reflected wavelengths of that light. The human eye does not see those wavelengths at the extremes of the spectrum such as infrared and ultraviolet. It is most sensitive to mid-wavelength colours, such as green and yellow (Connolly, 1967).

Several perceptual effects are thought to influence how people perceive and evaluate colour in general and the associated aesthetic response (Hard and Silvik, 2001). Established perceptual responses, such as the Craik-O'Brien effect, the Bezold effect and Simultaneous Contrast, can have important implications for designs that incorporate colour. These become particularly apparent when considering colours in combination or in proximity to one another. On the other hand, the effect known as colour constancy suggests that almost every person has the physiological ability to consistently perceive individual colours under different levels of illumination (Foster, et al, 1997).

There have been a number of empirical studies conducted to determine colour preferences among individuals and groups. Whitfield and Wiltshire (1990) contend that preference for certain colours is subject to demographic and cultural differences. These differences have obvious implications for public infrastructure designers whose inherent task is to appeal to an entire population, regardless of each individual's background.

Hard and Sivik (2001) suggest that colour preference has less to do with the physical dimensions of colour, such as hue and saturation, and more to do with the totality of the viewing experience.

It is widely believed that colour is an important factor in the perception and enjoyment of landscapes, though the exact reasons remain elusive.

There have been numerous empirical studies conducted since the 1930s to determine colour preferences among individuals, sub-groups and populations with perhaps the most notable of these being an overview of research from more than 20,000 subjects performed by Eysenck (1941). These many studies have produced some conflicting results, though a few findings appear to be consistent. For example, males and females tend to have very similar colour preferences. Familiarity may influence an individual's preference for certain colours or combinations of colours and this perception contributes to a more favourable aesthetic response (Chuang & Ou, 2001). High saturation, or the vividness of a colour, is generally preferred across all groups. In adults, reds and blues are often found to be the most preferred hues and yellow the least preferred. The order of preference for other colours between these extremes is much less clear.

Scale

Scale refers to the size of an element, object or feature in relation to its surroundings. In the field of landscape design, scale in often inferred by the size relationship between adjacent elements, objects or features. In a similar manner to form, the clever use or manipulation of scale can direct the viewer's eye in a desired manner (Texas A&M University, 2007). For example, small shrubs located alongside a building allow the latter to dominate whereas tall dense trees will make the construction appear smaller by comparison. Riding environments, like most landscape designs, need to be designed on what is universally known as 'the human scale'. Extreme size differentials between particular elements of a landscape have been shown to be poorly perceived by respondents (Booth & Hiss, 2007). This finding reinforces the earlier discussed notion of coherence or making sense of the environment dealt with in Kaplan's information-processing theory (Kaplan, 1987) and relates to the concept of landscape 'grain' proposed by the United States Department of Transportation (1990). It may also have relevance to the theory of harmony that is discussed in the upcoming section on bicycle path and trail design.

Use of design principles

In addition to the five key elements of landscape, designers also commonly acknowledge a further seven principles: unity, balance, proportion, emphasis, sequence or transition, rhythm and repetition.

Unity refers to the use of elements to create consistency with the main theme or idea of a particular landscape. It could be said to provide the viewer with a sense of oneness and interconnection. Studies have shown that an overemphasis on the creation of unity in a constructed landscape can lead to boredom (Laurie, 1986).

Balance refers to the visual weight of the various elements of a landscape working together so that none overwhelm the viewer. Balance can be either symmetrical or asymmetrical with the former having elements repeated on either sides of an axis and the latter having equal size or weight on either side of an axis without repeating specific elements. Balance in a landscape can also be achieved using a radial theme (Laurie, 1986).

Proportion is a function of how the area, volume or height of one element relates to the area, volume or height of other nearby elements. Landscape professionals often use proportion to create specific focal points.

Often referred to as focalisation, emphasis involves the direction of visual attention to a point of interest or prominent feature within a landscape. In landscape design, emphasis is often achieved by using contrasting colours, a different or unusual line, or a plain background space. The orientation of elements such as paths or trails can lead the eye to a focal point without distracting from the overall environment.

Sequence or transition refers to the visual movement created in a landscape design and is achieved by the gradual progression of size, form, colour and texture. Examples of landscape design elements in transition are plants that go from coarse texture through medium to fine textures, or soft landscapes that go from large trees to medium trees to shrubs to bedding plants. Transition in landscape design may also be used to create depth or distance, or to emphasize a focal point (Laurie, 1986).

Rhythm creates a feeling of motion which leads the eye from one part of the landscape design to another part. Repeating a colour scheme, shape, texture, line or form evokes rhythm in landscape design (Laurie, 1986). Proper expression of rhythm eliminates confusion and monotony from landscape design. Repetition in landscape design is the repeated use of objects or elements with identical shape, form, texture, or colour. Although it gives the landscape design a unified planting scheme, repetition runs the risk of being overdone. However, when correctly implemented, repetition can lead to rhythm, focalization or emphasis in landscape design.

2.4.3 Blue Ridge Parkway – a lesson in design

In recreation surveys conducted in the United States, respondents have repeatedly ranked driving for leisure purposes on scenic roads as one of their favourite activities. North American research has also shown that the view from the road is an important factor in shaping knowledge about the environment and the imagery associated with it (United States Department of Transportation, 1990).

Wilson (1991) cites the specific example of the Blue Ridge Parkway, which explores the spectacular Appalachian mountain chain in the American states of Virginia and North Carolina, as car-motivated landscape management at its most accomplished. He contends that the Parkway's exhilarating motoring experience can be attributed to a number of strategies, the most significant of which is the road's design features and the apparent separation of productive and non-productive landscapes. Wilson asserts that these features work to organize the car occupant's experience of nature, resulting in nature appearing in front of the viewer with no apparent relation to the cultures that inhabit it, or used it in the past. To achieve this, the Blue Ridge Parkway was built as a so-called 'landscape of leisure' with both an aesthetic and economic component.

A discussion with the transportation authority in Virginia by the researcher reveals that despite its primary role as an aesthetic tourist facility, the Parkway nevertheless still provides an effective transport corridor. This has important implications for this project as some bicycle routes must fulfil the dual purpose of being an interesting recreational avenue and also a reasonably efficient commuting route.

The Parkway, which straddles the American states of North Carolina and Virginia, is widely considered to be one of the most beautiful roads in the United States (NC Natural, 2006). It was an early collaborative project among policy-makers, civil engineers and landscape architects that incorporates design elements and a process that could offer important lessons for those involved in the construction of modern bicycle paths and trails (Figure 2.16).

The route was a long-term infrastructure project begun in 1934 and not fully completed until 1987. It was born out of the New Deal policies by the Roosevelt federal government during the Great Depression that aimed to use new infrastructure as a stimulus to the stalled economy (Whisnant, 2006).

Today the Parkway stretches over 700 kilometres from Rockfish Gap in Virginia to Oconaluftee in North Carolina and it, along with the surrounding right-of-way, is a unit of the United States National Park Service (NPS) and maintained by that agency.

Figure 2.16: The Blue Ridge Parkway is considered one of the most beautiful roads in North America

On-site attitudinal surveys have revealed that the predominant category of travellers making use of the Blue Ridge Parkway are doing so for leisure purposes (Myers, 2006). This fact has obvious implications for the task of path and trail design in Western Australia as they reflect a similar user profile for most facilities with recreational riders far in excess of commuter cyclists (Zappelli & Rounce, 2009). In order to determine precisely how the Blue Ridge Parkway can provide lessons for bicycle infrastructure, it is necessary to examine what design aspects are used to achieve a successful experience and how the theories underpinning those attributes were developed.

The National Park Service had overall responsibility for the Parkway's design and construction, receiving technical assistance from DOT civil engineers (Myers, 2004). The NPR staff viewed the facility as a linear park that contained a road, rather than a road that was surrounded by a national park. Accordingly, the designers appeared to emphasize innovative ideas and not simply rely on established standards, formulae or prototypes (McClellend, 1993).

Unfortunately, there are few formal records available that detail the exact design process used in the Blue Ridge Parkway, though the extant notes and original drawings of chief designer Stanley Abbott do provide some insight. These remaining historical administrative records indicate that landscape architects were the senior figures in the project design team and this lends credence to the assertion that aspects, such as aesthetics, were at the forefront of the design process.

As the Parkway was designed in the 1930s, more recent biological preference theories from people such as Appleton and Kaplan could not have played a direct part in the original design process. It is therefore necessary to seek out earlier theories that are likely to have contributed to the overall design.

The ideas of eighteenth-century artists Edmund Burke and William Hogarth appear to have played a significant part in the final design of the route. It is asserted by Myers (2004) that the principal designer of the Blue Ridge Parkway (Stanley Abbott) was a keen student of this style, based upon his educational background. McClelland (1993) also links the Parkway's design to early aesthetic treatises that were a foundation of English picturesque theory. Although neither establishes a direct causal link between the theories and final design, the principles set forth do offer a method of understanding the road's overarching design philosophy.

A major component of this design philosophy appears to be the 'Line of Grace' suggested by Hogarth that involves a change of direction that is neither too robust nor too impoverished (Figure 2.17). To illustrate this idea, he uses the examples of a line winding around the elegant and varied figure of a cone and the serpentine surfaces, convexities, and concavities of a cornucopia (Hogarth, 1997). To date there has been no formal research conducted to confirm the existence of an innate psychophysical attraction of such alignments during any mode of human movement. However, in the early 1960s American architectural and urban planning commentator Lewis Mumford observed a universal tendency for walkers to adopt a shallow curving path as a natural line of movement when they are not confined by a structured route. To illustrate this he used the observation of people walking in snow across an open field and noted how their tracks often form an arc rather than a straight line (Goodyear, 2009, November 23).

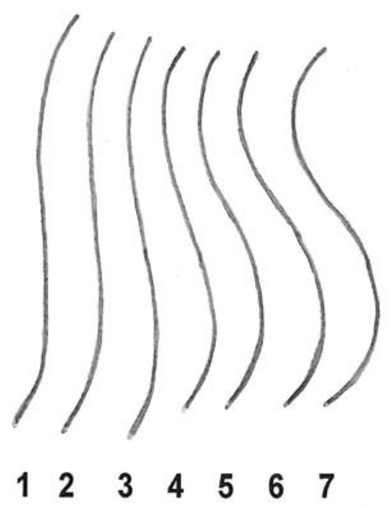


Figure 2.17: Illustrations of curving lines with Number 4 representing Hogarth's Line of Grace, being neither too robust nor too impoverished in form (Myers, 2006)

A core structural feature of the Blue Ridge Parkway is the spiral curve (also known as transition or easement curves) which was discussed in an earlier section of this thesis. When these curves are linked in multiples, the result has obvious similarities to Hogarth's serpentine ideal. According to Myers (2003), such curvilinear alignment permits a road or path to blend with its adjacent topography and keeps users engaged in the journey. Moreover, according to Myers (2004), there is no published research on the experiential effect of the curves or their effect on motorists' perception of roadway landscape.

Variety is the second major design element incorporated into the Blue Ridge Parkway. Hogarth claimed that variety was the antidote to boredom and that to have maximum impact it needed to be composed (Myers, 2004). Burke (1958) suggests that transitions between elements in a landscape should not be too abrupt because this sharpness can interfere with the melting effect that characterises the beautiful. The Parkway designers attempted to expose motorists to a changing landscape.

Motion is another principle seen by Hogarth as being important to aesthetics and likely to have been incorporated into the Parkway‘s meandering design. He uses the analogies of a ship rocking gently on the ocean’s waves and the subtle up-and-down motion of the minuet dance as examples of activated Lines of Grace (Myers, 2004). Burke argues that smooth, gentle fluctuating motion can relax a person and make them predisposed to find the surroundings attractive (Myers). Cycling is a kinaesthetically rich activity (Spinney, 2009), therefore the importance of a riding environment that produces this experiential rhythm cannot be ignored.

Connectivity of the user to the landscape may be the final key initiative designed into the Blue Ridge Parkway. This is accomplished by obscuring the boundaries between the edge of the road surface and the surrounding landscape through the use of irregular plantings and blending cuts and fills of the road construction with the adjacent topography. Native plants were favoured as they facilitated the merging of the road with the broader environment and help eradicate any distinction between right-of-ways and adjacencies (Myers, 2004).

According to Passonneau (1996), Parkways such as the Blue Ridge route have particular characteristics that users find aesthetically pleasing including attention to views, elimination of roadside advertising, and the use of berms, rather than solid walls, for noise control. He also notes the importance of edges by identifying the historical practice of framing a pathway with rows of closely spaced trees to create a fit between the infrastructure and the surrounding landscape.

Table 2.4: Respondent experience of Blue Ridge Parkway road structure (Myers, 2006 p. 45)

Question & possible responses	**n**	**%**
The curves on the Parkway road:		
1. Make me feel anxious	4	2.0
2. Make me uncomfortable but not anxious	15	7.6
3. Did not matter to me	47	23.9
4. Are pleasant	78	39.6
5. Are exhilarating	53	26.9
The parts of the road that I prefer are:		
1. Straights	35	18.3
2. Curves in one direction	30	15.7
3. A curve in one direction linked with a curve in another direction	114	59.7
All (write in answer)	11	5.8
Straight and curve in one direction (write in answer)	1	0.5
The changing alignment of the road is:		
1. Far too repetitive	1	0.5
2. Somewhat monotonous	0	0
3. Neutral	26	13.5
4. Fairly pleasant	47	24.5
5. Graceful, I really enjoyed it	120	61.5
The width of the paved road relative to the surrounding landscape seemed:		
1. Far too narrow	1	0.5
2. Relatively narrow	24	12.2
3. Appropriate	160	81.2
4. Relatively wide	11	5.6
5. Much too wide	1	0.5

The current route offers opportunities for travellers of all types to reflect on the cultural aspects that have been highlighted through the incorporation of signage, displays and visitor centres. Anyone who spends time bicycle-touring the Blue Ridge can experience a hint of the vulnerability early settlers endured in this unyielding, sparsely populated area (Skinner & Skinner, 2004).

The United States Federal Highway Administration has acknowledged that there is very little empirical information pertaining to road aesthetics (Myers, 2006). This in turn has meant that there is a lack of aesthetic theory for designers to draw upon. Accordingly, a pilot study and full study was conducted in conjunction with the University of Wisconsin to gain insight into user perceptions of the facility’s structure and applications. The results appear to provide some support to the theoretical premise of linear layout, motion and visual variety suggested by Hogarth and others (Myers).

Table 2.4 shows the results of respondent feedback about the Blue Ridge Parkway's inherent landscape variety. From the findings, there is a highly significant relationship between overall scenic experience and variety (X_2 = 27.108, df = 2, p≤.000), and between driving experience and variety (X_2 = 13.058, df = 2, p≤.001).

Similarly, the research results as shown in Table 2.5 also clearly demonstrated a highly significant relationship between preferred alignment (linked curves) and overall driving experience (X_2 = 14.962, df = 4, p≤.005). This finding appears to support the notion of the serpentine 'line of grace' being an attractive and engaging feature of infrastructure.

Table 2.5: Respondent experience of Blue Ridge Parkway road variety (Myers, 2006 p. 46)

Question & possible responses	**n**	**%**
Trees near the edge of the road are:		
1. Unattractive	0	0
2. Not very attractive	1	0.5
3. Neutral	13	7.0
4. Quite attractive	91	45.7
5. Very attractive	92	46.7
Trees near the edge of the road appear to be:		
1. Unsafe	1	0.5
2. Somewhat unsafe	1	0.5
3. Neutral	23	11.8
4. Relatively safe	84	43.4
5. Not a hazard at all	85	43.8
I find the variety of scenery along the parkway:		
1. Boring, not enough variety	0	0
2. Predictable	0	0
3. Okay	6	3.1
4. Good	29	15.3
5. Delightful, there are many different and interesting views	160	84.6
The colors and textures of the various plants I see on the parkway had the following effect:		
1. I find them distracting from my pleasure	2	1.0
2. I find them inconsequential, they don't seem to add much to the scenery	1	0.5
3. They are neutral	4	2.0
4. They contribute somewhat to my enjoyment of the scenery	43	22.1
5. They are an important contribution to my pleasure	145	74.4

Much of the Blue Ridge Parkway design was conceptualised outdoors. This is in contrast to the current practice of designing transport infrastructure from the confines of an office with only minimal site visits.

Perhaps as important as the technical design aspects incorporated into the Parkway was the working relationship between the engineering and landscape professions responsible for bringing the project to fruition. Unlike most infrastructure projects completed since, the two disciplines were on a equal footing with the project manager being a landscape architect.

The initial partnership was far from a smooth one, with the engineers wanting to separate the long route into pieces and then connect these parts. Concurrently, the landscape architects preferred a more uniform approach, perceiving the connectedness of the various road sections with each other and the surroundings (US Department of Transportation, 2001). In the end a form of compromise was reached.

Today in most advanced countries, including Australia, the profession of landscape architecture is more one of consultation than leadership, particularly for involvement with large or complex infrastructure projects. Design has become the work of separate professions, each additive and segregated. In many cases, the role of landscape architect in transport infrastructure design has been reduced to that of planting designer (Myers, 2003). This sidelining of experts trained in aesthetics in favour of functional efficiency and safety may be a major factor in the absence of roads and paths that offer appealing motoring and riding environments. A full analysis of this issue and its implications for future path and trail construction is discussed in the concluding chapter of this thesis.

Myers (2003, p.86) outlines a list of essential procedures for designing roads that successfully fit the land they inhabit. One of these mentions the need for landscape architects' involvement in road alignment and geometry decisions. If cycling is a richer experiential activity than motoring, this involvement of landscape professionals in the initial design process must surely be even more crucial for bicycle paths and trails. Infrastructure such as roads and paths no longer just lead to places; these facilities are places in their own right (Jackson, 1997).

As a major piece of transport infrastructure, the Blue Ridge Parkway remains a rarity, though there have been some smaller projects completed in the United States and around the world. Two other examples of experiential aspects being included in road design are the 20km Paris Pike in Kentucky and the Great Ocean Road in Victoria.

2.4.4. Summary

This section of the literature review has explored how and why natural and anthropogenic landscapes can have a significant influence on the design of riding environments.

While there is no single definitive theory explaining landscape preference that professional design practitioners can reliably call upon, there has been a substantial body of knowledge gathered over several decades by researchers that offers important clues for the designers seeking to create successful transport-based infrastructure.

The biological-based concept of information-processing has the strongest empirical claims. A person's apparent innate tendency to make sense of, and be involved with, his or her surroundings provides designers with a foundation upon which to build. The work of Appleton should also be considered in light of support obtained from independent studies.

The cultural and personal aspects of landscape perception are less understood and require careful consideration. Gibson's (1979) concept of affordances and its application to a viewer in motion has particular relevance for this research project. The design of riding environments that deliver stimuli in a specific manner and order is one possible outcome from this recognition of affordance.

Shafer's predictive model of vegetation placement appears to provide designers with a straightforward quantitative means of determining the most effective mix of vegetation at various distances from a path or trail. Giblett's (1996) theory of the four landscape perspectives should be used in tandem with the Shafer model, with the former relating to key landscape elements and the latter providing a broader guide.

A circumflex model for predicting landscape response developed by Russell (1980) shares much with the state-of-flow theory described in the previous section and therefore has a role to play in the development of research tools such as those used in this project.

The clear preference for landscapes that incorporate bodies of open water must be taken into account when designing riding environments that are attractive to the most number of potential users. The appeal of natural landscapes and some forms of built environment also has been shown in a number of studies, although not entirely confirmed by researchers.

As a specific landscape design principle, the line of grace has been supported by empirical research conducted among users of the Blue Ridge Parkway and deserves attention from path and trail designers.

It should be noted that much of the landscape preference research has been conducted from the viewpoint of a stationery observer. A cyclist experiences surroundings while in motion and it would be effective if some of the strong theories related to water and established landscape design principles and elements could be re-examined using a moving viewpoint.

2.5 Path and trail design

Bicycle paths and trails have not received the same theoretical and practical attention as other forms of transport infrastructure and the design guidelines currently followed by practitioners in various jurisdictions around the world reflect that deficiency.

For example, the existing Oregon Bicycle and Pedestrian Plan (Oregon Department of Transportation, 1995, p.113) states that one of the key components to a successful multi-use path is the "scenic qualities offering an aesthetic experience that attracts cyclists and pedestrians." However, the plan offers no guidelines about how to achieve those qualities or assess their effectiveness.

Similarly, the Cycle Network and Route Planning Guide currently used by authorities in New Zealand lists in order the key requirements of a bicycle route as being safety, comfort, directness, coherence and attractiveness (Government of New Zealand, 2004). Under the latter aspect, it offers a few broad ideas, such as locating some cycling infrastructure near watercourses, reserves and parks but does not articulate how, why and what extent these elements should be incorporated. Interestingly, the New Zealand guide also states that people cycling for utility reasons only achieve a very moderate benefit from routes that are experientially rich, compared to their counterparts who are riding for recreational purposes. This conclusion is reached despite an apparent lack of empirical evidence supporting the difference.

As stated previously in this thesis, the influence of bicycle facility experiential design and aesthetics has been almost completely ignored by researchers, despite its intuitive importance to patronage. Commentators, such as British urban planner Hugh McClintock (1992; 2002), have theorised that the value of well-designed bicycle paths and surrounds relies on the designer's attention to detail, yet such assertions cannot currently be supported by strong empirical evidence. The few attempts to investigate these aspects have been undertaken as part of larger cycling determinant studies, rather than as stand-alone projects, and have focussed on current users rather than potential users (Shahan, 2007). Troped et al. (2003) found that the perceived environmental variable of 'enjoyable scenery in the neighbourhood' played a significant role in transportation-related physical activity such as cycling. In a study of shared-use trails in Texas, Shafer et al. (1999) found that cyclists and walkers rated scenery as an important factor in route appreciation. A quantitative study of residents in Delft, The Netherlands concluded that the perceived quality of urban and natural scenery along bicycle routes had a measurable effect on the frequency of cycle trips (Shahan, 2007).

The following section outlines the policies and practices used by major jurisdictions when designing, constructing and maintaining bicycle infrastructure. It also explores the prominent theories and practices that have arisen in response to the growing popularity of cycling as form of recreation, tourism and transportation.

2.5.1 Current design policy and practices

The design of bicycle paths and high-standard trails in Australia can be divided into two major disciplines – the technical and the non-technical. The former is often guided by a strict methodology that is well-documented, and sometimes tightly regulated, such as urban paved paths. The latter has much less formal structure and includes many of the natural surface trails. This research project straddles both disciplines and therefore offers an opportunity to develop the tools that will allow path planners to apply a complete approach to the design process.

Paved paths

According to the widely-used Standards Australia *Guide to Traffic Engineering Practice Part 14 Bicycles* (Standards Australia, 1999), a recreational path is a facility that may be located along the coastline, a river foreshore, or a long a linear public open space corridor. These locations attract recreational users due to their scenic nature and possibly flat grades. Although provided mainly for recreational use, such paths often attract commuters during certain times. The guide states that a path designed for recreation should:

- offer an attractive and enjoyable ride of at least ten minutes duration or at least three kilometres in length;
- where possible, generally have flat gradients to better provide for children and novice adult cyclists;
- have few road crossings;
- be readily accessible;
- include such facilities as toilets, drinking water fountains, car, and bicycle parking; and

- display adequate signing to destinations, at junctions, and at points of discontinuity along the route.

The guide does not define what an attractive and enjoyable ride is or is not. Like most standards, it is devoted almost entirely to the safety, comfort or functionality of products, structures and developments. At the time of writing, Austroads (the association of Australian and New Zealand road transport and traffic authorities) is in the process of superseding the abovementioned Part 14 guidelines with an updated version of its *Guide to Road Design* (Austroads, 2009a; 2009b). However, this new set of standards retains much of the previous information and adds no experiential aspects.

Similarly, the Institution of Public Works Engineering Australia's *Local government guidelines for subdivisional development (2009)* widely used by local government technical staff in Western Australia only refers to "the provision of safe and convenient facilities for cyclists" and does not acknowledge the experiential value that such infrastructure can have.

Recently, there has been some limited qualitative research investigating attitudes to local cycling infrastructure, and this has revealed a lack of awareness of aesthetic, cultural and design aspects of paths. The Department for Planning and Infrastructure's recent review of the existing Perth Bicycle Network (Government of Western Australia, 2007) used community consultation to ascertain where improvements could be made. This consultation was based on public meetings where the participants were keen cycling activists. Not surprisingly, the outcome of the review focussed almost entirely on engineering aspects rather than on pure design aspects. Respondents themselves focussed on engineering aspects, displaying a general unawareness of the non-technical design aspects of paths and how they affect the riding experience and perception of the landscape. However, when these aspects were explained by the consultative supervisors, the respondents shifted their focus and began to take a great interest in the non-engineering design of paths. This preliminary work will be explored to a much greater extent during the data collection and analysis stage of this research project.

Forester (2006) asserts that recreational bike paths should be kept well away from parallel heavy motor traffic as such traffic degrades the aesthetic experience. However, he fails to understand that every bike path has some degree of recreational usage including those designed as commuter routes alongside major transport corridors.

A Path Environment Audit Tool developed by Purdue University for the Active Living Research Program in the United States provides an indication of how safety and function dominate the thinking of those given the task of assessing the overall effectiveness of cycling facilities (Troped & Cromley, 2005). Despite the primary stated purpose of the tool being to assist in the determination of how physical characteristics of trails may influence use, the entire document includes only one small section dealing with aesthetic interest and even this has no meaningful strategy for measurement or evaluation.

Natural surface trails

Unlike paved shared paths, there are no formal national standards for the design, construction and maintenance of natural surface bicycle trails in Australia. Informal guidelines published by organisations such as the International Mountain Bicycling Association are often used as a broad reference by local agencies (International Mountain Bicycling Association, 2007). Interestingly, there is an Australian Standard for the design, construction and maintenance of walking trails: AS2156.2. This document was first produced in 2001 (Standards Australia, 2001).

The Government of South Australia, in conjunction with a range of community stakeholder groups, has published a comprehensive set of guidelines for the planning, design, construction and maintenance of recreational trails that covers natural surface facilities for cycling, walking and horse riding (Government of South Australia, 2007). These guidelines were prepared to assist with the development of trails, with particular acknowledgement of the fact that off-road cycling is not currently addressed by any national standards. Although not currently mandatory in any Australian jurisdiction, they are used by trail planners in conjunction with other guidelines issued by mountain-biking authorities. A similar set of guidelines is being planned for Western Australia, with the South Australian model forming a template.

The South Australian guidelines state that a trail designed for recreation should:

- seek to connect places of environmental and historical significance;
- include attractions such as look-outs, existing recreational facilities and tourist-related businesses;
- where urban routes are involved, where possible, provide an alternative mode of transport;
- incorporate a sense-of-place into the design - this includes reflecting the unique features and character of an area by using local materials, interpreting the history of the area, public art, signage, furniture etc.;
- in difficult terrain, be a ‘path of least resistance’ to ensure that users do not leave the trail and form new easier routes.

Drainage is an important factor in the route choice for natural surface trails as unlike paved paths, it is often impractical or unviable to introduce artificial methods of removing excess water. Trail designers need to take advantage of the topography to improve drainage.

2.5.2 Theories of path and trail design

Designing for human perception and feelings

The relative importance of route directness to that of experiential value is not well understood by researchers. Forester (1996) contends that in some circumstances, design efforts to make cycling safer or more pleasant may lead to longer trips or greater delays. He also notes that there has been almost no evaluation of the trade-offs that cyclists are prepared to accept to enjoy a more aesthetically or experientially satisfying journey. Further on this point, Hunt and Abraham (2007) suggest that the design of cycling facilities would be significantly advanced if a full understanding of cyclist attitudes regarding trade-offs between directness and pleasantness of routes could be achieved.

The United States National Park Service trail development guidelines suggest the use of themes and sub-themes to create an optimum experience for the hiker or cyclist. The journey becomes a story that resonates with the user. It also suggests the use of progressive realisation for particular features along the route by beginning with only a faint outline and slowly moving toward refined details. This gradual and staged reveal acts as an impeller or magnet that draws the user from destination point to destination point.

Passonneau (1996) notes that although a post-war boom in the development of transport systems that can handle large volumes of traffic could, on the one hand, be viewed as a highly successful public works initiative, the design of these systems has increasingly and unnecessarily neglected aesthetics and other community values. In particular, he asserts that the fit between roads and their physical and social environments is often not even part of the design process. Passonneau theorises that aesthetic, scenic, historic and cultural values should be carefully considered in roadway design decisions in the same manner that geometric values are. He goes further by stating that design decisions embracing considerations of these experiential-based values should be seen as being a formal part of stated policy rather than a deviation from the norm.

Influential Danish architect Jan Gehl, who set out in the 1960s to examine the borderland between sociology, psychology and planning, is now considered a leader in the study of the human side of infrastructure. Gehl advocates a systematic approach that involves documenting urban spaces, making gradual incremental improvements then documenting them again (Gehl, 1971). This technique can be applied to the improvement of cycling infrastructure, and in particular, the introduction of new design elements. It could also prove useful in answering a question that landscape architecture professionals regularly deal with – how much can space be planned or designed before it becomes contrived and less effective?

Austrian architect and academic, Christopher Alexander believes that the use of pattern language can be used to design more effective transport systems. He has devised a set of rules that are invoked by circumstances and concludes that even small scale constructive elements can be viewed as part of a much larger scale landscape (Alexander, 1977). These pattern principles could be applied to path and trail design, particularly if they are viewed as being integrated elements of the entire built or natural environment.

A joint study conducted by several American government agencies in 1992 used on-site surveys to obtain demographic characteristics of mountain-bike trail riders and examine patterns of participation (Hollenhorst et al., 1995). The questionnaire-based study used open-ended items to determine responses to the reasons for participation. Results confirmed the findings of other similar studies that indicate existing riders have a plethora of reasons for riding mountain-bike trails including enjoyment, physical fitness and being in a natural environment. Unfortunately the study was limited to investigating the reasons for riding in general, rather than why certain trails or routes are preferred over others, or most importantly, what features of those preferred routes play a role in determining that preference.

Troy Parker is a pioneering path and trail designer and coined the phrase ‘natural shape’ for cycling and walking paths. His theoretical analysis of the design factors affecting human perception of a path or trail including basic shapes, anchors, edges, gateways and combinations of these elements, is cited as a reference by many planning jurisdictions in North America (Parker, 2004). In a lengthy conversation with senior management of the United States Department of Transportation, the researcher was able to ascertain that Parker is universally considered to be the leading authority on path and trail aesthetics in that hemisphere. His core theories are used extensively in the Department’s infrastructure planning and he is a long-time consultant for the Minnesota Department of Transportation, assisting with the design of that State’s path and trail networks. This outcome of this research project will greatly assist in supporting or discounting the concepts proposed by Parker that are currently being used in the development of paths and trails in some parts of the United States. Parker has also identified four key factors related to how a path or trail affects human feelings: safety; efficiency; playfulness; and harmony.

He admits that his broad design concepts, such as anchoring, edges and gateways have been adapted from several well-established principles of landscape architecture and that to date there has been no attempt to relate them directly to bicycle paths or trails using empirical data. This lack of relevant research is the reason for completing much of this project. By his own admission, Parker's concepts build upon the earlier work of architect, sculptor and a founder of the UK ecological movement, Christopher Day that involves the socially inclusive processes of place-making that lead to the creation of places that nourish both physically and psychologically.

Parker particularly notes the importance of distinguishing between feelings and opinions when assessing the appropriateness and effectiveness of riding environments. Feelings can be trusted and form the basis of legitimate decisions as people tend to feel much the same way about the same situation. Alexander (1979) contends that it can be empirically shown that a group of people can have similar feelings about a situation, but a wide range of different opinions about that same situation. This makes the use of emotion a very powerful tool in the design process. Parker also asserts that feelings should augment reason and logic rather than replacing them. He has identified a need to incorporate feelings into path and trail design in a bureaucratically palatable way and to avoid the pressure to only design facilities based on a consensus about how things should be.

Parker has developed a means of mentally testing the experiential quality of a proposed cycling route, a technique he calls 'the three stopwatches'. This involves the path designer envisaging that they are carrying three stopwatches during a journey. The designer resets the first one to zero whenever they encounter something mildly notable or interesting in the surrounding landscape, the second one to zero whenever they encounter landmark or a significant change in alignment or surface and the third one to zero when encountering major attractions that feel like destinations. Parker theorises that the more often the stopwatches are reset, the more engaging the path or trail will be.

Context Sensitive Design

A theoretical approach initially conceived by a think tank of American transportation planners in the 1990s, Context Sensitive Design (CSD) is the art of creating public works projects that meet the needs of the users, the neighbouring communities, and the environment. It integrates projects into the context or setting in a sensitive manner through careful planning, consideration of different perspectives, and tailoring designs to particular project circumstances (University of Minnesota, n.d.)

Context Sensitive Design uses a collaborative, interdisciplinary approach that includes early involvement of key stakeholders to ensure that transportation projects are not only “moving safely and efficiently,” but are also in harmony with the natural, social, economic, and cultural environments. The new infrastructure therefore fits its physical setting and preserves scenic, aesthetic, historical and environmental resources, while maintaining safety and mobility.

To achieve its potential, the initiative requires an early and continuous commitment to public involvement, flexibility in exploring new solutions, and an openness to new ideas. Community members play an important role in identifying local and regional problems and solutions that may better meet and balance the needs of all stakeholders. Early public involvement can help reduce expensive and time-consuming reworking later on and thus contribute to more efficient project development.

At a theoretical level, Context Sensitive Design promotes six key principles:

1. Balance safety, mobility, community, and environmental goals in all projects;
2. Involve the public and affected agencies early and continuously;
3. Use an interdisciplinary team tailored to project needs;
4. Address all modes of travel;
5. Apply flexibility inherent in design standards;
6. Incorporate aesthetics as an integral part of good design.

The latter principle is particularly applicable to the research aims of this project, though it is not supported by clear practical measures. This deficiency reflects the major problem with the current interpretation of Context Sensitive Design.

The United States Federal Highway Administration which has responsibility for the largest and most complex network of transport infrastructure in the world has published the following call to action:

> Citizens can demand ‘context-sensitive’ highway solutions (CSS) from their state department of transportation (DOT) to ensure that all road design considers an area's built and natural landscape; takes into

> account the environmental, scenic, aesthetic, historic, community, and preservation impacts of a road project; and provides access for other modes of transportation such as bicycles, pedestrians, and mass transit (Context Sensitive Solutions, n.d.).

Although the overall concept is sound, it remains a broad paradigm with limited use because it currently fails to provide with path and trail designers with specific methods and guidelines for achieving effective designs on a day-day to-basis.

In addition, there has been an increasing trend toward a centralised design approach rather than a site specific one. In the field of bridge construction for instance, design aspects such as cambers, super elevation, sight lines, drainage, safety barriers and other requirements have encouraged this move toward a one-size-fits-all model (Government of New South Wales, 2003a).

Designing for the senses

Sensory design is the concept of designing recreational environments based on imaginative approaches and finding ways of concentrating or stage-managing events and experiences (Shire of Nillumbik, 2007). It is one of the few theories that begin to address the multi-sensory nature of cycling (Stripling, 1995) and the role that carefully planned paths and trails can play in creating a meaningful riding experience. Only a small number of sporadic attempts have been made by authorities around the world to produce design guidelines for roads, paths and trails that address sensory stimulation.

In the early 1980s, staff of the United States Department of Transportation (1990) developed a publication entitled *Visual Impact Assessment for Highway Projects* to provide guidance in analysing and quantifying visual impacts for highway proposals. Despite being almost three decades old, this remains the standard methodology used throughout the country to identify visual impacts for highway improvements. The guide is also used extensively by trail building authorities such as the United States National Park Service and various States. It has never been evaluated for effectiveness though the US Transportation Research Board has recently indicated a desire to do so.

The Ministry of Transportation in the Canadian province of British Columbia has also attempted to quantify the visual impact of roadside environments. It should be noted that the agency has stated that this methodology is as much about road safety through the prevention of driver boredom or monotony, as it is with the provision of aesthetically pleasing motoring environments (British Columbia Ministry of Transportation, 1991).

A practical outcome of this quantification is the Ministry's aesthetic design manual for engineers that provide the following methods of stimulating driver interest:

- Varying the alignment style of the road between tangential and curvilinear alignments;
- Changing the cross section of the road, by adding a median, or by creating a split level section;
- Accessing views from the road. These may be appreciated while driving the road, or may be accessed by pullouts or rest areas. This requires careful alignment decisions, and selective vegetation removal;
- Focusing tangents on natural and created landmarks;
- Providing interpretive signage and related rest areas;
- Providing direct access to roadside trails, bikeways, parks, and picnic areas;
- Providing roadside rest areas and tourist information centres;
- Providing access to commercial facilities - villages, service stations, tourist attractions and accommodations;
- Careful design of bridges, tunnels and overpasses, and means to stop to appreciate these structures;
- Aligning the road to move into a different landscape unit, thereby creating a change in scenery;
- Manipulating roadside vegetation and planting to create interest - leaving stands of trees in the median, feathering the edges of clearings, or installing accent plantings;
- Accent lighting for bridges, tunnel portals and roadside waterfalls.

The checklist is largely based on trial and error rather than the results of empirical studies. However, it does provide road designers with a tool with which to assess the aesthetic potential of new motoring routes.

Although now jurisdiction has developed a dedicated aesthetic design manual for bicycle infrastructure, some work has been done at a broader multi-sensory level. The Sensory Trust in the United Kingdom has developed a measurement system for quantifying environmental experiences of a site called the 'rich-dreary spectrum'. It is primarily a set of guidelines for creating a more inclusive recreational environment for people with some form of physical impairment. However, the concept offers some useful insights that can be applied to facilities for general public.

In a further step, some Australian path and trail design authorities such as the Shire of Nillumbik in Victoria have begun to advocate the concept of sensory mapping using a data collection form originally developed by The Sensory Trust (Figure 2.18). Although basic, this form enables a designer, planner or researcher to assess what a particular site has to offer in terms of four senses of touch, sound, sight and smell. It also enables the recording of other feelings that a space evokes. Assessment includes:

- stopping at a point where something catches your interest or designated points on the map;
- recording this interest and then scanning the spot for other things of interest (hits);
- writing each hit on the form and marking a dot on the sketch map for each hit;
- upon completing the scan of this area, writing the location in the left hand column and drawing a line under that area group.

Location	Touch	Sound	Sight	Smell	Details	Comments

Figure 2.18: A basic sensory mapping form (Shire of Nillumbik, 2007)

Greenways

Greenways can be thought of as natural and human made linear corridors that provide connections for non-motorised traffic between places and people (Little, 1990; Amati, 2008). These convivial travel routes are developed in an integrated manner with the application of sustainable transport principles (The European Greenways Association, 2009). They can be simple open spaces incorporating isolated cycling and walking paths and trails, or form part of a wider network of these facilities. The policy imperative guiding the provision of greenways are best summed up in the United Kingdom's Sustrans Connec2 and Greenway Design Guide (2009, p.39) which lists the following functions:

- being a place, free from traffic, to learn to cycle again;
- delivering a high profile route which raises the status of walking and cycling;
- focussing popular usage so that walkers and particularly cyclists, are visible in large numbers, and as a consequence acting as a catalyst for change, as decision makers appreciate that the public will cycle if given half a chance;
- creating routes of particular value to the elderly and those with disabilities who may be unable to cope with either traffic or rough field paths;
- being a public place where it is natural to travel with strangers, to meet, stop and talk - to be a democracy;
- being a linear park giving local access to a large number of people;
- forming a wildlife corridor giving access to the countryside and linking with any number of pockets of interesting natural areas.

The United Kingdom's National Cycle Network includes numerous urban and rural greenways. In the rest of Europe, there is a comprehensive system of greenways being developed under the umbrella of the Eurovelo Network. North America has a long tradition of maintaining natural heritage for public benefit, though the idea of developing specific ecologically-based riding and walking routes in urban areas has only been recently embraced by planners.

Many jurisdictions in Australia now feature some form of greenway. For example, the City to Sea route that provides a riding environment from the

Perth central business district to the Indian Ocean is a linked series of paved paths that have been deliberately chosen as they either travel through or alongside parks, reserves or areas of urban bushland. The route is intended to immerse the cyclist in a continuous green experience, even though for much of the way they are travelling through what is an inner city suburban area. At the time of writing, no user-evaluation of the City to Sea route has been conducted by the Western Australian authorities.

Although the first planned greenways were established several decades ago, there has been little formal assessment conducted elsewhere in the world of their impact on community behaviour. In particular, Chon and Shafer (2009) assert that the human perception of greenways requires further academic study in order to fully explore their potential. With respect to the achievement of successful trail layout and design, they identify a current lack of knowledge about how potential users perceive these facilities and the factors that encourage or discourage usage. Chon and Shafer have begun to rectify this knowledge gap by recently conducting a web-based perceptual survey of greenway environments in the American cities of Houston and Austin. The results of this research indicated that the dimension of pleasantness had the greatest influence on preference and that a low level of anthropogenic features in an environment did not reduce that preference.

Chon and Shafer also found scenes that placed the greenway user close to roads were scored low in overall likeability, naturalness and distinctiveness, even though the study used photographic stimuli that did not convey aspects such as noise, movement and fumes. For the purposes of path placement, it would be helpful to know the minimum distance from a road at which this negative effect begins to fade. Further detailed research to test and ascertain this distance, or apparent distance, is therefore strongly suggested by this researcher. Although an important first step in the study of aesthetic perception of greenways, this study is limited by a reliance on surrogate visual stimuli. The researchers themselves acknowledge that in-situ experiments that include a wider range of sensory experiences may offer deeper insights into environmental perception.

Concept of playfulness

During his analysis of path design, Parker (2004) has coined the phrase playfulness and theorised that it is the factor that helps balance efficiency and safety, thereby characterising it as one of the most important aspects of recreational trails.

Parker defines playfulness as one or more of the following:

- Anticipation, excitement, curiosity and surprise;
- Peacefulness;
- Quirkiness and
- Contrasts between physical sensations (sight, sound, smell, touch, climbing, dropping and turning).

A key to achieving playfulness is appropriate timing, rhythm, and flow between sensations through different sensations occurring at a comfortable rate, not too fast or too slow for expectations.

Solnit (2000) contends that the best landscapes for walking incorporate aspects such as labyrinths and mazes to avoid boredom by fostering interplay between the body, the imagination, and the world around. It seems logical that effective cycling landscapes would achieve the same outcomes though with consideration given to the faster pace of the activity. This also appears to echo the concept of playful riding environments.

Gardner (1998) notes that qualitative studies have shown that the mountain bike has re-involved lapsed childhood cyclists, indicating that playfulness can be a powerful motivator.

Although not directly considered by Parker, his concept of playfulness could also be extended to include the introduction of fun to an otherwise sterile functional environment. In 2008, a practical example of this concept was initiated at a subway station in Stockholm, Sweden. Observational research conducted by staff of an advertising agency indicated that at locations where patrons had the choice of using stairs or an escalator to move from the platform to the street above, 80 per cent chose the latter. A technical team spent an evening installing pressure sensors on each tread of the stairs and then coloured them to look like a piano keyboard. The sensors were connected to a sound system which played musical notes as people moved from step tread to step tread. The initiative resulted in a reported increase of 66 per cent for people choosing the stairs instead of the escalator prior to the experiment being dismantled (Miller, 2009). Due to the location of the feature at a busy transport hub, it is likely that many of the people enjoying the musical stairs would have been commuters.

Concept of harmony

Parker (2004) further contends that successful riding environments must evoke a sense of harmony, which appears to be closely related to the state of flow theorised by Csikszentmihali (1990) in which harmony is achieved within an activity when the factors of attention, motivation and situation meet.

Parker asserts that harmony in a riding environment is not about being smooth, new or pretty. Instead it involves the creation of a comfortable and stable experience where physical and psychological forces support and enhance the interaction between the path or trail, the overall site and its current usage. This notion of stability requires that a riding environment be in a form of emotional equilibrium.

He also contends that the most harmonious riding environments achieve success by allowing the surrounding landscape to do much, or all of the work. In the context of infrastructure development, this philosophy means that a path or trail needs to seem to be part of the site rather than seeming to have been imposed upon it by outside forces. Parker extends his theory to include the concept of ‘leakage’ of unresolved forces causing disharmony in a riding environment. In specific terms this leakage can result from poor initial design decisions, or subsequent alterations, such as the introduction of disruptive elements such as path surface repairs that do not fit with the original infrastructure. If these fixes are partial, unintegrated or lacking grace, they call attention to themselves and detract from the riding experience.

A much earlier concept that needs to be addressed under this sub-topic is the Chinese philosophy of Feng Shui, which involves the balancing and creation of harmony with the surrounding environment through the harnessing of energy called chi. A key element of this process is achieving the successful location, orientation and composition of manmade structures, such as buildings, roads and paths.

The theory and practices of Feng Shui are often classified according to two distinct schools of thinking: Compass and Form. The latter school is considered to be more scientific and is therefore the preferred method used by building and landscape professionals for analysing an environment. The Form School is based on the understanding of physical configuration of geographical features in a built environment, and these principles can be applied at a macro level, such as the design of a city and selection of site, or at a micro level such as the orientation of building and interior layout of an interior (Mak & Ng, 2004).

While some elements of Feng Shui are included in the formal civil engineering university curricula of a number of nations in Asia, the profession in Australia does not currently treat the subject seriously and it rarely receives consideration in the design process. This presents an obvious issue for the construction of any infrastructure that relies on decisions of user-choice such as bicycle paths and trails. Regardless of the beliefs of the designer, if a potential user adheres to the theories and principles of Feng Shui, their decision to use or avoid a particular path, trail or route will be influenced by infrastructure design and the experience it delivers. Residents with an Asian background and tourists from that part of the world may prefer one path, trail or route over another, based on their particular cultural experiential outlook. Govert (1998) contends that the art of using Feng Shui in the making of paths and trails requires an exploration of the connecting filament of a series of experiences. It involves tuning the effects of a series of places to a string of positive place influences.

According to Parker, modality, or the way we move, appears to significantly affect how much harmony we feel. He asserts that harmony is a user's feeling of overall appropriateness, or more precisely, the path or trail being comfortable in its site.

Concept of mystery

Mystery, in the context of path and trail design, is the use or display of any feature that arouses curiosity and provokes the rider to seek more information. Mystery suggests the potential for exploration, either because of the variety of elements or because of the cues that imply there is more to be seen (Kaplan et al., 1998; Herzog, 1986).

Common methods of achieving a degree of mystery in path and trail infrastructure include curves in the path alignment that restrict extended sightlines, a vista partially screened by vegetation, topographic variations, natural and artificial gateways, and differences in light intensity achieved by filtering from the surrounding landscape (Figure 2.19).

Figure 2.19: Kaplan concept of mystery in a path (Myers, 2004)

Following research using scene perception, Stamps (2007) concluded that the experience of environmental mystery was a product of several factors. Three experiments designed to establish the basis of the phenomenon were conducted with totals of 145 respondents and 33 scenes. Light had the largest effect on mystery, followed by occlusion of both vision and locomotion and occlusion only of locomotion. Stamps theorised that mystery might be a function of vision, not of locomotion. Overall, depth of view had a very small effect on mystery, but effect of depth on mystery was higher at shorter ranges than at longer ranges, suggesting that distance from observer to occluding boundary might be an influential covariate in environmental mystery.

According to (Gross et al., 2006), a sense of mystery can be produced by the use of concepts that do not rely on aesthetic or visual cues. The authors suggest that a feeling of mystery can be evoked through the use of enticing path and trail names, stories of artefacts or historical events relevant to the location, and descriptive signage. Non-visual sensory cues such as the fragrance of an unusual blossom or the distant sound of rushing water are also suggested as means of achieving mystery in riding environments. Giblett (2004) asserts that unexplained visual cues, such as ruins located in proximity to a path or trail, can achieve a similar response. This effect is particularly strong if the explanation is revealed slowly over time rather than in a single visit.

Kent (1989) concludes that mystery can be a useful element in the interior built environment, as well as the outdoor environment. A study of visitor behaviour and preferences in shopping malls revealed a correlation between design-induced mystery and shopper preference. Kent found that participants responded positively to such design initiatives as screening, spatial definition and differential lighting in a similar way to that reported in studies of natural environments. Kent concludes that when landscape elements are arranged to produce a view that evokes mystery, the user's desire to be involved in the landscape is increased along with the preference for that landscape. This has important implications for this research project as some aspects of path infrastructure involve close alignment with the urban built environment.

Similarly, the introduction of uncertainty into an environment can induce a sense of intrigue and a heightened awareness of surroundings on the part of a traveller (Engwicht, 2005). Engwicht uses the example of a high-speed freeway which has been designed to remove the "unpredictable" from the driving environment. He observes that this deliberate reduction of uncertainty can over time dull the senses of the driver and put them into a monotonous head space devoid of spontaneity. This has obvious safety implications, but also determines how the driving experience is perceived.

Herzog & Kirk (2005) sound a word of caution for the use mystery in path environments by concluding that in certain specific settings, it could promote the concept of danger and this would have a negative impact upon overall preference.

Concept of narrative

An aspect not addressed by path design theorists such as Parker is the notion that cycling and walking routes can possess a formal or loosely constructed narrative that impacts upon the user. Within a primary story there are countless sub-themes around which a riding environment can be designed (United States National Park Service, 2001).

Little immediate academic study has been conducted into the narrative function of bicycle infrastructure. However, in his analysis of the narrative of roads, Edensor (2003) infers that space is invariably storied by its 'situatedness' amidst a sea of imaginative associations (both material and social), regardless of whether it is familiar terrain. Edensor suggests that all journeys resonate with the memories and experiences of previous and future journeys. He argues that car travel should be conceptualized as a defined experience of place and that even those routine or regular journeys, by virtue of their being performed as second nature, free up the user's experience to other stimuli or provide repetitive sensual, imaginative and spatial comforts.

Edensor also asserts that British motorways have been distinctly underrepresented within popular culture despite the fact that there are many words and stories surrounding them. A similar assertion could be made about bicycle infrastructure throughout the world. Jackson (1997, p.253) succinctly sums up this notion by stating that: "the road offers a journey that could end up allowing us to discover who we are and where we belong."

Another theory that originated from research conducted into the design of shopping precincts could also have relevance to the layout of cycling routes. The concept of 'cumulative attraction' involves the assertion that the appeal of two or more moderate attractors along the same route or in the same general area are a much stronger inducement to patronage than only a single large attractor (Lue et al., 1993). From a design perspective, this use of multiple elements or features in a linked narrative, rather than the inclusion of one major drawcard, could be a more feasible solution in cost/benefit terms.

The researcher contends that when designed correctly, bicycle paths and trails can be an ideal means of creating a specific geographic cultural narrative. This narrative may take the form of an evolving journey incorporating individual points-of-interest, or a holistic experience where the route itself has significance. The ten-kilometre William C. O'Neill Bike Path in the American State of Rhode Island is an example of the former, linking the cultural resources of several historic villages. An example of the latter is the recently completed Nawiliwili to Anahola Path on the Hawaiian island of Kauai. This path follows the coastline and attempts to engage the user in a cultural experience that includes indigenous customs and history. The Kauai facility is described in more detail in the subsequent section on public art.

Pikora et al. (2003) provide a broad overview of the potential aesthetic environmental factors that could influence cycling participation rates. They identify the current absence of empirical research to explore these factors and also the need to create a coherent framework in order to adequately coordinate this future research. Pikora et al. have developed a basic draft conceptual framework for the specific behaviours of cycling for recreation and cycling for transport for use in the conduct of in-depth interviews and a Delphi study using a group of international experts aimed at clarifying the factors that could influence cycling. Despite some attention being given to environmental aesthetics, this framework has little usefulness because of the current lack of knowledge about how and why experiential design aspects affect rider preference. However, the findings emerging from this thesis may enable Pikora et al. to repeat the exercise at a future date.

2.5.3 Elements of path and trail design

The following section investigates the various experiential elements and features that are currently used in the design of bicycle paths and trails. It should be read in conjunction with the findings of a worldwide search for design ideas documented in section 3.3 Choice of Stimuli.

Technical features

Surface

The texture, colour and firmness of a path or trail has been shown to have an experiential effect on riders and play a role in determining preference for a particular riding environment (Gobster, 1988). Locally, a survey of mountain-bike trail users in Western Australia revealed that a firm surface was preferred by a majority of riders (Goeft & Adler, 2000). During a quantitative investigation of greenway path environments in Texas, Chon and Shafer (2009) found that a smooth path surface was preferred by the majority of participants. Gobster (1995) reached similar conclusions though noting that trail surface preference varied according to user type. By contrast, other studies have indicated that a rough textured surface provided a more favoured riding environment for most participants (Refs).

It needs to be noted that the Chon and Shafer study mentioned above used a visual surrogate platform to deliver the environmental stimuli. Appreciation of surface texture relies on direct sensory feedback and is difficult to replicate in a two-dimensional visual format, such as photographs or video.

To ensure efficacy, this research project incorporates both in-situ and photo-surrogate routes in the experiential assessment phase to provide a variety of path surfaces to which participants will be required to respond.

Alignment

Despite the fact that attitudinal surveys have shown a clear preference for meandering riding environments over straight or very windy riding environments (Still et al., 2007; Figure 2.3), the actual psychophysical effects of bicycle path or trail alignment (its meander and undulation in the horizontal and vertical planes) on the continuous riding experience is poorly understood and has not been the subject of any empirical study. Although some previously mentioned work has been undertaken in which alignment is used in conjunction with other aspects, such as vegetation, to induce certain environmental characteristics, such as mystery, the psychological and physical impact on a rider of negotiating curves and undulations themselves remains unknown (Figure 2.20).

Figure 2.20: The comparative psychophysical effects of straight and curved alignments is not well understood

The deliberate incorporation of spiral curves in the layout of other transport-related infrastructure such as tourist parkways has occasionally been achieved, with commentators suggesting that they promote greater connection with the landscape and set up a visual rhythm (Myers, 2006). It has also been theorised that there may be an evolutionary basis leading to a preference for meandering routes as straight lines are rare in nature (Parker, 2004). However, no hard data has been collected that would allow researchers to establish how and why the use of these features can effect motorists' perception of the roadway landscape and the overall driving experience. Despite this lack of empirical support, various path-building authorities have written these alignment aspects into policy.

Similarly, path and trail alignment is a technical aspect that is not only determined by fixed parameters, such as topography, but can also be a voluntary design feature introduced at the early planning stage. Accordingly, this research project will seek to begin an exploration of the extent to which the designed alignment of a path or trail can influence user preference. For example, from *Recreation Trail Design and Construction* (Rathke & Baughman, 2009) published by the University of Minnesota comes the following statement:

> Incorporate curves and subtle bends into the trail design to increase user interest and promote an atmosphere of remoteness. Straight sections

> rarely should exceed 100 feet. This rule may be broken when trails cross open fields, motorized roads, waterways, or potential hazards. Trail users may become lost or leave the trail when crossing an open field. To avoid these problems, select the most direct route, or parallel a woodland edge or fencerow.

The United Kingdom's National Cycle Network is an ongoing project coordinated by a not-for-profit agency called Sustrans. The design team responsible for developing the network has recognised the experiential deficiencies arising from these very straight alignments. To add interest to Network routes that incorporate rail trails, the designers have attempted to move the path from side-to-side as much as possible to break up long forward views (Sustrans, 1997).

The City of Omaha in the United States recently opened a cyclist/pedestrian bridge over the Missouri River that links Iowa and Nebraska (Figure 2.21). The 900 metre-long bridge and associated path infrastructure uses a unique design incorporating sweeping curves. This meandering alignment was chosen by the design team because it offered a continuously changing riparian vista that is, unlike motor vehicle occupants, important at the time scale of someone who is cycling or walking. It also serves a second purpose of reducing the incidence of speeding cyclists by slowing their progress (personal communication).

Figure 2.21: Model of Bob Kerrey Pedestrian and Cyclist Bridge and associated path spanning the Missouri River that links the states of Iowa and Nebraska (Courtesy of Iowa Department of Transportation)

The experiential affects of changes in vertical alignment such as undulations also need further investigation by researchers. Troped et al. (2001) concluded that environmental barriers, such as hilly terrain can affect rail trail usage, though they noted that the psychophysical nature these factors is not well understood. This means that path and trail designers may need to consider the location and frequency of these environmental barriers, but must do so without knowing why or to what extent.

Furthermore, the designer’s concept of ideal placement, frequency and size of meanders may not match the perceived ‘desire line’ of the path or trail user, who may create their own shortcuts rather than slavishly follow an unsatisfying alignment.

Anchors, edges and gateways

In terms of path and trail design, an anchor is any distinct vertical feature visible to a rider. Its effectiveness is directly related to how well it can hold that rider’s attention, and to what extent the site reacts to it (Parker, 2004).

Figure 2.22: This rocky outcrop makes a strong anchor because it forces the path to wrap around it (Parker, 2004)

Research has shown that people are particularly drawn to natural anchors, such as trees and rocky outcrops, though in certain circumstances manmade features, such as retaining walls, can perform a similar role. Parker suggests that anchors with a natural shape, such as trees, that are wider near the base than the top, are more attractive and stable than anchors which have a defined shape such as buildings. He contends that this preference results from the tree having a natural feeling of stability due to the wider base, as well as natural shape in the vertical dimension.

Parker also asserts that the effectiveness of an anchor as a path feature is often determined by its relationship to the landscape it occupies. The more distinctive an anchor is due to its contrast with the surrounding environment e.g. a lone tree in an open area, the greater its potential drawing-power for the viewer. This power of attraction is maximised if the anchor is incorporated into the path or trail site. The most obvious example of this incorporation is if the anchor forces the path or trail to change direction (Figure 2.22).

In pure engineering terms, many anchors are at best unnecessary or barriers to efficiency, and at worst, hazards. This makes their use in riding environments a potentially contentious point among design teams.

In a similar manner to anchors, the edges between different features or elements in a path or trail landscape can attract and hold the attention of a rider. According to Parker (2004), examples of edges that can occur in these circumstances include the border between meadow and forest, land and water, walls and floor or even in distant features, such as mountain ranges and valleys.

Parker suggests that the attraction of edges is similar to anchors in that both rely on contrast to be experientially effective. He also asserts that being on a path or trail that follows an edge can allow the rider to experience the realms on both sides, with the most powerful response coming when there is a sharp contrast between the two sides (Figure 2.23).

Figure 2.23: Path built on a causeway beside Loch Venachar in Scotland creating a sharp contrast between realms (Sustrans, 2009)

There is some limited evidence to support these assertions. North American research into the effect of landscape variables on pedestrian perceptions concluded that ‘edge of space’, or a defined sense of spatial sequence (a well-delineated edge of a path), was a crucial factor in whether a walking environment was highly considered (Naderi, 2003).

This apparent human preference for a defined boundary may be a practical example of prospect-refuge theory (Appleton, 1996) that was attributed to the findings from a Dutch study of recreational area usage (de Jonge, 1967).

A third technical design feature championed by Parker is the concept of the gateway. These can be either natural or anthropogenic in origin (Figure 2.24), and are formed when a path or trail is constrained on two or three sides (left, right and/or above). Gateways can be as simple as a squeeze point created by a couple of trees, or have more complexity, such as a structured arch.

Although they can sometimes perform the function of an anchor in a path environment, gateways are more often involved in providing riders with a sense of passage and distance. Parker reminds us that gateways are used extensively in architecture and that their usefulness extends to the design of landscapes. Some forms of engineering infrastructure, such as bridges, also perform the function of gateways.

Parker theorises that gateways appearing in riding environments are at their most effective if they require a rider to adjust their travel. Furthermore, he believes that they have a psychological aspect and uses the example of a gateway near a parking area that makes it easier for users to adapt from a ‘car world’ to a ‘bicycle world’. A similar theory of transition is also suggested by Herzog (1989).

Figure 2.24: Artificial gateway provides an entrance to the Old Town Trail in Fresno, California USA (Courtesy of Caltrans)

Signage

Although it is a core informational component of any path system, signage can serve a dual purpose by enhancing the aesthetic, experiential and cultural appeal of a particular location or route. Accordingly, the placement, design and delivered message of path signage should be part of the initial design of a riding environment.

Figure 2.25: Directional path signage in the City of Melville that incorporates trip attractors

According to the Greater Shepparton Bicycle Strategy used by that jurisdiction in Victoria (David Lock & Associates, 2005), good bicycle path signage can assist people to move through their surroundings and get more from the experience of that movement by providing:

1. information that enables people to get to their chosen destination and understand the commitment they need in terms of time and effort;
2. information that enables people to get more from their journey, either by diminishing risk or allowing an appreciation of the surroundings;
3. features that contribute to the quality of their surroundings in their own right.

Bicycle path signage should ensure people have access to the information they need and also ideally contribute to the experience of the journey, irrespective of whether the information provided is useful to them.

Public art

Opportunities to increase the use of a trail should be considered, including the installation of public art, such as sculptures or murals (Government of South Australia, 2007). The main objective of site specific public artwork is to: provide rhythm and points of interest; mark-out intervals; create memorable routes that users will want to revisit; and offer historical and geographical interpretation to enhance users' knowledge of a particular location (Sustrans, 2009).

There are a number of involvement levels for public artwork in the design of path and trail routes. These levels include:

1. located so that it can be viewed at a distance from the path;
2. located adjacent to the path;
3. forming a part of the path structure;
4. featuring the path itself as a complete work of art.

The first of these levels relies on the ability of the path or trail designer to produce an alignment that enables users to experience the remote artwork. One method of achieving this is by having the path lead directly toward the feature before slowly veering away, thereby keeping it within the sightline of a rider for an extended period of time (Figure 2.26). Smaller works of art can be located next to sections of path such as the indigenous representations found in Maylands, Western Australia (Figure 2.27).

Figure 2.26: Modern art adjacent to a path in Burswood, Western Australia

Figure 2.27: Public artwork alongside a path layout in Maylands, Western Australia

A more recent innovation in path and trail development has been the incorporation of artistic or cultural items within the confines of the infrastructure itself. Often the decision to include such features needs to be made at the initial planning stage and involves the creation of items specifically designed for a location. The use of such artwork can be unobtrusive or highly visible to the users of the facility.

The Spen Valley Greenway, which forms part of the United Kingdom's National Cycle Network, features several works of civic art including a large horizontal coil made from giant steel hoops dubbed 'Rotate' (Figure 2.28). This feature creates a curved tunnel that path users travel through on their journey.

Figure 2.28: 'Rotate' is a work of civil art forming part of the Spen Valley Greenway in the United Kingdom

Planners at the City of Mandurah in Western Australia have taken this concept a step further by locating three-dimensional artworks in the path so that users are forced to ride or walk around it to continue their journey (Figure 2.29). The Mandurah example is multi-purpose feature, functioning as a place to sit and enjoy the coastal vista, and as a reminder of local indigenous culture. It can be seen as a nuisance or even a hazard by path users

Figure 2.29: Public artwork integrated into a path layout in Mandurah, Western Australia

In a different move, the City of Melville in Western Australia has incorporated small works of public art in the surface of a riverside shared path (Figure 2.30). Anecdotal evidence collected by the researcher indicates that this form of path artwork is too subtle and goes largely unnoticed by cyclists.

Figure 2.30: Public artwork integrated into a path layout in City of Melville, Western Australia

The city of Tempe in Arizona, has extended this concept of integrated artwork with construction of the 1.6 km Rio Salado bike path that runs alongside an urban lake (City of Tempe, n.d.). The concrete surface of the route incorporates raised colour wave bands and is imbedded with animal, foliage and human imprints. This design by local artist Laurie Lundquist attempts to reflect the natural habitat and historical character of the area that existed prior to the building of a dam that dramatically changed the original ecology. Although this artwork is far more visible than the aforementioned City of Melville in-path design, neither has been formally evaluated to determine either awareness or impact among path users.

The ultimate artistic input into path design occurs when the path itself functions as a work of public art. Examples of this level of usage are rare because of the technical, engineering and legislative constraints applied to the construction of transport infrastructure in most jurisdictions that restrict the scope of creative ideas. Perhaps the best known of these initiatives can be found the in the United Kingdom and forms part of the previously mentioned Spen Valley Greenway. A work of civil art dubbed ‘Lines of Desire’ features an alternative section of path next to the main route. According to the artist:

> The curved and gently tilted path rises up above, or cuts through the ground to take people either by a shorter route – ‘taking the 'desire line', or lengthening it - taking a 'line of desire'. My sculpture is concerned with the way people move through a space. I hope a relationship is parked and then develops as people continue on their journey - at whatever speed - and that this relationship continues to develop in subsequent journeys and pauses along the way (Spen Valley Greenway. n.d.).

Another example of this path-as-art phenomenon is the Rolling Path by sculptor Simon Perry that sits at the end of a bicycle path in Brunswick, Victoria (Figure 2.31). This concept gives the impression of a path being rolled up like a carpet. The Mooreland City Council who commissioned this artwork, have not formally evaluated it in terms of recognition, but do report plenty of anecdotal interest from residents and visitors alike. It should be noted that the Rolling Path artwork is located at the end of a short spur path and therefore does not hinder traffic movement on an existing through route.

Figure 2.31: ‘Rolling path’ artwork in Brunswick, Victoria

Authorities on the Hawaiian island of Kauai have introduced a further dimension to this use of a functioning path as the centre of artistic initiative. ‘Ke Ala Hele Makalae’ is the local term given to a shared-use path that runs along the coast on the eastern side of the island (Figure 2.32). The path is being constructed in six phases, with the completed project to cover a total distance of 30 kilometres between the villages of Nawiliwili and Anahola. Instead of being a work of art, the path is an avenue to the cultural and artistic foundation of the region. The path user, whether they be local or visitor, is engulfed in a physical and emotional experience just by completing the journey.

Figure 2.32: Coastal path built on the island of Kauai in Hawaii

Other jurisdictions have attempted to make public art a linked and highlighted attraction for an entire cycle route. An example of this initiative is the 17 kilometre-long Coastal Art Trail in Victoria that skirts Port Phillip Bay from Brighton to Beaumaris. The dual-use walk and cycle trail features large signboards that display landscape artwork from renowned Australian artists such as Roberts, Streeton and McCubbin. These signboards are located as close as possible to the actual spot where the artists set up their easels, enabling path users to compare the artistic depiction with the real scene itself. This strategy adds another experiential dimension to the placement of public art, with the viewer given the opportunity to delve into the creative process, rather than simply enjoying the completed product. In doing so, it requires the path-user, whether walker or cyclist, to momentarily break their journey.

Not all artwork that can influence the experiential nature of riding environments is carefully planned by authorities. Canadian graffiti artist Peter Gibson, who is more commonly known by the moniker 'Roadsworth', has used his stencilling skills to decorate pavements in and around the city of Montreal since 2001 at which point Gibson was quoted as saying that he began his art as a crusade to see more bike lanes constructed in his city. His activities eventually led in 2004 to several charges of public mischief being laid by the police (Boudreau, 2006). He received a relatively lenient sentence of a small fine and 40 hours community service, due in part to the community support garnered following his arrest. Gibson was officially commissioned by the City of Montreal to enhance walking and cycling infrastructure after the decision-makers realised the experiential value that his work could create.

To the best of the researcher's knowledge, there has been no formal evaluation of the impact of public artwork associated with transport infrastructure on user attitudes and behaviour conducted anywhere in the world. Researchers from the University of Central Lancashire recently scoped a project to monitor the values obtained from artwork by users of the Sustrans trails but sufficient funding was not available to complete the task (personal communication with L. Lumsdon).

Educational facilities

Riding environments often traverse areas of natural, cultural or historical significance. This alignment provides an opportunity for the development of infrastructure that incorporates an artistic, educational, informational or awareness component, which in turn can add to the overall riding experience (Figure 2.33).

Figure 2.33: Public artwork along a Swan Valley trail combining an indigenous design with historical data about the surrounding area

Visitors are no longer content with simply viewing the sights and now seek more involvement. They want to experience and know the meanings of what they are viewing (Tourism Queensland, 2000). Bicycle paths and trails present an excellent opportunity to incorporate this experiential desire. Through the use of additional infrastructure, a riding environment can deliver users with a meaningful educational or interpretative experience. At this point it is important to define these two terms.

Interpretation forges emotional and intellectual connections between the interests of the audience and the inherent meanings in the resource (Tilden, 1957). It can substantially improve the quality of a visitor’s experience by giving it a context and meaning (Shire of Nillumbik, 2007).

According to the South Australian trail planning guidelines, the inclusion of successful interpretation infrastructure is an art form and requires specific skills (Government of South Australia, 2007). In the guide, authors make particular note of the importance of correctly designing and siting interpretive signs or structures and how inappropriate design or placement can detract from the very thing that is being highlighted. However, there are few resources available that path and trail designers can access to assist them with this process. Even those researchers that do address this topic in depth, such as Gross et al. (2006), admit via personal communication that none of the suggested strategies have been formally evaluated. This lack of field testing means the path or trail designer is forced to work from opinions rather than tried and true techniques.

On the basis of a study into visitor preferences for natural environments, Hammitt (1981) concludes that relying on visitor information centres and simulated experiences as a substitute for in-situ experiences may be a mistake. He does not dismiss the effectiveness of exposure to media prior to a journey or experience, but suggests that such media should be carefully planned to strongly encourage in-situ experiences and not serve to substitute for them.

It is useful to examine practical examples of how educational and interpretive aspects can assist to deliver a rich riding experience. Technical staff members of the Calliope Shire Council in Central Queensland have attempted to combine elements of aesthetics, functionality and interpretive public education in the construction of the Turtle Way. This 18km long shared path conceived by landscape architect Nick Alderson, links the coastal communities of Tannum Sands and Boyne Island, running alongside the tree-lined banks of the Boyne River estuary (Tourism Queensland, 2000).

The path acts, first and foremost, as an important transport link between two townships and includes links to local schools and shopping precincts. A scenic natural landscape and the addition of some interpretive design features also enable the infrastructure to offer a recreational experience. The uninterrupted path includes standard directional signage, in-path symbolic artwork and six etched plinths. These stainless steel plinths set in stone interconnect to form a visual puzzle that path users can piece together to reveal the story of the flatback turtle, a species which is native to the region.

Path monitoring conducted by the local authority has shown that the facility is well used by a wide variety of cyclists including commuters, tourists and family groups on recreational rides. Following installation of the signage, an intercept survey conducted in 2002 revealed a significant increase in the number of recreational users (Shire of Calliope, 2003).

The Turtle Way has won several awards for design and offers support for the notion that a bicycle path or trail can successfully integrate safety, functionality and a satisfying riding experience. A conversation between the project manager of the Turtle Way and the researcher revealed that the central concept behind the infrastructure was the development of a theme in which the various elements were named. The establishment of this theme encouraged the local community to get to know its landscape and thereby making it more likely that they would associate with it. This notion of a path theme is similar to the concept of narrative discussed earlier in this chapter.

Other infrastructure

In recent years, an increasing number of Australian designers of riding environments have begun incorporating non-core elements en-route with functional and experiential aspects that can be collectively referred to as utility-based path enhancements. These include features such as lookouts, rest areas, shelters, drinking fountains and picnic facilities.

The effectiveness of such non-core enhancements is maximized when both functional and experiential aspects are taken into account during the initial planning (Gross et al., 2006). For example, a well-designed shelter, lookout or picnic facility can not only fulfil its primary role but also double as a location for interpretative or educational material.

Bridge aesthetics

As previously stated, little empirical work has been done into the experiential aspects of transport infrastructure. However, it is worthy of note that some limited research has been completed into the experiential design of bridges, though this work is generally restricted to the aesthetic value of the facility to the surrounding environment rather than any use-related impacts.

Some technical information is available to designers regarding the overall appearance of bridges in their environment. Australian bridge design guidelines currently assert that complexity in infrastructure design tend to attract the eye and compete with surrounding landscape for attention (Figure 2.34). Simple structures frame the landscape and provide aesthetically pleasing contrast with the natural textures of a particular bridge's backdrop (Government of New South Wales, 2003a).

Figure 2.34: Cycling bridge on a paved route (Courtesy of Tourism WA)

2.5.4 Summary

This section of the literature review has provided an overview of the design practices, policies and theories guiding the development of bicycle paths, trails and associated facilities around the world.

In stark contrast to the safety and functional aspects of bicycle infrastructure, which in many jurisdictions are thoroughly enshrined within formal literature, the experiential design aspects have not been studied in depth and have only recently been the subject of any form of theory despite their importance being widely acknowledged.

Without doubt, the work completed by Parker (2004) during the past decade offers the best direction for new researchers in the field. Although not grounded by any significant body of empirical evidence, his assertion that successful riding environments must include a range of environmental components, such as harmony, playfulness, narrative and mystery, seems to be sensible. In particular, the concept of narrative is reflected in the notion of themes and sub-themes that form part of the planning documents of major trail-building organisations such as the United States National Park Service and the United Kingdom's Sustrans. Similarly, the concept of mystery is indirectly supported by similar theories of landscape perception, such as information-processing and Freud's (see Giblet, 1996) notion of the uncanny.

In addition, recently devised theoretical programs, such as context sensitive design and sensory mapping, also include strategic parts that have direct relevance to the design of aesthetically and experientially-rich riding environments.

At a practical level in the design and construction of bicycle paths, trails and associated infrastructure, there is no shortage of ideas. However once introduced to a riding environment, there has been an almost complete lack of any formal evaluation of these innovative applications. Without adequate feedback from users it is not possible to establish the positive or negative impact of any particular feature, element or aspect.

Greenways, or green transport corridors, have received some attention from serious researchers that reveals some important facts that may have relevance for most forms of paved or natural surface path. For example, location-specific factors of apparent influence such as a path's vicinity to roads and other anthropogenic features are worthy of further investigation.

2.6 Overview of literature review

The preceding literature review indicates that there are several key elements that need to be considered when designing the research methodology and effective data collection instruments for this project.

- Cycling is a popular worldwide activity conducted for a variety of reasons, although most participants share some common needs.

People cycle for a variety of reasons and have differing expectations, yet they appear to share a common desire for an experience, either consciously or subconsciously. Pleasure has been found to be a principal motivation for riding a bicycle, rather than to arrive at a particular destination, and even those people who cycle primarily for commuting or utilitarian purposes still have a need for stimulating riding environments. Additionally, many of these people have graduated from being recreational riders and their attitudes and expectations about the nature of cycling were most likely to have been established during those earlier non-destinational rides.

- Bicycle paths are a unique form of transport infrastructure yet their nature and effect on users has not been the subject of extensive study

Bicycle paths are multi-purpose in nature and their design must reflect that fact. They are also a recent innovation that has not been studied to any great extent. Some researchers such as Forester (1996), Hunt and Abraham (2007) and Urry (2000) have noted the lack of data describing the extent to which cyclists are willing to make trade-offs in terms of directness or convenience, in order to enjoy a more aesthetically or experientially satisfying riding experience. This paucity of information makes it difficult to design a successful route that meets the requirements of the most number of cyclists or potential cyclists.

- Cycling is a multi-sensory activity that involves important cognitive characteristics.

Unlike travelling inside the glass and metal confines of a car or train carriage, cycling and walking are innately richer, multi-sensory experiential activities and it is therefore imperative that a potentially stimulating riding environment cater to these experiential and perceptual aspects.

Specific attention also needs to be paid to the mechanics of cognition. For example, eye swing arc is likely to be an important factor when determining the appropriate placement and use of design aspects that rely on visual cues. Features that are located outside the normal visual range for a cyclist moving at moderate riding speed will be unable to be properly processed and therefore perceived. Although vision plays an undeniably vital role in how we perceive a particular environment, it would also appear that several of the other senses contribute to the overall riding experience. Natural sounds and a high surface tactility are well-established examples of this multi-sensory preference. In addition, the human sense of time and Gestalt principles appear to influence our concept of overall route complexity. Perhaps most importantly of all, the construction of space associated with a riding environment depends upon a smooth integration between the various senses.

At the time of writing, research on mobilities in general and the performativity of cycling in particular, has been largely ignored by the academic community. Very recent work by researchers, such as Spinney, does hold promise but it may be some years before meaningful findings can be used to inform design practice.

- Riding environments occupy a landscape and this has an important psychophysical impact upon the cyclist

There is currently no unifying theory of landscape-preference for researchers to rely on. Kaplan’s information-processing idea probably has the strongest claims based on experimental findings, but is by no means the fundamental concept for designing successful scenes. Appleton’s prospect and refuge theory is also worth considering in relation to the development of riding environments and the fundamental importance of affordance to the design process needs further exploration.

Landscape preference can be influenced at varying levels by a number of social and demographic factors such as age, familiarity, gender, education and cultural background. Although there remains a lack of consensus among landscape theorists about preferences for certain aspects of the complex interaction of affective and cognitive responses to stimuli, some factors such as the vicinity of open bodies of water have proven to be almost universal.

The Shafer model of vegetation placement (1969) provides a useful and practical formula for predicting natural scenic preferences. There are also accepted landscape design practices involving the use of line, form, colour and rhythm that should not be ignored when seeking to understand environmental preferences. Proven tourist-based infrastructure, such as the Blue Ridge Parkway in the United States, can offer path and trail researchers important insights into how transport infrastructure can produce an aesthetic experience without sacrificing functionality.

- The design of bicycle paths and their associated surroundings is currently conducted in an isolated and restrictive manner

There have been some limited empirical studies investigating the experiential and aesthetic aspects of roads and specific commercial environments such as shopping malls. Even these few studies have tended to have a broad focus and did not address specific questions of why particular routes are preferred and which elements contribute to these preferences.

With respect to bicycle infrastructure, Parker (2004) has made the only known attempt to develop a defined theory of the experiential design aspects of bicycle paths and trails. His theoretical work on mystery, harmony and playfulness is based on anecdotal evidence and observation that has been outlined and repeated by several government agencies around the world. While Parker’s theory is a good starting point, it is clear from the other findings mentioned above that there are other significant and important aspects that need to be considered. Once this has been accomplished, the new theories can be properly tested as part of this research project.

Several path-authorities, such as the United Kingdom’s Sustrans, have been active in the use of public artwork, within its design priorities. However, none of the authorities have conducted a formal evaluation of this artwork that can be used to support that use. The recent emergence of the path or trail as a work of art itself is an interesting development that needs to be given further study.

Technical aspects of path and trail design such as curves, undulations and edges, have some empirical support, but practical details are sorely lacking. For example, what curve radius is the most effective and how frequent should these technical features appear in a finely-balanced stimulating riding environment? There is also some support for the positive experiential impact of ruins, wrecks or other cultural manifestations, yet once again the nature and extent of this impact is simply not understood.

Overall it is evident that although considerable work has been conducted into the reasons and motivations for a riding a bicycle, little has been done on the process of route-selection, and none at all on the experiential preferences that lead to those selections. This research project seeks to rectify that knowledge deficit and the following pages detail how the methodology was conducted.

Chapter 3 Research design and methodology

3.1 Introduction

This chapter outlines the research design and methodology used in this project and seeks to explain how and why the approach used is sound.

Based on the research questions and the examination of extant literature, the following overall key objectives informed and guided the methodology chosen for this project:

- To explore people's perceptions of different riding environments at an experiential level;
- To identify factors that contribute to the perception of an experientially satisfying riding environment;
- To identify opportunities to incorporate positively perceived attributes into the ongoing design process.

Due to the paucity of previous empirical research dealing with the experiential value and effectiveness of cycling infrastructure, a staged approach mixing quantitative and qualitative methods has been adopted that enhances the opportunity to delve into a full range of aspects and realise potentially rich data.

The chapter includes an autoethnography that provides a declaration of the researcher's background and association with the topic. It also details the rationale, structure and tools employed during the other important research phases.

In addition, there is an explanation of how and why the stimuli comprising the photo-surrogate and in-situ riding environments were chosen.

Finally, the chapter outlines the ethical considerations arising during the project.

3.2 Methodology

The theoretical framework of this project has been informed from multiple sources including the initial literature review and associated theoretical framework; a series of in-depth interviews with key informants in the field of path or trail design; and an autoethnographic analysis conducted by the researcher (Figure 3.1).

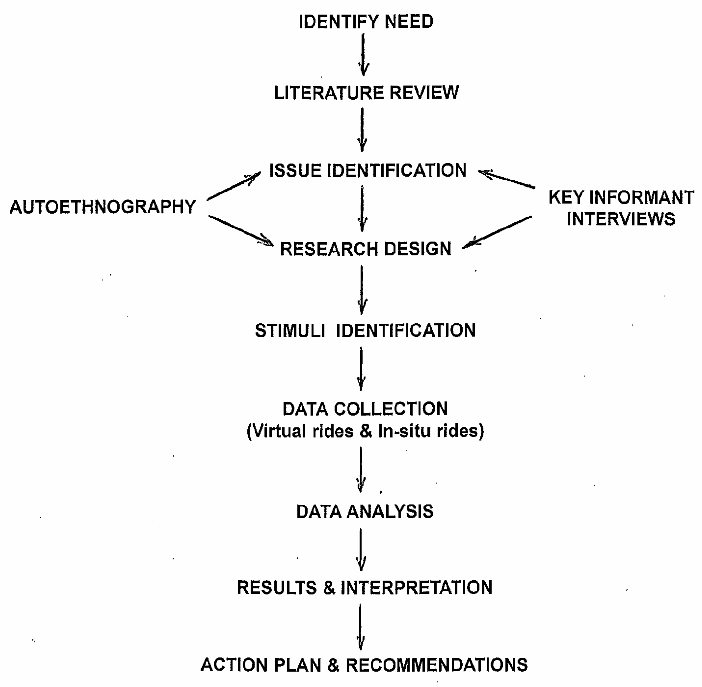


Figure 3.1: Research process

The design and conduct of the study comprises three stages, with each making a significant contribution to overall understanding of the research questions.

The three stages include:

- An auto-ethnography that introduces reflexivity to the project by acknowledging the researcher's contribution to the construction of meanings throughout the research process;

- Interviews with key informants that assist in understanding the cultural complexities in the design decision-making paradigm and enable deeper exploration of the topic;

- Qualitative research (meanings in context – look for meanings in the data and relate findings to previous studies to see if they support existing research) facilitated by quantitative work that included a demographic component and personality profiling to gauge participants openness to experience.

The study requires the satisfaction of three common research purposes: exploration; description; and explanation (Babbie, 1982). A mixture of methods is used to answer the research questions, including structured interviews, unstructured interviews and document analysis.

The review outlined in the previous chapter suggests some factors or concepts that may influence a rider's perception of their riding environment, but established little understanding of how these would produce this influence and the extent of the behavioural changes. Using in-depth, semi-structured interviews with a representative sample from the target group enables the researcher to gather the necessary information to test some of theories previously identified (Miles & Huberman, 1994).

To enhance the richness of the research and validity of the results, a combination of quantitative and qualitative approaches has been used in this study. In addition, data from a number of different sources allows for confirmation and the provision of new ideas and fresh insights (Miles & Huberman, 1994).

Qualitative methodology has been chosen for this project because it provides the most appropriate means of dealing with the multidisciplinary nature of the research and the need for in-depth social enquiry to adequately address all questions raised by that research. Unlike quantitative research, which is concerned with systematic measurement and analysing well-defined or constant variables (Rosnov & Rosenthal, 1996), qualitative research attempts to gain an intimate understanding of a given phenomena within certain contexts (Pring, 2000). In doing so, it enables researchers to conjure rich descriptions of points-of-view. Although not considered as replicable or generalisable as most quantitative-based techniques, well-planned qualitative research can provide quality interpretations that lead to shared understandings and common meanings (Denzin & Lincoln, 2000).

The use of interviews for collection of data has been widely applied to academic quantitative study around the world. In particular, face-to-face interviewing is commonly employed to gain insights and perceptions from human participants (Fontana & Frey, 2000; Miles & Huberman, 1994). These interviews can have varying degrees of structure depending on the nature of the research and the intent of the researcher. Strictly structured formats using pre-determined and ordered questions are useful tools when opinions on distinct phenomena are being sought. Less structured conversational formats comprised of open-ended questions are often used to facilitate a deeper understanding of participant feelings (Fontana & Frey, 2000). In the latter case, the immediacy of face-to-face interviewing allows the researcher to quickly clarify responses, thereby minimising data discrepancies and misinterpretations that could otherwise impinge upon the descriptive validity of the research.

While having the ability to explore core issues, the semi-structured format also possesses a degree of flexibility that allows time to explore unexpected, but potentially important, digressions. Accordingly, the use of a semi-structured technique incorporating a mix of rigid demographic and open experiential enquiry has been chosen as part of the primary method for this project.

The Blue Ridge Parkway intercept survey developed by Myers (2006) contained a mix of both demographic and experiential questions. The experiential component included multi-choice questions about the variety of scenery, effect of curves, effect of gradients, changes to alignment, width of road surface relative to the landscape, location of trees, duration of scenes, fit of road to landscape, presence and effect of colours and textures, use of vistas and a general rating of overall attractiveness.

The semi-structured interviews provided the context and insight to the study that a formal questionnaire would be unable to achieve. In addition, interviews allowed for questions and issues that may have been otherwise overlooked by participants.

Part 1 – in-situ rides followed by interviews with 12 participants

Includes:

- Questions to gather demographic information;
- Questions to establish openness to experience;
- Questions based on participants perceptions of three in-situ riding environments.

Part 2 – in-depth interviews of one hour with 12 participants

Includes:

- Questions to gather demographic information;
- Questions to establish openness to experience;
- Questions based on participants perceptions of five photo-surrogate riding environments.

As previously mentioned, a qualitative and predominantly inductive research methodology was deemed appropriate for this study given its physical and socio-psychological nature and the need to encompass rich descriptive data. Accordingly, the research project uses the concept of grounded theory as the primary method of analysis, assisted by means of phenomenological investigation and content analysis. Grounded theory is a methodology developed by American sociologists Barney Glaser and Anselm Strauss in the 1960s as a reaction against the extreme positivism that prevailed in most fields of research at that time. It is an iterative research method that seeks to assist researchers to explore and understand complex social processes. Instead of using data to test a formulated hypothesis, grounded theory focuses on the raising of generative questions to guide the research and the progressive development of theory through the systematic collection and analysis of data.

In grounded theory, the number of participants is not usually specified at the beginning of the research. Instead the researcher continues with data collection until a saturation point is reached whereby no new information is forthcoming. This flexible technique enables issues to emerge progressively.

There is a common misconception that a researcher using grounded theory must defer reviewing the relevant literature until data has been collected and analysed. This myth stems from the belief that an examination of prior studies may taint the researcher's decision-making. Even though early proponents of the theory, such as Glaser and Strauss, were critical of the development of a single grand theory to address complex research questions, their formulation of grounded theory was never intended to advocate research that ignored extant knowledge (Suddaby, 2006). Instead, they noted the importance of commencing the search for theory from a solid base and acknowledged that it is difficult to find a grounded formal theory that has not in some way been stimulated by substantive extant theory.

Although grounded theory is inherently inductive or bottom-up, to be of any practical use it must also possess a deductive aspect. Some researchers have suggested a combination of fundamental approaches known as analytic induction or abduction where new knowledge emerges from this combined approach (Suddaby, 2006). It is this middle ground that best defines the process used in the research project.

3.3 Autoethnography

3.3.1 Rationale

The decision to include a brief self-disclosure as a component of this research project reflects a current trend for researchers to declare their background and association with the chosen topic, particularly when that association may have the potential to influence the research design and ensuing treatment of the research questions.

Use of autoethnography in social science research activities is now well-established with self-disclosure and reflection by the researcher being used to make sense of his or her individual experiences and beliefs. Chang (2008) asserts that autoethnography offers a strong research method that can readily engage both researchers and readers. He argues strongly that this methodology enables researchers to gain a cultural insight into the relationship of themselves to others and that this insight provides a solid foundation on which cross-cultural coalition can be built.

A major methodological advantage of analytical autoethnography is proposed by Anderson (2006). He submits that being a 'complete member' researcher, or part of the actual project, facilitates the availability of data. Anderson also asserts that autoethnography provides increased access to insider meanings. He qualifies this assertion by suggesting that for autoethnographers to gain full benefit from the task, they must assiduously pursue other insiders' interpretations, attitudes and feelings in addition to their own. It should be noted that this factor has been introduced separately to the bike path research project through the use of key informant interviews which are dealt with in a following section.

The limitations of analytical autoethnography also need to be acknowledged and considered. Anderson (2006) concedes that it is rare for research interest to be deeply entwined with the individual's personal life so as to produce an entirely effective analysis. It is my assertion that my professional connection to the topic of this study sits at the deeper end of this spectrum. Although it could be argued my personal involvement is somewhat less entwined as I am at present only a semi-regular cyclist, the topic itself is one that is directly relevant to anyone who uses, or intends to use, riding environments. Gilmore (2001) notes the importance of avoiding the constraints on self-representation created by the author placing an over-reliance on only the information that is verifiable.

The ultimate value of autoethnography has been analysed and questioned by some qualitative researchers and is not without its critics. Krizek (2003) raises the potential for autoethnography to devolve into a form of narcissism and, to avoid this happening, the researcher must make every effort to connect even the most personal aspects of their writing to some larger element of life.

Chang (2008) also warns about this tendency to focus too much on oneself in isolation from others. I would contend that a focus on oneself is inevitable and would only become a problem if the researcher fails to acknowledge how others are impacted. Chang lists some other potential pitfalls that autoethnographers need to avoid, including an overemphasis on narration rather than interpretation, the exclusive reliance on personal memory to recall data, and ignorance of ethical standards regarding other people in self-narratives. All of these concerns have been carefully considered in the development of an autoethnography for this project and I am satisfied that none will present a problem. For instance, I have the luxury of a written record of achievements during my professional life which can be used to supplement memories.

Accordingly, I believe it is important to recognise my professional and personal interest in the topic of this research project and also the broader aspects of cycling as a means of transport, form of recreation and a platform for tourism. The following discourse attempts to do that.

3.3.2 Background

In common with many Western Australians, my personal connection with cycling extends back to childhood when a bicycle provided both reliable transport to and from school, and a means to explore the wider world on weekends and during term holidays. My first bike was a wide-tyred dragster with a banana-shaped seat and three-speed gearing that was by far the most popular design for youngsters at the time. Apart from providing me with a means of independent travel, it offered a unique opportunity for creative expression. During my primary school years, a considerable amount of spare time was spent customising the bicycle to reflect a developing personality and to cultivate an image. I recall saving up to buy an array of lights, gauges, mud flaps and various other accessories, often in direct competition with other children in the neighbourhood in an effort to see who could fit the most gear on their bike and still be able to ride it around as a form of artwork in motion. I even remember building a dashboard fitted between the handlebars that housed the gauges and switches to operate the lights, making the bicycle resemble a motorcycle more than a ‘treadly’.

Having a bicycle at that age of 10 or 11 also meant the opportunity to explore a geographical area much larger than would be possible on foot. My choice of riding environment at time was often concerned with the challenges it offered. This might be summed up with the maxim of ‘the rougher the riding terrain, the better’. It was a test of rider and machine against the environment. Would the mudflaps prevent a drenching when I rode through puddles of water? Could I jump that kerb without having to dismount? Cycle paths were not widespread, but cyclists were permitted to ride on footpaths.

During the high school years, I upgraded to a ten-speed road bike that still provided a handy means of transport, albeit without the previous devotion to creativity and personal expression. The arrival of a driver’s licence marked a decline in cycling activity and saw my bicycle garnering rust for a number of years. This indifference remained in place until the early 1990s when I was employed by the state government’s Office of Road Safety in a research role and had to investigate the factors that contributed to the concerns of vulnerable road users, such as cyclists and pedestrians. Immediately after my road safety projects were completed, I accepted a permanent position with the Department of Transport’s Bikewest unit and have remained there for the decade or so since.

Established in 1987, Bikewest is a functional operational unit of the Department for Transport, and the government agency responsible for coordinating the development and promotion of bicycle infrastructure throughout Western Australia. This dual responsibility requires a team with a wide range of skills incorporating both engineering and community education disciplines. The organisation is the primary source of information and education for non-sporting cyclists in Western Australia. The unit’s staff members employ a variety of methods and avenues to promote cycling, including publications, surveys and consultative initiatives, websites and special events.

Since its inception, Bikewest has been periodically housed within several different host agencies including the Department of Transport, Department of Sports and Recreation and the Department for Planning and Infrastructure. This difficulty in finding a clear niche may stem from the fact that it is the only state government agency in Australia with an integrated infrastructure development, policy development and promotional role. In other jurisdictions these functions are carried out by separate public and private membership-based organisations. This unique holistic local approach to cycling may also have played a significant factor in the identification of how the design, policy and promotional functions depend upon one another and thereby eventually led to the birth of this research project.

I entered the public service with an undergraduate degree in media studies and geography. During the course of my tenure, I also managed to complete postgraduate studies in environmental management at Murdoch University. Over the next decade, I carried out general research and duties associated with community education, particularly the production of various publications aimed at highlighting local rides or routes and encouraging people to experience them.

I ride a bicycle periodically as part of my research and policy development role with Bikewest, often making use of available pool bikes. I own a hybrid bicycle and a folding bicycle, both of which are regularly ridden on the weekends. My preference is to avoid riding on high volume or high speed roads and instead try to make maximum use of paths, trails and quiet streets.

My current personal preferences for a riding environment are somewhat eclectic. I enjoy natural water features, such as rivers and the ocean, and I dislike riding adjacent to overtly artificial features, such as fountains and landscaped ponds. I get especially annoyed with the traditional grey-coloured concrete paths that have regular exposed expansion joints and I find any riding environment featuring them to be an assault against the senses. I enjoy riding routes that provide some form of narrative, even those with overt signage or educational wayside exhibits as they provide the rider with a choice of experiences; he or she can choose to ignore or engage with the experiential aspects. Although I occasionally choose to travel on local rail trails, I don't find the Australian native vegetation particularly attractive and if given the opportunity would much prefer to ride on natural surface trails that traverse lusher landscapes, such as the temperate forests of Europe and North America.

Bikewest conducts an annual audit of cycling and walking behaviours and attitudes using multiple-choice questionnaires. This survey focuses on bicycle ownership, bicycle usage, and access to cycling facilities. However, at the time of writing it does not include any questions relating to infrastructure design. My research project will seek to fill this gap and empower planners with the information necessary to make crucial design decisions. The data collection component of the research project will require the use of several communication strategies during the interview process and this will have a two-fold benefit. It will expedite the data-collection process and also enable the analysis of the effectiveness of print, video and information technology communication strategies in delivering messages related to path and trail design to different target groups.

3.3.3 Potential impact of my experience on the project

A notable part of my professional role and a considerable personal point of pride has been a deep involvement with the development of designated recreational cycling routes throughout Western Australia. In particular, I single-handedly planned riding routes along the Sunset Coast and the Hills region of the Perth metropolitan area that have since become major tourist attractions. The planning of these facilities encouraged me to consider the experiential nature of cycling and, specifically, the factors that combine to produce a physically and psychologically satisfying riding experience. As a direct result of this immersion in the development of recreational routes, I have discovered how little is known about the experiential aspects of riding a bicycle and the need for further research to fill this knowledge gap.

This early discovery has been further reinforced through my most recent role within Bikewest which has involved the development of written and audiovisual promotional materials aimed at marketing specific, existing Western Australia bicycle infrastructure, and designated paved recreational routes in particular. All of this experience has directly exposed me to the key problems raised in this research project and the consequences of incomplete design processes. In doing so, I have formed opinions about the significance of the riding experience in the production of successful riding environments and the subsequent marketing of those environments.

I have become increasingly concerned about the apparent self-imposed distance between infrastructure designers and the people they are designing it for. There appears to be a 'we know what is best for you' attitude toward the public that is prevalent across the various authorities responsible for designing and building public works. Too often among decision-makers, community consultation is considered to be more of an obligation that is grudgingly arranged, rather than a crucial part of the overall design process.

The ability to promote a facility for residents and visitors who have not used it before is hampered to a great extent if that facility has not been planned with attention to aesthetic and experiential aspects. A number of times I have struggled to make a specific route seem worthwhile to leisure and recreational riders because the riding environment has little or no positive impact on the senses. It has been a case of trying to sell a product that has been designed to meet regulatory and economic parameters but not to satisfy or challenge the needs of potential users. This lack of a human element in the design process has become a point of continuing frustration to myself, and I suspect, to every other marketer around the world who is attempting to achieve the same outcomes. In the limited instances where the riding experience appears to have been at least considered in the design process, I believe it has inevitably been more through coincidence rather than any deliberate planning.

I am not a trained civil engineer, but I have been reliant on their skills in order to complete my actual role as a promoter of their handy work. Through my ongoing professional involvement, it has become all too obvious how the design function of bicycle infrastructure has until now, been completed in isolation from the future marketing of that infrastructure. I therefore acknowledge the need for the two disciplines (engineering and social marketing) to work as a synergistic partnership and to recognise how this can become a crucial issue for maximising public patronage.

A characteristic common to practitioners of land transport-related engineering is a focus on destinations rather than journeys. Too much emphasis is placed on joining two geographic points and not enough about creating a driving, riding or walking experience in between those points. Members of the profession often find it difficult to involve human perception in their design processes and tend to seek safety and function as the key outcomes. This may be a result of training, or of the mathematical nature of the work, or perhaps a combination of several elements.

In my experience, the development of bicycle infrastructure in Australia has seen the promotion of functionality as the prevailing philosophy, with cycling being seen, at least from a funding perspective, as being primarily a transport activity, even though every official attitudinal survey conducted in the last decade across the nation shows recreation or leisure to be by far the main reason cited for why people choose to ride a bike. I have begun to sense a slight shift in this administrative focus on transport as the dominant force driving new infrastructure. I am particularly interested in a growing recognition of the importance of bicycle tourism at both a macroeconomic and microeconomic level. Tourism is all about the sensory and emotional experience, rather than sterile functionality, and it appears this fact is now forcing many authorities to consider how and why infrastructure is used and the motivations of those users.

At an internal professional level, there also appears to be another significant divide arising between those responsible for designing local bicycle infrastructure and those given the task of informing and selling it to the public. This divide has largely been created by separate pay scales introduced during 2008 whereby engineers are being paid more than their counterparts in the promotional section. Although the situation is related to the difficulty in recruiting qualified engineers, rather than any preference for particular skill sets, it nevertheless creates a perceived hierarchy of influences on the design process with the standard engineering principles taking precedence. It is my view that both of these scenarios have led to an emphasis on the functional and economic aspects of new projects, at the expense of the overall riding experience.

In Western Australia, cyclists are legally permitted to ride on the road unless otherwise signed. Of course this does not automatically make the practice safe or risk free - a fact that has become a personal bugbear of mine. As a cycling promotion officer, my role has been to encourage cycling in all its forms and to the maximum degree. However, I personally feel it is unwise to promote an activity (riding on busy roads) that potentially places riders at significant risk. For this reason, I have faced an ethical dilemma that is still far from being resolved.

A further work-related concern arises from the apparent lack of understanding in the community about what is involved in the development of transport infrastructure. It has surprised me that few people, apart from some dedicated lobbyists, actively demand better facilities. This lack of interest may be a result of the previously mentioned paternalism commonly practiced by those responsible for designing the facilities.

Despite that reservation, it has to be noted that based on my observations, most staff involved in transport behaviour management and infrastructure development at all levels seem to have a genuine passion for their work. In addition, as far as I am aware, political control in the day-to-day design aspects of proposed bicycle infrastructure has been surprisingly limited.

In summary, I believe my professional and personal experience with the activity of cycling and its infrastructure, add an important relevant perspective to the research topic and enable me to construct a more meaningful assessment of the many issues involved and to more fully understand and interpret the experiences of other riders.

3.4 Interviews with key informants

This component of the research was conducted to gain an insight into the practical issues and obstacles related to path and trail design. The information gained from these interviews proved useful in understanding the practical issues faced by designers and decision-makers in the design process. The following pages outline the reasons behind the interviews, profile the participants and describe the process used. Results and a discussion of the interviews are detailed in Chapter 6.

3.4.1 Rationale

The key informant interview is a loosely structured conversation between the researcher and people who have specialised knowledge about the research topic or the issues and aspects associated with it. These interviews were originally developed as an ethnographic tool to help understand cultural complexities but are now used widely in many forms of qualitative research to enable deeper exploration of a topic (Jimenez, 1985).

According to Bolton (1979), there are a number of potential benefits offered by interviewing key informants including:

- assisting with the analysis of specialised systems or processes;
- identifying target populations or issues worthy of further investigation;
- gathering information when social or cultural barriers make broad survey research difficult;
- developing effective data collection techniques that make best use of time and resources;
- clarifying findings by introducing new background information;
- assessing progress, particularly in the use of coalition work;
- motivating others to be involved in the research by proving its worth;
- assisting with the generation of recommendations by identifying gaps in knowledge or targets for further investigation.

The specific benefits of interviewing key informants for this project are related to the technical nature of the topic. Path and trail development is a specialised activity conducted by highly qualified individuals who inhabit a professional culture that is not well-documented. The interviews assisted the researcher to better understand how and why path and trail-design decisions are currently made at a local and national level. It is also beneficial to delve into this world to obtain provocative ideas, useful insights and assist with development of a meaningful framework upon which further research can be built. It has particular relevance to the secondary research question that deals with the local path and trail design process and the factors guiding its progress.

3.4.2 The participants

After an initial broad assessment of potential sources by the researcher, a final choice of key informants for the study was made to ensure a mix of skills, knowledge, priorities and reliability. This process involved the use of purposive sampling whereby the researcher selects people who are capable of providing the most pertinent information (Neuman, 2006). All the chosen informants are currently in senior roles and have a good overview of other related areas. They are representatives of major stakeholder groups or organisations directly involved in the development or bicycle infrastructure and are either decision-makers themselves or able to influence government policy. The chosen eight included:

- Two senior transport engineers responsible for major path design and construction projects and employed by a major State road authority;

- A senior civil engineer responsible for suburban path design and construction projects and employed by a large metropolitan local government authority;

- The chief engineering officer responsible for coordination of path development throughout Western Australia and employed by Bikewest;

- A consulting civil engineer who has been employed on a variety of major and minor bicycle infrastructure projects throughout Western Australia;

- A technical officer responsible for the design and construction of natural surface trails and employed by the Western Australian Department of Environment and Conservation;

- A consulting landscape architect who has been employed on several major path projects throughout Australia, who had previously worked in a local government role;

- A landscape architect employed by a major State road authority who has in excess of 20 years experience.

3.4.3 The interview process

All informants approached agreed to participate in the research without the need for incentives to be offered. With the exception of one informant who was based interstate and contacted via email and telephone, the interviews were conducted face-to-face. Each participant was made aware of the nature and scope of the research, but was not provided with any of the questions prior to the interviews. They were all required to sign a consent form and an offer was made to withhold their name and position if required (see Appendix 5). Although none of the eight participants requested anonymity, for reasons of privacy the researcher decided to refer only to the key informants' professional roles. The researcher recorded all of the interviews in writing using a form of shorthand.

The participants were interviewed separately, except for the two engineers from a major State road authority. In that instance, the engineers were interviewed together because of time constraints, with the researcher taking care to propose each question on an individual basis. The length of the interviews varied between one and a half hours and two hours in duration. Most of the interviews took place at the key informant's place of work or at a convenient, local coffee shop. This procedure is based on sound psychological rationales confirming that one-on-one interviews in a comfortable location with a trusted researcher can enhance honest disclosure (Bolton, 1979).

The researcher recorded the gender and age group of all key informants and they were asked to provide a short summary of their professional background and the nature of their current role. Each informant was then asked a similar set of ten questions using prompts where required and responses were recorded by the researcher. The questions were slightly modified according to their particular area of expertise or involvement in the field of study. This strategy was adopted in order to enable the responses to be compared and contrasted, while still allowing the individuals involved to contribute from their own particular perspective. The core questions used in the interviews are outlined on the following page. A full version is also contained in Appendix 3 at the end of this thesis.

1. Did your professional training include a component that dealt with the aesthetics or attractiveness of infrastructure?

2. Do you call on other professionals who have that specific training?

3. From a design perspective, how do you think bicycle paths/trails differ from other transport-related infrastructure such as roads and rail lines?

4. Of the three design aspects – safety, functionality and experience - which do consider to be the most important and why?

5. What current design guidelines do you refer to? Are they mandatory?

6. Where do you source path and trail design ideas from?

7. In terms of functionality, do you design facilities with a particular user group in mind or do you attempt to cater for multiple-user types? If multiple, which types have priority and why?

8. Do you use a cost/benefit analysis in the design process? If so, how do you make the necessary calculations and where do you source the data from?

Question 1 seeks to explore the extent to which expert knowledge of aesthetics is available and used by decision-makers in the design of path and trail infrastructure. It also seeks to establish if there is uniformity and consistency in the professional training of designers.

Question 2 seeks to explore the multi-disciplinary aspects of path and trail design in Australia, in addition to the reliance on consultation and the relationship between professions involved in the path and trail design process.

Question 3 seeks to discover if path and trail design is viewed by the professions and industry as a speciality requiring its own fundamentals or simply a segment of transport infrastructure that includes roads, bridges, railways and other major facilities.

Question 4 seeks to explore the theoretical framework that supports the path and trail design process. An important aspect of this exploration is the apparent balance between the various design aspects in the minds of designers.

Question 5 seeks to understand and confirm the legislative and regulatory framework that governs the design of bicycle infrastructure in Australia.

Question 6 seeks to fully explore the creative process behind the development of paths and trails. In particular, the question investigates how and why ideas are sourced for new projects.

Question 7 seeks to explore the practical considerations of designers when they are producing facilities for the general public.

Question 8 seeks to explore the economic considerations of designers when producing government-funded facilities for the general public. It also attempts to determine if there is an underlying imperative that impacts upon the use of aesthetic or experiential design elements.

3.4.4 Data processing and analysis

When all of the interviews had been completed, the written transcripts were dissected, collated and reassembled into a set of documents that related to each of the core questions. In instances when a comment applying to one question was intermingled with an answer to another question, the comments were duplicated so that all of the data emerging from the interviewees was considered.

As a useful adjunct to the key informant interviews, the researcher performed an investigation of the curricula of civil engineering courses offered by Australian universities.

A full discussion of the findings and outcomes from the interviews with key informants and associated investigation is provided in Chapter 6.

3.5 Route preference research

The route assessment phase of this research project consisted of one group of respondents completing five in-situ path-based cycling routes and another group being asked to view five photo-surrogate path-based cycling routes. No respondent took part in both studies and none of the key informants participated in this phase. Full descriptions of all ten routes are given in Chapter 4.

After viewing or completion of their five required routes, individual respondents were then interviewed by the researcher who began by seeking demographic information and asking questions aimed at establishing the participant's personal level of experiential openness. This initial section of the interview process used the same structured questions for each respondent. It was then followed by a series of semi-structured questions aimed at exploring preferences related to the path itself, the path surrounds and associated features.

The following information provides an explanation of the various components of the route preference research and the rationale for their inclusion in the research design.

3.5.1 Demographic profiling

In the initial data collection phase of the qualitative research involving both in-situ and photo-surrogate riding environments, the opportunity was taken to collect a limited amount of demographic data from each of the participants. This decision was made to enable comparative analysis to be conducted to gain an insight into the preferences of different types of path-user.

To minimise participant inconvenience, the data was collected using a multiple-choice questionnaire and included gender, suburb of residence, age group and educational attainment. Specific physical limitations that could have affected a participant's ability to perceive a particular riding environment, such as colour-blindness and hearing impairment, were also ascertained.

Participants were also questioned about their current cycling activity. This included how often they rode a bicycle, the average length and speed of a journey, the main purpose for their rides, the type of bicycle and accessories, percentage of riding done alone, type of riding environment and if they had any experience of cycling outside of Australia.

Some sections of Western Australian society are significantly underrepresented in cycling participation statistics. Accordingly, the promotional activities of government agencies such as Bikewest often involve the targeting of particular demographic cohorts.

Existing empirical evidence resulting from research commissioned by the Western Australian government has demonstrated that socio-economic factors can impact upon respondent attitudes and self-reported cycling behaviour (Zappelli & Rounce, 2009). It is important to determine if similar differences occur with regard to aesthetic and experiential aspects of riding environments.

3.5.2 Personality profiling

To facilitate a better understanding of how individuals assess riding environments, the researcher decided to also include a short section in the questionnaire that pertains to the scientifically recognised personality trait of openness to experience.

People who score high in openness are interested in experience for its own sake. They enjoy novelty and variety, are sensitive to their own feelings and have a greater than average ability to recognize the emotions of others. Often, they hold a high appreciation of beauty in art and nature. They are willing to consider new ideas and values, and may be somewhat unconventional in their own views. Their peers rate such people as original and curious.

A few studies have examined the influence of personality traits on landscape preferences. Macia (1979) conducted personality profiling of subjects prior to showing them photographic representations of environments. He discovered that males who scored high in emotional maturity tended to prefer human landscapes and both genders with extrovert characteristics favoured rounded trees. The study also showed females with a sensitive personality preferred natural landscapes.

In another study, Abello and Bernaldez (1986) found that individuals recorded as having low emotional stability demonstrated a significant preference for landscapes that exhibited recurring patterns and structural rhythms.

There appears to be an established correlation between the gender of the cyclist and openness to scenic experience. For example, research conducted by Antonakos (1994) indicates scenery and terrain were more important to women on average than it was to men.

The cycling activity phase of the data collection will include some simple psychometric testing to determine how open or closed participants are to experiential stimuli and their level of aesthetic sensitivity. Openness to experience is one of the five major domains of personality within the field of psychology – the other four being conscientiousness, extraversion, agreeableness and neuroticism (Paunonen & Ashton, 2001). This openness commonly involves an active imagination, sensitivity to aesthetics, attentiveness to inner feelings, preference for variety and intellectual curiosity. Current psychometric research indicates that these qualities are statistically correlated and that openness is a global personality trait.

Openness tends to be normally distributed throughout a population, with a small number of individuals scoring at the high and low extremities and most people scoring near the average. Individuals who score low are considered to be closed to experience and tend to be ultra-conservative and traditional in their outlook. There is no known relationship between openness and psychological wellbeing, with the tendency to be open or closed to experience being simply two different ways of relating to the world.

Several scientific tests of personality traits are available for use by modern social researchers. The two most widely used in Australia are the Revised

NEO Personality Inventory (NEO PI-R) and the Sixteen Personality Factor Questionnaire (16PF).

The original *Neuroticism Extroversion Openness Personality Inventory* (NEO PI) was developed in the 1980s by American psychologists Robert McCrae and Paul Costa, while researching the effects of ageing on personality structure. Over the years this test has been revised and now consists of 240 multiple choice questions. A condensed version (NEO-FFI) with 60 questions is also available, of which twelve are directly related to openness to experience. Extensive international trials of both the full and condensed versions of the test have shown them to have high reliability and validity (McCrae & Costa, 2004).

The Sixteen Personality Factor Questionnaire (16PF) is a multiple-choice survey developed over a number of years by British psychologist Raymond Cattell. It is designed to measure the fundamental traits of human personality. A shortened version of the test (16PF Select) has been developed for field research situations where time with participants is limited. The 107 questions in 16PF Select tend to focus on actual behavioural situations that remove the problems of self-rating that can reflect an individual's own self-image rather than their actual personality. This questionnaire contains 18 questions related to openness and takes about seven minutes to complete.

The NEO-FFI questions are answered on a five-point scale that ranges from strongly agree to strongly disagree.

The NEO-FFI scales show correlations of .75 to .89 with the NEO-PI validimax factors. Internal consistency values range from .74 to .89.

Although Edith Cowan University is in possession of profiling tests such as the Revised NEO Personality Inventory (NEO PI-R) and the Sixteen Personality Factor Questionnaire (16PF), I was unable to access these tests because they can only be made available to graduate students of psychology under strict supervision. Existing rules dictate that the content of these restricted-access tests cannot be made available to students in other fields of study, regardless of the academic level of that study. Therefore, I have had to use a research instrument that is free from any access restrictions to investigate experiential openness and this may not meet the same professional standards as those mentioned above. Accordingly, I chose to use The Big Five Inventory (BFI) developed by researchers at the University of California, Berkley (John et al., 1991).

The BFI is a multiple-choice questionnaire using short phrases based on trait adjectives known to be prototypical markers of the Big Five personality dimensions (John & Srivastava, 1999).

The questionnaire contains ten questions related to openness to experience and takes about five minutes to complete.

John and Srivastava found that the BFI had similar coefficient alpha reliability to those of NEO-FFI (0.83 compared to 0.79).

3.5.3 Qualitative experiential research

The decision to use in-situ and photo-surrogate routes to assess response to riding environments was based on three factors:

1. the research aims;
2. quality assurance;
3. previous studies.

A secondary aim of the research is to gain a better understanding of which methods of communicating the features and benefits of the experiential aspects of bicycle infrastructure are the most effective.

The use of two forms of assessment will enable the research to be tested for trustworthiness through the means of triangulation.

Other studies designed to investigate environmental preference have used this dual strategy. For example, Kroh & Gimblett (1992) conducted a study of preferential responses to walk-trail sites and photographic slides using the same group of participants. They concluded that multi-sensory variables via in-situ experiences have a profound impact on preference for trail environments not found in standard laboratory research.

Pocock (1982) and Shuttleworth (1980) also concluded that using a photograph to replicate a multi-dimensional experience both inhibits and distorts preference. In particular, Pocock notes that a photograph is unable to convey the life of a scene as it merely records everything at that one instant in time.

Kroh and Gimblett (1992) assert that humans are multi-sensory beings and this must play an intrinsic role in their perception of landscape and construction of space.

Zacharias (2001), notes that computer-based images have the benefit of enabling the researcher to finely control the stimuli when they are attempting to determine public preferences for visual aspects of a landscape. However, they also acknowledge that photographs can fail to provide the viewer with a sense of spatial relationship and do not relay the experience of distance and energy-expenditure that occurs if that viewer is cycling or walking through the scene. Photographic stimuli for landscapes usually observed while in motion is therefore unlikely to be used with confidence as a surrogate for predicting responses in the real environment.

There is evidence that images of low resolution used in preference surveys produce lower overall preference levels (Zacharias, 2001).

Chon and Shafer (2009) who employed a web-based methodology to test aesthetic responses to greenway trail environments in Texas, concede the limitations that a reliance on surrogate environments has in eliciting meaningful responses. They note that in-situ research offers a better means of defining aesthetic dimensions as it enables participants to assess distant views, trail-side amenities and the finer details of the trail surface. In particular, they suggest that smells, sounds, people's behaviour and other environmental variables only available to an on-site participant all make an important contribution to the experience of a path or trail, and that these need to be examined in concert with visual stimuli.

Parker (2004) asserts that feelings rather than opinions are the more trustworthy basis for assessing the effectiveness of riding environments. The most efficient way of gauging feelings in the context of this research project is to conduct semi-structured in-depth interviews with people immediately following their completion of an actual ride.

Kroh and Gimblett (1982) alert us to the importance of sequence in landscape perception. They assert that the opportunity afforded for a sequential experience is removed when landscape simulations are shown in laboratory settings. A series of photographs cannot replicate the continuous, multi-sensory feedback of an in-situ experience.

The choice of using a surrogate technique is often one of resources. On-site research is logistically difficult and often precludes its use in large scale studies.

The use of semi-structured interviews provided the opportunity for participants to supply individual responses to a similar set of questions while explanation and understanding of the responses to the basic structured questions is facilitated through further, spontaneous probing-questions (Sarantakos, 1994).

A third alternative is proposed by Brown & Spinney (2009). This involves the use of an in-situ video camera (either mounted on the helmet or attached to the handlebars) to record the rider's journey and provide a simultaneous visual depiction of the environment being experienced. They argue that this produces a useful moving ethnography. By enabling riders to talk about their practices in relation to the contexts of their performance, Brown and Spinney suggest that in-situ video can allow participants to provide more nuanced and situated linguistic accounts of their embodied mobility than would otherwise be possible.

Although acknowledging the usefulness of this solution for ethnographic studies, it is not considered appropriate for this research project. Brown and Spinney support their methodology by suggesting that much traditional cycling research based on quantitative research, such as stated preference surveys, can provide data about how and why people move around by bicycle, yet fail to address the more intangible sensory, emotional, kinaesthetic and symbolic aspects of cycling. To overcome this identified deficiency, this project will seek to explore these aspects using a qualitative methodology that will enable the researcher to delve deeply into the aesthetic and experiential return of riding environments. This qualitative approach will involve extended semi-structured interviews of participants immediately after the completion of rides. Brown and Spinney assert that the use of one-on-one interviews require participants to consciously rationalise their actions and their reasons for acting in a particular way. In addition they argue that interviews can be unsuitable as everyday thoughts and practices are not always rationalised and they are often fleeting, ephemeral and corporeal in nature meaning they are hard to capture using language alone.

While this assertion has some value, it does not take into account the added pressure on participants produced by having an ethnographer riding alongside, or the need to continuously vocalise their feelings along the route for a video, will not occur with post-ride interviews. Although the inability to record very fleeting experiences with post-ride interviews is acknowledged, the value of these experiences in terms of this research is considered minimal.

Spinney (in Horton et al., 2007) used ethnographic self-assessment to examine the embodied practice of cycling by a group of riders as they rode through various parts of London. While this methodology has the benefit of immediate experiential feedback, it fails to provide the immediate opportunity for deeper probing by the researcher.

An experiential evaluation by motorists completing a section of the Blue Ridge Parkway in the United States used a multiple choice questionnaire. Respondents were required to answer a total of 33 questions. The first third of the questionnaire was devoted to demographic information and the latter two thirds to experiential attitudes and beliefs. Although this form of research is relatively easy to conduct and can be effective in certain circumstances, it does not provide enough depth in the data collected to enable a researcher to gain insight into psychophysical impact of elements and features in an environment. For example, the Blue Ridge Parkway survey asked participants to give their impression of the ‘fit’ of the road to the surrounding terrain. The relevant choices being: 1. very poor (the road was an imposition to the land); 2. moderately poor; 3. neutral; 4. fairly good; and very good (seemed to fit like a glove with the topography). Using these simple descriptors, it is not possible to establish why the infrastructure did, or did not, achieve a fit with the landscape. Accordingly, this research project will use semi-structured interviews to record participant feelings, thoughts and analysis of responses to stimuli.

A few researchers in the field of environmental preference have avoided the use of visual stimuli altogether. In his quantitative investigation of perceived reasons for enjoyment of scenic motoring routes in the American state of Connecticut, Kent (1993) designed a questionnaire that used written descriptions of 19 features which could impact on overall perception. He then relied on participants having actually driven the three study routes at some time in the past and then been able to recall the experience sufficiently clearly to enable them to assign values to the structured questions. This technique is straightforward enough, but runs the risk that participants will forget previous exposure to particular stimuli and therefore produce inaccurate or meaningless results.

Other researchers have asserted that a virtual environment can be most effectively delivered through the use of a detailed three-dimensional model and a high performance computer to allow people to explore interactively (Bishop et al., 2001). The use of such technology has been shown to produce different choices from people than exposure to still images only.

The Swedish National Road and Transport Research Institute possess a driving simulator that could offer the ultimate in virtual or surrogate experience for other transport modes (Green, 2008). This advanced equipment accurately reproduces driving scenarios, but it may be less effective as a surrogate for riding environments in which the user is more open to the elements than a motorist would be on a road.

Researchers conducting experience-based preference studies have the choice of using the real environment, a simulation of that environment, or a surrogate for that environment. To many people, the latter two are one and the same. However, some theorists, such as Daniel and Ittelson (1981) and Lange (2001) contend that a simulation is something that assumes the actual appearance of the real environment while a surrogate serves in the place of such an environment. For the purposes of this study, both real (in-situ) and surrogate (photographed) bicycle routes will be used to ascertain rider preferences. The photographed routes will be considered surrogates rather than simulations because of the practical limitations in reproducing exact copies of real routes that can be displayed using available technology.

The use of photographs to represent environments has been a widely adopted practice in the evaluation of people's environmental preference (Stamps, 2000; Zube et al., 1987; Hull & Stewart, 1992) and offers the researcher several advantages over in-situ experimentation. Photographs avoid the costly and often time-consuming task of transporting respondents to actual locations (Stamps, 1990). In addition, they can be digitally altered to achieve consistency, such as presenting the same ambient lighting and weather conditions to all respondents.

Chon and Shafer (2009) used computer technology to manipulate photographs of existing paths and trails in an effort to create different environments for comparison purposes. This had the obvious advantage of enabling the researcher to isolate the effect of individual features or elements without disrupting other features and elements. This technique requires considerable expertise in photographic manipulation to produce realistic stimuli. It is also restricted to a static and two dimensional realm.

Brown and Daniel (1991) found that while photographs could be valid surrogates for predominantly static landscapes, they were less successful for the representation of dynamic environments containing elements in motion, such as flowing rivers and visible fauna. Heft and Nasar (2000) also report differences of response for static and dynamic displays and recommend caution when extrapolating findings from studies that rely solely on static photographic representations of environmental settings. To overcome this potential problem, Brown and Daniel suggest the use of video presentations. Although acknowledging the advantages of using video for multi-modal environmental preference research, it was deemed impractical for this study of riding environments. While it was generally a straightforward exercise to gather examples of such environments from around the world in a photographic format, a similar attempt involving a video-based format would have been far more difficult. Agencies regularly record routes, features and elements within their jurisdiction photographically, but rarely do so using video technology.

Naderi (2003) reports a direct comparison of subjects responding to walking environments first depicted on video and then by field experiments, in which the same environments were rated significantly lower in the virtual realm. Further exploration of this difference by the researcher revealed that the video failed to provide an amorphous quality of context.

In-situ routes

The in-situ experiential section of this research project involved participants being asked to complete five separate rides of approximately five kilometres in length. These rides were conducted using existing paved and natural surface routes within the Perth metropolitan area that represented a range of riding environments and incorporated a variety of elements and features. The participants were interviewed immediately after completing each ride, either face-to-face or by telephone. This procedure required each participant to ride a total of approximately 25 kilometres and to travel using their own transport between the various routes which were scattered throughout the metropolitan area.

To aid with recruitment, it was decided to offer small incentives in the form of department store vouchers to potential participants in a gesture to recompense them for the considerable time and effort involved in completing this exercise. This decision was made following a review of literature related to the use of incentives to recruit and retain research subjects. The review concluded that such usage was innocuous and ethically unproblematic in most general research situations. Grant and Sugarman (2004) found that the use of incentives may became a problem where the subject is in a dependency relationship with the researcher, where the research is potentially degrading or overly burdensome, or where the participants are likely to have an aversion to the research. None of these factors are relevant to this research project. All of the participants were completely independent of the researcher and the leisure-based topic has a fun aspect to it that attracts people rather than discourages or repels them. Although it is acknowledged that the project required participants in the in-situ qualitative segment of the research to commit a few hours of time, this also was not considered to be of sufficient extent to affect their overall attitude to the topic itself. Following data collection, participants provided feedback that indicated that the incentives given were viewed as fair recompense for the time and effort rather than payment for completing an onerous or objectionable task. According to Grant and Sugarman, undue influence occurs when an incentive is attractive enough to tempt people to participate in a research study against their better judgement. The incentive offered to participants of this research project is only of moderate value and is not considered large enough to persuade anyone to participate if they had any concerns about the nature of the work involved. No incentives were required for the recruitment of participants in the photo-surrogate route assessment component of the research because of the lower investment of time and energy involved.

Photo-surrogate routes

The photo-surrogate experiential section of this research project involved participants being asked to assess five separate routes that were presented using a series of colour photographs. These composite routes were developed from aspects of existing routes sourced during a worldwide search by the researcher and combined with some aspects of the chosen routes comprising the in-situ component of the study.

The participants were interviewed in person after they had been given ample opportunity to absorb the alignment, features and elements of each route.

3.5.4 Choice of stimuli

Overview

The in-situ riding environments chosen for this research included features, elements and landscapes that reflected some of the key issues raised during the literature review.

Although the qualitative nature of this project precluded the need to develop of specific perceptual rating scales, measurement tools such as the state of flow proposed by Czikszentmihalyi (1997) and Russell's (1980) circumplex model for predicting response proved important sources of descriptors when analysing responses to the semi-structured questions. Previous environmental experiential studies such as a survey of motorists using the Blue Ridge Parkway in the United States (Myers, 2006) provided guidance for the development of emotional descriptors. Myers reports the use of six categories of responses:

1. Negative words, such as scary, boring and tired
2. Words associated with awe, such as awesome, breathtaking and inspired
3. Words associated with excitement and motion, such as fun and exhilarating
4. Words associated with mild relaxation, such as comfortable, pleasant and refreshing
5. Words associated with strong relaxation, such as tranquil and calm
6. The word ‘beautiful’.

The development of five suitable photo-surrogate riding environments for the first part of the research that was designed to record rider perception, required the use of a wide range of elements and features related to path, trail and associated infrastructure. Although Western Australia is acknowledged as having world-class bicycle facilities, it was felt that the range and style of those local facilities would be too narrow to enable the researcher to produce photo-surrogate riding environment of sufficiently diverse character. Accordingly, it was decided to investigate elements and features being incorporated into path and trail design by other jurisdictions around the world, with the aim of creating a library of design ideas that could be referred to during the course of the qualitative research.

Library of design ideas

The design ideas included elements, features and aspects that could contribute to, or affect, the aesthetic, cultural and experiential impact of riding environments. For the purposes of the exercise the following categories were devised:

- Path or trail design features – including topographical aspects

- Path or trail treatments – including surface textures, colours

- Associated infrastructure – including bridges, lookouts, rest areas
- Signage – including directional, interpretive and educational
- Public artwork – including stand-alone features, in-path features and adjacent features.

The requesting of prospective stimuli was conducted using email directed at the chief engineering officer or head technical officer of each jurisdiction. These individuals were sourced from existing databases and from detailed internet searches. The majority of individuals contacted belonged to government agencies with a small number representing community or user groups. A description of the research project and a high quality photograph of the identified items were also requested.

One of the difficulties encountered while conducting this exercise was the sheer number of authorities and organisations that design, construct or control bicycle infrastructure in various parts of the world. For example, in the United States the design and construction of bicycle infrastructure is often the responsibility of individual counties, of which there are currently over three thousand across the nation. In addition, larger cities, state governments and the federal government may be involved in building bicycle facilities. This makes the task of sourcing ideas a time-consuming and resource-intensive one.

The response from jurisdictions approached was generally positive. A total of 258 items were identified. Of these, only 235 were able to provide suitable colour photographs. Responses were then sorted and catalogued according to type of element or feature.

It should also be noted that the international search for design ideas provided some additional feedback that further strengthened the significance of this study. Many of the jurisdictions contacted expressed an interest in obtaining the results of the research with a view to improving or enhancing their own design process.

The received responses were sorted into the five above-mentioned categories and then further sorted into sub-categories that described their purpose. The sorted photographs were then catalogued for use in this project and for future Bikewest promotional purposes.

Five photo-surrogate routes were then developed using ten linked photographs per route placed in a specific order that were all sourced from the library of design ideas.

Photo-surrogate routes were designed to reflect a variety of riding environments that could reasonably be encountered by cyclists in an Australian context. The composition of these routes reflected findings from the literature review through the incorporation of aspects into some routes and omission from others.

The content of in-situ routes did not draw specifically on the library of design ideas. The final selection of five routes for the in-situ component of this research project was made following an extensive review of all available bicycle paths and trails in the Perth metropolitan area and its immediate surrounds. The five routes were chosen because they best reflected the range of available riding environments, thus enabling the researcher to fully explore the research questions and any issues raised in the review of literature.

3.6 Ethical considerations

The research methods and tools used in this project were approved by the Edith Cowan University Human Research Ethics Committee. These factors were closely scrutinised by the Committee to ensure that the rights of participants in the study would be protected.

Participants invited to complete the face-to-face or telephone-based key informant interviews and the in-depth assessments of photo-surrogate and real riding environments were provided with an information letter clearly describing the nature, purpose and implications of the research (see Appendix 4) and asked to sign Informed Consent forms (see Appendix 5). One of the key informants was located interstate and interviewed by telephone. In this instance, the information letter and consent form were emailed to the participant with a request for the signed agreement to be posted back to the researcher.

Every effort was made to treat the people involved in the study with courtesy and respect. In particular, the researcher ensured that all interviews and riding environment assessments were conducted at convenient times for the individual participants. All participants had the right to withdraw from the study at any time, though none chose to do so.

In addition, all participants in the research were offered anonymity and a guarantee of confidentiality. Each interview respondent was allocated a research code by which they were referred to throughout the study.

All data collected during the project was securely stored in a locked cabinet at the researcher's place of work and only made available to that person and the research project supervisor. This material (in both electronic and hard copy formats) will be destroyed after a period of five years from the date of publication.

In line with the researcher's desire to provide feedback to interested parties, all participants in the study were offered the opportunity to obtain a copy of the major findings and outcomes from the research.

Chapter 4 Experiential data collection

4.1 Introduction

This section constitutes a full description of the specific study objectives for the research project, in addition to the planning, input and activities related to the collection of data using surveys, interviews and trial rides.

The data collection process used in the experiential phase of this research project is explained.

The collection of data is intended to enable analysis of the path elements and features that enhance sensory experience and thereby lead to preference for particular types of riding environment.

The chapter also includes a detailed description of the in-situ and photo-surrogate routes used to assess riding environment perception.

4.2 Process and administration

As the in-situ component of the research necessarily involved participants cycling out-of-doors, it was speculated that weather conditions could have affected the nature and duration of their experience. For example, heavy rain and strong winds have been shown to reduce the willingness of some people to cycle to and from work (Grounds, 2007). In an effort to minimise the potential impact of weather on the research, it was decided to complete all of the in-situ rides during the warmer, drier and less windy months of the year. This approach ensured a greater consistency by enabling each in-situ participant to complete their respective rides in similar weather conditions.

Prior to attempting the in-situ and photo-surrogate rides, participants were provided with a copy of an information sheet outlining the project and explaining their involvement (Appendix 4). After being given the opportunity to have any questions clarified, each participant was asked to sign a consent form (Appendix 5). Participants of the in-situ component were then provided with a written briefing note about their task. This briefing note provided a map and word description of each route. This description only gave geographic directional details and did not provide the respondents with any indication of the researcher's opinions about the aesthetic or experiential content of individual routes. According to the theory of cognitive dissonance (Brown et al., 1988), people have a tendency to tailor their beliefs to appear consistent with what they consider to be the beliefs of others. In this study, the respondents had no knowledge of the researcher's opinions about the routes and therefore were not influenced to reflect those in their own assessments.

Participants of the in-situ component of the research were also instructed that:

- all five rides had to be completed during the hours of daylight and within the space of a few days;
- the rides could be completed in any order;
- the rides could be completed at a speed they found comfortable and on a bicycle of their choice;
- if they rode in company with others, they could not interact with those people during the ride and could not discuss any aspect of the route with those people following completion of a ride.

Participants were instructed to contact the researcher immediately after they had completed all five designated routes. A mutually agreed time and place was then arranged for the post-ride interview. Prior to the interviews commencing, the researcher conveyed to each participant the fact that there were no right or wrong answers to the upcoming set of questions and that there was no time limit on the their responses.

A digital recording device was used during most of the interviews that followed completion of both the in-situ routes and the photo-surrogate routes. The exceptions being those interviews that were conducted by telephone and those recorded manually in shorthand due to a brief period of mechanical failure of the equipment. Recording of a conversation has the advantage of capturing data more accurately and faithfully than written notes. The use of a recording device can also make it easier for the researcher to focus on the interview process and structure. There is some risk that the presence of a recording device may reduce the likelihood of full disclosure from some participants, particularly in cases where the subject matter is of a sensitive or highly personal nature. However, it was felt that the topic of this project was of such an inoffensive nature that any reluctance to offer information was likely to be minimal.

The researcher made observational notes on a pad during each interview that provided contributing, substantiated or corroborative data not implicit in the participant's verbal responses.

Separate questionnaires were devised for the in-situ and photo-surrogate routes. All of the demographic questions, the personality profiling questions and five questions aimed at assessing riding environment experience were common to both. The in-situ questionnaire included an additional four questions about the riding environment that related to non-visual sensory aspects.

4.3 Respondents

Participants in the assessment of both the in-situ and photo-surrogate cycling routes were sourced from the residential population of Perth, Western Australia. A variety of avenues were used to recruit these people including general word-of-mouth, specific requests to bicycle user groups and advertising on local recreational-based online forums.

Gender and age were not a consideration. People who could not ride a bicycle were not considered because they would not be able to complete the requirements of the study. Similarly, anyone who was colour blind or had an uncorrected hearing impairment were excluded from the in-situ rides as these conditions would inhibit experiential comparisons.

Employees of Bikewest, Main Roads Western Australia, the trails section of the Department of Environment and Conservation and the technical engineering sections of local government authorities were excluded from the recruitment stage as their direct involvement in specific riding environments may have unduly influenced their perception of those riding environments.

An initial request for volunteers was placed on the relevant websites outlining a brief explanation of the research, the role of participants and the researcher's contact details. All respondents to the initial request were then sent an email that fully outlined the tasks involved. The respondents were also asked to confirm their willingness to be involved in the research project.

When confirmation was received, the researcher then sent each person intending to participate in the in-situ rides a document with detailed instructions and descriptions of the five routes.

No respondents completed both the in-situ and photo-surrogate components of the research. This separation was achieved in order to reduce the impost on individuals and to facilitate validity.

4.4 Sample size

Qualitative inquiry has no set rules about the sample size. It depends upon a number of variables including the type of information being sought and the saturation point where any likelihood of gathering any new data is too low to be of value to the researcher.

Sample sizes that are too small may not be able to support claims of having achieved theoretical saturation. Those that are too large may not permit a deep, case-oriented analysis.

A sample size of 12 for the in-situ study and 12 for the photo-surrogate study was initially determined to be the most appropriate for this research project because it was sufficient to ensure diversity while remaining manageable. This initial estimate was proven to be ideal, with saturation only beginning to become obvious near the end of the sample for both the in-situ and photo-surrogate phases of the research.

4.5 In-situ route descriptions

Each participant involved in the assessment of in-situ riding environments was instructed about the need to wear a helmet while riding, refrain from using headphones and to obey the Road Traffic Act. The routes could be ridden in any order. Participants were also advised to ride at a speed they found comfortable and appropriate for the conditions.

A total of five riding routes were chosen for the in-situ component of the experiential research phase. Following discussions with the university's resident research consultant, a proposal reviewer and the research project supervisor, it was felt that this number of routes would be sufficient to ensure research depth while remaining reasonable in terms of logistics and participant comfort. The final choice of routes was made after an extensive examination of all the riding environments in the Perth metropolitan area that incorporate either paved paths or natural surface trails. Perth is the capital city and principal urban centre of the Australian State of Western Australia. The greater metropolitan population is estimated to be 1.7 million people.

All effort was made during the selection process to ensure that the five routes reflected different topographical, aesthetic and elements. Based on the researcher's knowledge of recreational riding and statistical data on local riding habits (Zappelli et al., 2008), a decision was made to restrict each of the routes to 5 kilometres in length. This distance takes an average rider approximately 20 minutes to complete when riding at a leisurely pace.

The final five routes forming part of the experiential research phase of the project belonged to the following riding environment categories:

- Coastal suburban path;
- Urban principal shared path;
- Outer suburban path;
- Riverside suburban path;
- Recreational trail.

A full description of these five routes is outlined on the following pages, along with a brief overview from the researcher addressing aesthetic and experiential aspects.

Route 1. Coastal suburban path

The route uses a section of the shared path that follows the Indian Ocean coastline from Burns Beach to Woodman Point. It consists of a variety of surface treatments including bitumen, concrete and paving bricks. The chosen section of the path lies between Sorrento Beach and Trigg Point, meandering its way southwards through the coastal dunes or along the rocky shoreline with a number of ocean or beachside vistas. The 5km route traverses a terrain that is largely flat except for a couple of minor undulations near the half way point. The route has a predominance of straight sections that are interspersed with some sweeping curves. There are no artificial or natural gateways and the path edges are constructed and create a definite contrast with the surroundings.

These surrounds could be described as a moderately complex landscape that includes a mix of suburban land-use and coastal development but with little remaining of the natural bushland (Figure 4.1).

The initial section of the route runs alongside the sandy shallow foreshore at Sorrento then skirts a far more rocky area further south. At one point the path comes as close as 20 metres to the high tide level. Cyclists using this facility have a uniform high-quality red bitumen surface on which to ride and much of the barrier fencing is constructed using treated timber (Figure 4.2).

Further along the route, there are a number of features and elements that may affect the riding experience. Several rest areas are located adjacent to the path on the ocean side and these provide some of the best uninterrupted views. Many of them also have educational signage that gives path users an overview of the marine park and its ecological importance (Figure 4.5). At about the three-quarter point of the route, the wreck of the Centaur lies about 3.5 km off the coast and the path curves around a piece of public artwork that commemorates the event (Figure 4.3). The artwork is accompanied by a plaque providing some brief background information about the shipwreck (Figure 4.4), and a small lookout area is situated nearby.

The final portion of the route moves further away from the road than previously and meanders through a small semi-landscaped beachside park (Figure 4.6). Following a slight descent the path surface changes to a light-coloured paving brick that firstly runs alongside a public car park and then a café overlooking the water (Figure 4.7).

Although the ocean is visible for almost the entire length of the ride, the shallows, the beach and beachgoers are only glimpsed intermittently as the path is built on land that is considerably higher than the water. The earliest section of the route provides riders with the best long and middle distance views.

At most times of the day, riders will experience a mix of ambient noise from the ocean on one side and traffic on the other. Although there are a number of cultural and environmental features along the way, the route has no distinctive linked narrative.

Figure 4.1: Route 1 of the experiential assessment representing a coastal suburban path (Courtesy of the Western Australian Department of Transport)

Figure 4.2: Initial portion of Route 1

Figure 4.3: Artwork denoting a shipwreck

Figure 4.4: Educational signage

Figure 4.5: Descriptive signage in the intermediate portion of Route 1

Figure 4.6: End portion of Route 1

Figure 4.7: End portion of Route 1

Route 2. Urban principal shared path

This route uses a section of the major shared path that generally follows the rail alignment from the Perth Central Business District to Fremantle and also incorporates a section of a greenway ride known as the 'City to Sea'. The chosen route is approximately five kilometres in length and, as shown in Figure 4.8, begins in the suburb of Subiaco then continues in a westerly direction through the suburb of Jolimont, concluding adjacent to the corner of Selby Street and Hay Street.

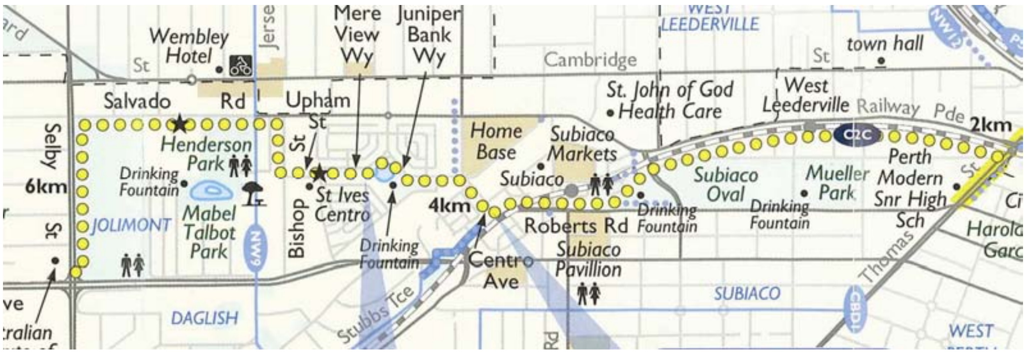


Figure 4.8: Route 2 of the experiential assessment representing a mix of urban principal shared path and general urban shared path (Courtesy of the Western Australian Department of Transport)

The route has a mix of curves and straight sections. The initial section of the route runs alongside the Perth to Fremantle railway line (Figure 4.9) and includes parts that are considerably lower than the rail reserve and confined by barriers (Figure 4.10). The middle section cuts through the central Subiaco using a combination of meandering curves (Figure 4.11) and straights (Figure 4.12). Near the half-way point, a landscaped park containing a water feature is visible to riders over a low hedge that borders one side of the path (Figure 4.13). The final portion of the route consists of long straight sections that run adjacent to major roads and incorporates some paving that produces a rougher surface texture than the high quality bitumen used elsewhere (Figure 4.14).

Figure 4.9: Initial portion of Route 2

Figure 4.10: Initial portion of Route 2

Figure 4.11: Intermediate portion of Route 2

Figure 4.12: Intermediate portion of Route 2

Figure 4.13: View to water feature in the intermediate portion of Route 2

Figure 4.14: End portion of Route 2

Being a principal bicycle transport corridor, the terrain is largely flat with a few minor undulations in the Subiaco section. The route traverses a complex mix of urban and suburban landscapes, and some anthropogenic parklands with little natural bushland. There is only the one water feature visible to riders along the entire route.

Although the route travels through one of the older areas of the Perth metropolitan area, it does not approach any ruins or sites of historical interest.

Riders will only experience brief exposure to traffic noise in a few locations along the route. There is a small amount of in-path artwork and a major landscaped rest area at approximately the half-way point of the ride.

Route 3. Outer suburban path

This route uses a section of the shared path that runs alongside Tonkin Highway in the south-eastern part of the metropolitan area (Figure 4.15). The prevailing surface treatment consists of medium-quality bitumen. The terrain is very flat with long straight, or near-straight, stretches and few curves. The route traverses a simple natural landscape consisting of low scrub interspersed with towers holding high-tension power lines (Figure 4.17). The path crosses one intersection which has traffic control lights with a bicycle phase (Figure 4.18). There are no water features apart from a small patch of intermittent marshland near the southern end (Figure 4.20) and much of the route provides a vista of the Darling Range in the far distance.

There are no artificial or natural gateways along the route and the path edges are not constructed. Low wire fencing separates the path precinct from the road reserve in several places along the route.

The southern extremity of the route lies adjacent to an Aboriginal archaeological site documented as a traditional camping ground where flaked stone artefacts have been discovered. A very small sign giving brief details of this indigenous site is located next to the path (Figure 4.21). A protective coating on this sign has been damaged by the elements making it difficult to read, even when viewed at close proximity.

Figure 4.15: Route 3 of the experiential assessment representing an outer suburban path (Courtesy of the Western Australian Department of Transport)

Figure 4.16: Initial portion of Route 3

Figure 4.17: Electrical pylons in the vicinity of Route 3

Figure 4.18: Road crossing on Route 3

Figure 4.19: Intermediate portion of Route 3

Figure 4.20: Path crosses swamp land near the end of Route 3

Figure 4.21: Small heritage sign near the end of Route 3

Route 4. Riverside suburban path

This route uses a shared path that skirts the Burswood resort precinct, travels through Burswood Park and then roughly follows the course of the Swan River (Figure 4.22). The prevailing surface treatment consists of medium-quality bitumen with very well defined edges. The terrain is very flat with a mix of long straight sections and curvilinear alignment. It is a moderately complex landscape that contains little remaining natural vegetation.

The first section of the route runs alongside a major through road and a rail line (Figure 4.23). Much of this early section is dominated by a series of multi-storey residential complexes.

The intermediate section travels through landscaped parkland that is well-shaded by mature trees and the canopies of some create natural gateways (Figure 4.24). This middle portion of the route also incorporates a number of on-route facilities that may affect the riding experience including the following:

- A statue of Paddy Hannan, an early pioneer of the Western Australian goldfields. A comprehensive sign accompanies the artwork and outlines the background story (Figure 4.25).

- A statue of Willem de Vlamingh, an early Dutch explorer who named the nearby Swan River. This statue is accompanied by another of a black swan and a comprehensive sign that outlines the historical significance of the artwork (Figure 4.26).

- The Swan Shell, a 20 metre-high white structure designed to simulate the movement of a swan in flight (Figure 2.26).

The final section of the route runs along the banks of the Swan River and in the near vicinity of a golf course with artificial lakes (Figure 4.27). Educational signage along this section alerts users to the local birdlife (Figure 4.28).

During this route, riders will experience a mix of ambient noise arising from traffic at certain spots, children’s activities, water birds and songbirds. Although there is an eclectic mix of cultural and environmental features and elements that attempt to tell a story along the way, the route has no distinctive linked narrative.

Figure 4.22: Route 4 of the experiential assessment representing a riverside suburban path (Courtesy of the Department of Transport)

Figure 4.23: Initial portion of Route 4

Figure 4.24: Intermediate portion of Route 4

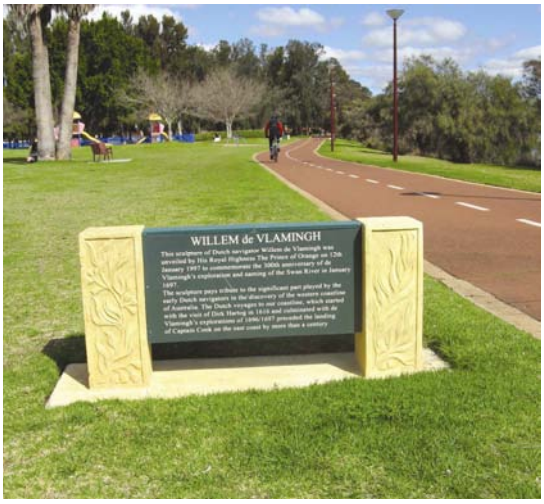


Figure 4.25: Artwork and interpretive signage

Figure 4.26: Interpretive signage

Figure 4.27: Interpretive signage

Figure 4.28: End portion of Route 4

Route 5. Recreational trail

This 5km route uses short sections of the Kep Track Mountain Bike Trail, the Railway Reserve Trail and the Munda Biddi Trail (Figure 4.29). It includes a section built on a disused railway reserve and a natural surface section developed from the surrounding bushland with a hard gravel base. The chosen section begins near the township of Sawyers Valley and continues to Sculpture Park in Mundaring where it joins a separate trail heading southwards towards Mundaring Weir. The terrain is moderately undulating but has no significant gradients and the route has no fencing and does not travel near any natural or artificial water features.

The first section from Sawyers Valley to Mundaring is a designated Western Australian rail trail and therefore wide and very straight with a firm base. Signage is limited to small directional markers (Figure 4.30). In this vicinity the route traverses dense native regrowth forest that restricts the riders long-distance view to the trail itself and the canopy creates an uneven light at most times of the day (Figure 4.31).

The middle section includes an out-and-back journey that requires riders to travel through Sculpture Park which is the main recreational area in the Mundaring township and a mix of landscaped and natural features. After crossing a couple of local roads, riders are invited to discover the heritage, artistic and ecological aspects of the region through several covered interpretive displays (Figure 4.32). At one point the trail travels through a set of old railway signals that has been restored to its original condition (Figure 4.33). Despite this prevalence of cultural elements, the route had no distinctive linked narrative.

Near the end of the section, the trail crosses another local road then becomes narrower and instead of following a previously used rail reserve, it meanders through the native bushland which in places forms natural gateways (Figure 4.34). The moderately firm trail surface is a blend of gravel and sand. In this riding environment, the landscape quickly changes from dense to open and back to dense again (Figure 4.35).

Riders will experience bushland sounds occasionally joined by traffic noise, particularly near Great Eastern Highway.

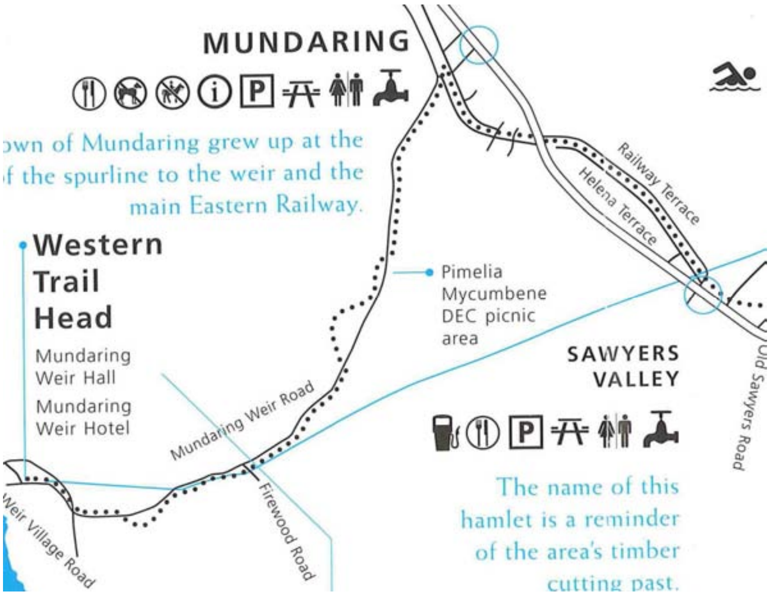


Figure 4.29: Route 5 of the experiential assessment representing a recreational trail (Courtesy of the National Trust)

Figure 4.30: Initial portion of Route 5

Figure 4.31: Initial portion of Route 5

Figure 4.32: Intermediate portion of Route 5

Figure 4.33: Intermediate portion of Route 5

Figure 4.34: End portion of Route 5

Figure 4.35: End portion of Route 5

Researcher overview of the in-situ routes

Selection of the five routes used in this component of the experiential research required me to ride each a number of times. In doing so, I have been able to assess the experiential value of each and an exploration of these values may further inform the project.

When all five rides had been completed by a participant, the researcher arranged and conducted an interview. Each participant was asked a similar set of semi-structured questions and prompted, where necessary, to expand upon their thoughts or to clarify particular points (a sample questionnaire is provided in Appendix 2). As with the photo-surrogate route component, the interviews were designed to engage the participants in a conversation to establish their impressions of individual routes and specific features with an emphasis on comparing the different riding environments at an aesthetic and experiential level.

4.6 Photo-surrogate route descriptions

A total of five riding routes were developed for the photo-surrogate component of the experiential research phase. This number was chosen to ensure research depth while remaining a manageable operation in terms of time and resources for both the researcher and all of the participants.

As outlined in the previous chapter, the photo-surrogate routes were formulated using a series of colour photographs that displayed a mix of the path alignment, path surrounds, various features encountered during the journey and nearby landscape.

The individual A4-sized photographs were incorporated into a Microsoft Powerpoint presentation that displayed each image in a pre-determined set sequence and without accompanying explanatory text or labels. This presentation was then loaded onto the hard drive on the researcher’s laptop computer.

Participants were invited to complete the demographic and personality profiling component of the survey. They were then asked to view each of the routes via the laptop screen while the researcher left the room. During this process, they were permitted to control the speed at which the presentation was displayed and the length of time each individual photograph was visible. This allowance reflected a cyclist’s ability to vary their riding velocity when moving through real environments.

When all five routes had been viewed, the researcher conducted the interview. Each participant was asked a similar set of semi-structured questions and prompted where necessary to expand upon their thoughts or clarify particular points (a sample questionnaire is provided in Appendix 2). The interviews were designed to engage the participants in a conversation to establish their impressions of individual routes and specific features, with an emphasis on comparing the different riding environments at an aesthetic level.

The five photo-surrogate routes represented a broad mix of riding environments that incorporated many of the elements, features and aspects which may reasonably be encountered by a cyclist in an Australian urban, suburban and semi-rural landscape.

Route 1 used a selection of landscapes and features to create a varied riding environment (Figure 4.36). Several pieces of public artwork and interpretive infrastructure are visible to the rider. Some of these are incorporated into associated infrastructure, such as rest areas and signage. The route has defined edges and some boundary fencing that restricts visibility. A short section of path runs alongside a major road with traffic visible.

Figure 4.36: Route 1 of the photo-surrogate experiential assessment

Route 2 consisted of a mix of path surface treatments including dark and light-coloured bitumen, concrete and paving bricks (Figure 4.37). Riders are exposed to intermittent glimpses of the beach and ocean. The first half of the ride is well-shaded with an arching canopy while the latter half is open with little vegetation in the vicinity of the path. The route includes one major piece of interpretive artwork.

Figure 4.37: Route 2 of the photo-surrogate experiential assessment

Route 3 used a selection of concrete shared paths that traverse a landscape with the appearance of being inner to mid suburban (Figure 4.38). Much of the route consists of long straight sections with a short meandering section through parkland in the concluding stage. There is no water feature or public artwork visible to the rider at any point along the route.

Figure 4.38: Route 3 of the photo-surrogate experiential assessment

Route 4 mirrored the riverside suburban path used during the in-situ assessment. This enabled the direct comparison of a surrogate depiction of a route with the real route itself. The sequence of images depicted a riding environment (Figure 4.39) that consisted entirely of high quality red bitumen with clearly delineated edges. The initial section followed a road reserve past multistorey residential developments. The middle section meanders through manicured parkland that incorporates artificial water features and several pieces of themed public artwork. The concluding portion of the route skirts the edge of river with grassy banks.

Figure 4.39: Route 4 of the photo-surrogate experiential assessment representing a riverside suburban riding environment

Route 5 mirrored the natural surface trail used during the in-situ assessment. This also enabled the direct comparison of a surrogate depiction of a route with the real route itself. The sequence of images depicted a firm gravel surface and an alignment that was predominantly straight throughout the first half and then meandering during the latter half (Figure 4.40). This riding environment has the appearance of a rural setting with a substantial portion of the route surrounded by heavy natural vegetation.

Figure 4.40: Route 5 of the photo-surrogate experiential assessment representing an outer suburban natural surface trail

Chapter 5 Data analysis

5.1 Introduction

Quasi-experimental research methods were employed to identify and examine patterns of response to various riding environments.

When selecting methods of data analysis for this project, a range of alternatives were considered and these were based on the guidance provided by Miles and Huberman (1994), Wilkinson et al. (1999) and Coolican (2004). The final choice of methods provides familiarity and reliability while generating sufficient statistical evidence to contend with the research questions and aims.

The analysis of data arising from the photo-surrogate and in-situ interviews was conducted using the three-stage flow method described by Miles and Huberman (1994):

1. Reducing and coding the data;
2. Reporting the outcomes;
3. Drawing conclusions and verification.

These stages are discussed in this chapter and in chapters 6 and 7. The initial stage involved the transcription of all the notes and audio recordings from the interviews into a Microsoft Word document using voice recognition software. Any notations relating to body language that were made during the interviews were duly documented during this process.

The qualitative data analysis software package QSR NVivo 7 was chosen to assist in the organisation and coding of raw data.

5.2 Initial analysis and coding

An initial step in analysis of the collected raw data was to transcribe into a readable format the recorded verbal content of the 24 interviews held with the photo-surrogate and in-situ route participants and the separate notes made by the researcher during the interviews. This process involved using the voice-recognition software Dragon Naturally Speaking to convert each spoken word into text and then saving it as a Word document.

The transcribed information was checked for accuracy against the original recordings of the conversations, with any inconsistencies rectified in the Word document.

Data reduction can be thought of as the selecting, focussing, simplifying, abstracting and transforming of information into manageable sections (Miles & Huberman, 1994). In this instance, the task of data reduction involved the approach of inductive content analysis and was completed through a process of editing, segmenting and summarising. This reduced information was then subjected to coding and memoing.

The emergence of perceptual response descriptors in this project was a progressive process. Green (1999) suggests that the development of rating scales for environmental experiential assessment requires the generation of a large number of adjectives or constructs that reflect qualities and attributes of the environment being studied, with the most salient then being selected. The transcription of participant interviews revealed a list of descriptors and these were compared to response scales used in existing analytical tools such as Russell's circumplex model for predicting landscape response (Russell, 1980) and the experiential flow measurement scale devised by Czikszentmihalyi (1997).

During the preliminary reading of transcribed information, data that did not add value or meaning to the analysis was removed.

The raw data gathered from all route assessments was allocated a primary code according to the type of stimuli delivery method used (in-situ or photo-surrogate), the respondent's gender and the order of being interviewed. These primary codes being RM for in-situ male, RF for in-situ female, VM for photo-surrogate male and VF for photo-surrogate female. Broad categories were then set by the researcher based upon the primary research question which was used to provide direction.

5.3 Ordering and integration

The computer-aided qualitative data analysis system QSR NVivo 7 was used to assist in the management of data generated through this research project. This software package is able to handle very rich text-based information, particularly where deep levels of analysis of both large and small volumes of data are needed. For this project, it met the requirements of ergonomics, use-friendliness flexibility and analytical depth. Although having a longer history of use in quantitative research, the benefits provided by computer-based analysis tools for qualitative study are now becoming well established and may be changing research methodology. Fielding and Lee (1998) assert that such tools offer convenience and efficiency that actively encourages researchers to investigate data in much greater depth than they would otherwise do if manual analysis was the only option.

Data was entered as it was collected and the emerging themes were continuously updated to reflect any changes.

After the first coding was completed, the same data was re-coded a second time to ensure consistency and thoroughness.

5.4 Abstraction, comparison and display

Following the preliminary coding of data from the in-situ and photo-surrogate route assessments, meaning in the form of sub-themes, patterns, flows, regularities and propositions was abstracted for further analysis.

A manual comparison of meanings as they related to specific features, individual routes and the attitudes and beliefs of different demographic groups was then completed by the researcher.

According to Miles and Huberman (1994), the display of qualitative data is designed to assemble organised information into an accessible and compact form that assists the researcher to analyse what is happening with the data and determine whether conclusions can be drawn. For this research project, the information emerging from the data analysis phase was presented and displayed using a combination of descriptive discourse and figures or tables showing numerical values.

5.5 Validation of data

All researchers, whether working in a positivist quantitative or interpretivist qualitative paradigm, must aim to produce authentic, trustworthy and valid knowledge gained through ethical means (Merriam, 1998).

The trustworthiness and rigour of the methodology used in this study was demonstrated through the application of six distinct activities. Firstly, the data was subject to a degree of triangulation through the use of multiple practices to validate the research. Two distinct methods of route stimuli delivery were employed using surrogate and real riding environments.

Secondly, rigour was promoted by the researcher's professional background and its direct relevance to the research topic. Any bias was acknowledged in a comprehensive autoethnography that established the researcher's ontological and epistemological positions and assumptions at the outset of the study.

Thirdly, the use of computer-assisted qualitative data analysis software (CAQDAS) enabled the researcher to log the steps taken and remove the uncertainty and tentativeness of conclusions reached (Richards and Richards, 1991). As mentioned earlier, the researcher kept field notes that provided substantiation corroboration or clarification of the interviews and discussions. In addition, raw data and interpretations of data were taken back to a select number of participants for verification when the researcher felt it necessary.

Fourthly, a breadth of academic literature was referred to in the development of data collection tools. The theoretical stances and critiques presented in the review of literature.

Finally, an overriding factor further encouraging validity was the nature of the topic itself. Participants in all phases of the project demonstrated an eagerness to be involved and an appreciation of how the results of the research could benefit cyclists.

Chapter 6 Research outcomes

6.1 Overview

This chapter begins with an outline and discussion of the results arising from semi-structured interviews with key informants involved in the design and construction of bicycle paths and trails. It then outlines the results of the photo-surrogate and in-situ experiential research component of the study.

A full analysis of the research outcomes and their implications is then provided in the following chapter.

6.2 Interviews with key informants

The key informants identified in Chapter 3 were able to contribute valuable insight and knowledge to the research project through a series of in-depth, structured interviews conducted by the researcher. The following is an outline of the responses to the set questions, followed by an analysis. Note that not all key informants were required to respond to every question because of the relevance to their respective experience and current professional activities.

1. *Did your professional training include a component that dealt with the aesthetics or attractiveness of infrastructure?*

Despite the fact that their formal training had been completed at a variety of institutions in Australia or overseas, only one of the engineering professionals could recall any time being spent examining aesthetics or other experiential-based aspects during their tertiary-level education. The consulting engineer, who was the youngest of all the key informants interviewed as part of the study, recalled completing a marina project during his course tenure that involved an investigation of indigenous issues, but these were related to gaining approval for the venture rather than any design requirement.

One of the engineers from the major state road authority spent a short period examining bridge aesthetics during his tertiary engineering course. However, this learning module was primarily concerned with the reduction of visual pollution, rather than influencing user preference.

The Bikewest engineer, who had completed his formal training in the United Kingdom, mentioned that factors, such as safety and cost, were the primary focus of engineering education and that the look or feel of the structure was not a consideration when choosing one type of infrastructure over another. Since taking up his current position, the opportunity has arisen for him to attend seminars by visiting academics, such as Jan Gehl, and some of these seminars had incorporated a thought-provoking aesthetic and experiential design component that revealed how restricted his earlier training had been.

During her employment tenure, the natural surface trail designer was given the opportunity to attend a short course on aesthetics that was run in-house.

The consulting landscape architect briefly covered aesthetics in his course of study during the early 1980s, though not in any great depth. The course did devote a considerable amount of time to the fundamental principles of design, such as unity and colour, which partially focussed on the appearance of the human environment. The major state road authority landscape architect preferred to use the word ‘amenity’ to explain this aspect of his training. Aesthetics was just a part of an overall analysis of how and why people find built and natural environments pleasant and amenable. He also added that, in his opinion, the word ‘aesthetics’ conjured up preconceptions in the minds of engineers and it was far better to use a more encompassing term such as ‘visual amenity’.

A supplementary investigation by the researcher of the current undergraduate curricula offered through the civil engineering faculties of Australian universities confirmed that there are no core units or subjects devoted to aesthetics or ‘visual amenity’. Students with free electives could conceivably complete units from other fields such industrial design or landscape architecture that often have an aesthetics component, but yet this would seem to be highly unusual.

This widespread lack of training in aesthetics among civil engineers has clear implications for the design process used to develop bicycle paths. These are discussed further in Chapter 7.

2. In your planning or design role, do you call on other professionals who have that specific training?

The local government engineer only ever dealt with other civil or structural engineers. He stated that cycling facilities are often additions to an existing anthropogenic landscape and that his role was to 'just build a path.' Although he is almost always the project manager, many of the decisions relating to design had already been made by the time of his involvement.

The engineers from the major state road authority had direct access to a staff landscape architect for path-related projects. However, this individual was only called upon to assist with final landscaping activities and had little or no input into the initial design process. A similar scenario existed for projects that included a public artwork component. In this case, the project management team would seek assistance from a consultant skilled in indigenous or contemporary art, but only as an add-on to an established design.

On complex projects that involved issues outside of his immediate role, the Bikewest engineer generally had to liaise with a consulting design firm that would engage any professional it deemed appropriate. The consulting engineer, who had been employed by these firms in the past, mentioned that the lead engineer on a major path project would only draw upon other expertise if the design brief specifically called for it. Otherwise, all of the design aspects of a project would be the responsibility of the firm's civil and structural engineers.

The natural surface trail designer explained that the expertise of landscape architects, anthropologists and other non-engineering professionals was sometimes called upon for specific infrastructure, such as bridge crossings and campsites, but not normally for design work associated with the trail alignment itself. In addition, the chief designer often received input from regional officers administering the land through which a proposed trail would be constructed and this liaison enabled important local factors to be considered during the design process.

The consulting landscape architect was often a member of an interdisciplinary project team including engineers, architects and planners. However, in these instances he was rarely employed in the role of manager, who would normally be the person responsible for seeking input from other professionals. He noted that civil engineers appear to have routinely taken on the role of project manager, despite only being technicians. They occasionally called on other professionals to provide ‘flair’ but their inherent lack of understanding of the qualitative process meant they usually gave such matters a low priority. This resulted in reluctance on the part of professionals such as landscape architects to then submit their ideas. He ended his comments by saying that engineers are trained to consider projects quantitatively and don’t think holistically about infrastructure design.

Based on the interviews, the consensus appeared to be that the engineers would only seek input from non-engineers when directed to by an overarching policy or design brief. In many cases they would rely on their own knowledge base to design the entire project.

3. From a design perspective, how do you think bicycle paths/trails differ from other transport-related infrastructure such as roads and rail lines?

This question proved to be one of the most difficult to administer, with the researcher having to frequently provide a fuller explanation of the information being sought and some of the key informants requiring additional time to consider their answers. Despite this setback, the final responses were insightful when considered against the research objectives of this project.

The major state government road authority engineers noted that bicycle paths are less complex and have a higher construction tolerance than roads, i.e. they could be built to a less stringent engineering standard. This lower level of complexity meant that there was an increased degree of freedom to 'think outside the square' and be flexible with elements such as alignment and associated features.

The local government engineer suggested that surface quality was a more important factor for paths than for roads as bicycle tyres transmit much more information to the rider than a car tyre does to the driver. He also asserted that path designers needed to avoid certain features commonly used in road design, such as roundabouts, as they increase environmental risk for cyclists. This in turn forced path designers to seek alternative features, or adapt those used in road design.

The Bikewest engineer suggested that compared to motorists, cyclists could put up with a lower level of safety or usability and most had a mindset that allowed them to compromise on the ability of infrastructure to satisfy their needs at a level that the driver of a motor vehicle would not tolerate. He also asserted that bicycle paths have to be designed differently from roads as children and the disabled are important user groups of the former but rarely the latter.

The consulting engineer felt that the design and construction regulations pertaining to paths were less onerous than for roads or railways. He also reflected the comments from his Bikewest counterpart about the willingness of cyclists to compromise more than motorists by stating that the car is seen as 'a big deal' and that there is likely to be much more outcry if a motorist is inconvenienced because of poor design decisions than if a cyclist is. Engineers tend to avoid conflict just as much as any other profession.

As a regular cyclist himself, the major state road authority landscape architect was convinced that riding a bicycle involved a unique experiential aspect and that this resulted in a different relationship with the respective infrastructure than that of a motorist.

Put bluntly, this question really got people thinking. Logically, the design of a bicycle path should differ from other transport-related infrastructure because of a number of factors including the relatively low speed of cycling and the unique experiential qualities as described in Chapter 2. Yet these differences were not part of standard thinking for path designers and were only acknowledged when the researcher actually pointed them out. An example of this is the use of signage for bicycle infrastructure. Following some prompting from the researcher, it was determined that none of the interviewees had considered the particular signage needs of cyclists in comparison to motorists. The relevant Australian standard does provide some guidance as to the dimensions of path signage, but not its placement or orientation. Accordingly, none of the engineers considered factors such as the optical properties of angular speed when locating features associated with bicycle paths and trails, such as signage.

4. Of the three design aspects – safety, functionality and experience - which do you consider to be the most important and why?

This question provided a surprisingly wide variety of answers. The local government representative suggested that function was the most important design aspect as it often determines whether a facility is built in the first place. "Put more simply, it is functionality that drives funding which, in turn, drives the project". He concluded that the current focus of path planning at a local level is the destination and that all other factors are, by comparison, minor considerations. Although not ignored, safety only became an important aspect once functionality had been established.

The local government engineer also noted that on occasion, external agencies, such as redevelopment authorities, had a preference for more complex infrastructure designs and this could result in conflicting priorities.

The engineers from the major state road authority were adamant that safety was always the primary design aspect when designing new cycling infrastructure. The threat of legal ramifications for failing to ameliorate potential hazards was the main driving force behind this philosophy.

The Bikewest engineer considered functionality and safety to be intrinsically linked. His contention was that if a facility was functional, then it should also probably be safe. The consulting engineer also saw a close connection between function and safety but added that he believed the quality of the path surface was crucial because it affected the ride experience. In addition, he related that all of the surveys he had perused asking cyclists for their suggestions of how to improve existing infrastructure, most seemed to indicate results that focussed on safety and functional aspects, such as path-width, lighting or pedestrian conflict. He theorised that matters contributing to riding experience were not mentioned by respondents because they were generally perceived at a sub-conscious level. This didn't make these factors any less important, but meant they were not reported and therefore not readily included in the design process.

Although conceding the need to design for safety, the natural surface trails designer placed the ride experience higher in importance than any of the civil engineers. Part of the reason for this was an assertion that the key function of natural surface trails was to create an experience, rather than as a means of getting from one place to another. Paved paths had to fill a transport role. However, she still believed they clearly had an experiential aspect for some users.

There is no doubt that safety and functionality are important components of a successful bicycle path and therefore rightly feature heavily in current design practice. However, the third element of ride experience that completes the equation outlined on page 12 of this thesis may be much less established in the minds of designers. This deficiency appears to be more a case of ignorance, rather than any deliberate omission. The engineers interviewed as part of this project did not reject outright the researcher's equation for a successful path, but had simply never made a thorough examination of what does, or does not, contribute to successful infrastructure. An interesting theory proposed by the consulting engineer to explain the apparent invisibility of experiential aspects in the minds of both path users and designers can be further explored in the photo-surrogate and in-situ route research component of this project.

5. What current design guidelines do you refer to? Are they mandatory?

The civil engineers from the major state road authority used the relevant Australian Standards including Austroads Part 14 (Bicycles) extensively in addition to their own organisational records. These records have formed the basis of an in-house set of path design guidelines that are currently in draft format and not available to anyone outside of the agency. While the Western Australian Liveable Neighbourhoods policy was acknowledged as a useful overarching strategic plan, it was considered much too broad in content to be a meaningful source of information for day-to-day design procedures.

Local government engineers refer to the relevant Australian Standards and also use the International Infrastructure Management Manual for the management of existing cycling infrastructure and occasionally as a reference for unusual new facilities. The state Government's Liveable Neighbourhoods guidelines provided an important design blueprint, particularly where bicycle infrastructure was being planned for inclusion in new housing developments.

The Austroads Part 14 for bicycles was the main reference used by both the Bikewest engineer and the consulting engineer, with the new Austroads Guide to Road Design set to take precedence when it becomes available. Although these guidelines were not legally mandated, in practice they were considered mandatory and it would be a brave engineer that decided to ignore them.

The natural surface trail designer stated that less than ten percent of mountain-bike trails under his agency's jurisdiction were constructed paths. The vast majority had a natural surface base and were therefore not considered under existing formal bicycle infrastructure standards. Some trail designers feel this lack of formal guidelines needs to be addressed; particularly bearing in mind that there is already an Australian Standard for the design, construction and maintenance of natural surface walking trails (AS2156.2).

The trail designer also referred to in-house guidelines that were based on principles developed by the International Mountain Bicycle Association and adopted by many trail building agencies around the world.

The major state road authority landscape architect made mention of the apparent disparate views across a number of agencies about the role and design of bicycle infrastructure. In his opinion, there needed to be an overarching urban design policy that formed a foundation upon which other guidelines and standards could be built.

It is clear that the Austroads Standards for bicycle infrastructure is the principal document guiding the design of paths throughout Australia. As discussed in Chapter 2, these standards do not include any content related to designing for the riding experience and the researcher contends that they are therefore insufficient as a sole source of information to enable engineers to produce path environments that encourage maximum usage.

6. Where do you source path and trail design ideas from?

The engineers from the major state road authority mentioned that they regularly receive suggestions for new or modified facilities from the general public and cycling user-groups. Neither of the engineers actively sought design ideas from other parts of the world, in part because they felt the local context would be too different to enable a close comparison.

The local government engineer had previously sourced design ideas from external stakeholders and quoted the specific example of a path educational initiative in the Perth southern suburbs. In this instance, primary teachers had suggested the need for some form of visual encouragement to increase student use of the path network servicing their school. Liaison between the teaching professionals and council technical staff had led to the development of embedded footprint symbols and raised platforms to make the existing paths more attractive and accessible.

The Bikewest engineer had taken the opportunity to attend occasional external seminars on the latest planning and design theories, but noted that there was little opportunity to incorporate any of this new information in projects. He also believed that the public consultation process could be a source of design ideas, though these had to be considered within the context of changing political, economic and engineering constraints.

The consulting engineer regularly referred to industry publications for the latest trends. He suggested that special circumstances could be a catalyst for the consideration and analysis of new design ideas. An example of this would be the Copenhagen Lane using a low concrete barrier or parking area to separate cyclists from motor vehicular traffic and which offers an engineering solution for tight spaces, but may not necessarily fit neatly into the local network of bicycle infrastructure.

The natural surface trails designer stated that all of the employees involved in the design of trails were expected to have experience as trail riders. This gave them a clearer insight into the needs of existing and potential users. This experiential requirement was now actually part of the official job description criteria. Staff members located at regional offices were a regular source of design ideas and the trail authority also actively sought feedback from users in the form of log-books stationed at various points along major routes.

The consulting landscape architect sourced ideas from his own reading of professional journals and from community input. He favoured organic design where entire systems are planned in conjunction with the people who will be using them. The landscape architect from the major state road authority read a variety of industry journals and also sourced ideas from his counterparts in other parts of Australia, North America and Europe.

From the interviews it was apparent that the use of innovation in path design was hindered by an apparent philosophy of doing what had worked in the past. Designers did not tend to seek out new ideas because they were not required to do so and could not envisage an advantage in doing so.

7. In terms of functionality, do you design facilities with a particular user group in mind or do you attempt to cater for multiple user-types? If multiple, which types have priority and why?

The major state road authority engineers provided a two-part qualified answer to this question. In principle, authority staff designed bicycle infrastructure for a wide range of potential user from high-speed commuters to children riding to school. However, in practice they tended to focus more on the perceived needs of the regular commuter.

The local government engineer, the Bikewest engineer and the consulting engineer, all described how they create designs from a multi-purpose point-of-view.

The natural surface trail designer stated that most facilities under her jurisdiction were designed primarily for general purpose recreation. The core trail design policy adhered to by her agency was to create seamless experiences which flow from one type or variety of environment to another.

The consulting landscape architect also indicated an intention to design for a wide audience, unless otherwise directed. He asserted that a path or trail benefited from having a theme as this allowed the community to get to know its landscape and be more likely to associate with it. He also strongly contended that all too often infrastructure just suddenly appears and the people who are supposed to embrace it have had no input into its development. The major state road authority landscape architect did not have a specific user group in mind.

8. Do you use a cost/benefit analysis in the design process? If so, how do you make the necessary calculations and where do you source the data from?

The engineers from the major state road authority stated that cost was not really a factor in any of their design work. This was in stark contrast to statements made by both the Bikewest engineer and the natural surface trail designer who commented that cost per metre for paths was an important consideration when deciding upon final design standards and inclusions.

The local government engineer reiterated an earlier assertion that most of the project costings were set prior to his involvement and that he had little to do with the actual calculations. Similarly, the consulting engineer was usually required to adhere to a design brief with strict budget parameters.

Unlike his counterparts at the major state road authority, the Bikewest engineer advised that cost was a major factor in the development of local bicycle infrastructure. All facilities could be upgraded later if required and savings obtained from one job could be put toward the cost of another future job. He described how it was often a case of designing for the best outcome, rather than to an inflexible formula. It was better to build more paths at an adequate safety and functional standard than to settle for less albeit at an ultimate level of quality. To put it another way, the gains to be made from using very high technical standards were not exponential.

The natural surface trail designer also stated that cost was a major factor and explained how the design process was closely linked to user feedback and subsequent statistical trend analysis obtained through a number of avenues, including on-route surveys and trail counters.

The major state road authority landscape architect was required to work within established budget parameters that had been determined by the project planners.

Most path projects have definite cost constraints placed upon them and this has an obvious affect on the scope and nature of the design process. However, even for those projects where cost is not a major deciding design factor, the experiential aspects of riding environments are not being considered. This fact was clearly communicated by the Bikewest engineer who conceded that even path projects designed to a theoretical ultimate standard and featuring state-of-the-art safety and functional aspects, would not necessarily provide an effective riding experience because that would not be part of the initial design.

Discussion

The key informant interviews have provided valuable insights that assist in addressing a secondary, yet significant, research question about the contemporary path and trail design process. Although establishing empirical knowledge about what constitutes an experientially successful riding environment is the primary goal of this project, it is valueless if the supporting process does not provide an opportunity for implementation. Accordingly, the attitudes, beliefs and motivations of the people responsible for this implementation take on considerable ongoing importance.

It is clear from the review of the literature that the psychophysical, sensory and cognitive nature of cycling allows bicycle paths and trails to occupy a unique niche in the field of civil engineering. Unlike other infrastructure, such as roads, ports or dams, that are overwhelmingly functional, riding environments have a direct and immediate impact on the human experience and therefore require a different theory of design. Responses from most of the key informants demonstrate that aesthetic and experiential components of these riding environments are not simply given a low priority, but they are missing entirely from the design process. The study of such matters is entirely absent from the training of the experienced civil engineers who were interviewed, and it would seem that even current engineering students receive no relevant exposure, either because of an already overcrowded curriculum or due to a lack of specific knowledge amongst course developers.

The education of engineers may not be the only factor behind a current lack of affinity with experiential design. As commented on by several of the informants, engineers and other transport infrastructure designers are not generally paid to be innovative and accordingly, tend to only “do what they know”. It is clear that a quantitative mindset prevails across the profession and this hinders the introduction of concepts and strategies which are qualitative in nature, such as riding experiences, derived from and heightened by the fully informed design of infrastructure. This no doubt is further hindered by the apparent sub-conscious or ‘invisible’ nature of experiential aspects.

Perhaps the most telling remark arising out of the key informant interviews came from the landscape architect who passionately asserted that from a community point-of-view, substantial infrastructure all too often just seemed to materialise overnight from nowhere and the people it was meant to serve had enjoyed no input and were therefore all-to-often immediately alienated from it. This cuts to the core of the research project by illustrating how the design of infrastructure can be so completely inhuman and lead to facilities that are underused or ignored completely.

Further discussion about the above mentioned points and additional aspects of the design process can be found in the recommendations section of Chapter 7.

6.3 Results of route elements and environs evaluation

This section provides an analysis of the specific elements or features of the various riding environments and is not route dependent. The results are presented for aspects related to the path itself, the landscape surrounding the path and any associated features of the overall riding environment.

6.3.1 In-situ routes assessment

Path

Several experientially influential aspects of the path or trail itself emerged during the in-situ component of the research including texture or composition, colour and alignment.

The preference for paths with a smooth, uninterrupted surface was very strong. A path surface that consisted of individual paving bricks was uniformly perceived by respondents as less favourable than solid surfaces. The unevenness of the pavers created a distinctive tactile response and that proved to be disturbing to the overall riding experience. This attitude was regardless of the type of bicycle being ridden with those using wide-tyred hybrid bicycles just as likely to find fault with paving as those using narrow-tyred road bikes.

Colour preferences of the path surface proved to be harder to distinguish with some respondents enjoying a lighter shade and others happiest with a traditional darker-coloured bitumen. In some instances, the decision on preferred colour was based on the prevailing landscape. For example, a riding environment that traversed an area of natural vegetation or parkland was most likely to be perceived best as having a light-coloured path that seemed less obtrusive to the visual scenery. Through further prompting it was inferred that this reflected a desire on the part of the respondents for the Kaplan concept of legibility in the riding environment and in turn gave the impression that the path or trail was a meaningful part of the landscape, rather than being forced upon it.

The respondent perception of path alignments that were meandering and straight was clearly differentiated. Gentle meanders were found to be either pleasant or likeable and to accentuate the variations present in the surrounding landscape. Straight sections were not considered unpleasant and a negative perception only became significant when they appeared to dominate a particular riding environment. The ‘right’ combination of curves, straights, mild undulations and flats provided experiential variety, both via the riding action itself and the exposure to different lines of sight that introduced new scenes or created anticipation for future scenes. This important so-called ‘butter-zone of alignment’ is discussed further in Chapter 7.

Finally, it also needs to be noted that all but two of the in-situ route respondents mentioned undesirable interaction with pedestrians during one or more of their rides. Although this aspect falls outside the scope of the research project and has therefore not been included in the analysis, its overwhelming prevalence would suggest a need for the relationship between path users and the impact of that relationship upon the riding experience to be explored in some future empirical investigation.

Path surrounds

The presence of shade was a highly valued characteristic among the majority of respondents. However, the specific optimal extent and nature of the shade was difficult to gauge. The statement that seemed to describe this concept most representatively was ‘intermittent canopy’. Riders preferred vegetation that was within ten metres of the path or trail, dense and sufficiently high enough to provide periods of shade.

Another important factor influencing the riding experience was the presence of traffic noise. It is notable from the research that the auditory sensation of nearby traffic was more powerful than the visual sensation with more respondents commenting on the noise created by large motor vehicles than the view of those vehicles. Where it was applicable (routes 2 and 4), the noise generated from the adjacent rail line was not considered to be reportable by the respondents.

During the interviews, the occurrence of both recreational activity and provision for that activity emerged as desirable features for the area surrounding a path or trail. Several respondents highlighted activity-based stimuli, such as playgrounds, boats and golf courses, and when discussed at greater depth, revealed that the riding environment was rather more than just a strip of concrete or bitumen that traverses a landscape. Birdlife also provided a significant boost to the perceived value of a riding environment.

Other key descriptive phrases used in relation to the path or trail surrounds included those associated with experiencing open bodies of fresh water, either natural (rivers and lakes) or artificial (ponds and fountains). From this emerged a clear preference for riding environments that included at least one such feature every few kilometres.

Several respondents made mention of a particular feature on Route 2 of which the researcher was unaware. None of them was able to immediately identify it and this created a degree of fascination as they rode past. Further investigation by the researcher after the interviews had been completed revealed that the structure in question was a water treatment facility housed in a partially-exposed historical building.

Associated features

The most frequently mentioned features associated with a riding environment were those that provided the rider with an insight into the landscape they were moving through. These included interpretive signage, monuments and lookouts. The effect was particularly strong when the associated features had a direct and immediate relationship to the surroundings. Further prompting revealed that this relationship led to high levels of coherence and legibility which, according to the Kaplan information-processing theory (Kaplan, 1987), provides a preferred perceptual response.

Reaction to public artwork appeared to be related to size and placement, rather than substance. Much of the time the respondents would refer directly to prominent pieces of public artwork that were within the direct sightline of the path alignment, but could only recall other works located outside of this angle of visual acuity when actively prompted by the researcher. Items situated at right angles to the path alignment and not introduced through the avenue of an earlier curve had little or no impact on the riding experience.

6.3.2 Photo-surrogate routes assessment

Path

As with the in-situ component of the research, several experientially influential aspects of the path or trail itself emerged during the photo-surrogate assessments, including composition, surface colour and horizontal alignment. Most of the respondents found the coloured path surfaces and the natural gravel surface more inviting than the traditional grey surface of the concrete paths. This formula applied regardless of whether the entire route consisted of one type of surface, or there was a mix of surfaces used along a single route.

There was a distinct preference for some mild curvature in the path alignment in comparison to long straight sections. Those images presented to respondents that clearly showed a meander (a curve in one direction followed by a curve in the other direction) were more preferred than those that only depicted a single curve. This relationship applied to all of the routes regardless of the surface composition and colour.

The appearance of clearly defined path edges, particularly when painted, and centre markings among the photo-surrogate routes received favourable comments from several of the respondents.

Path surrounds

Natural vegetation and manicured grassed areas stood out as the most preferred feature of the path surroundings. If large trees with a broad structure were also present in the vicinity of the path, this specific factor produced the strongest positive response. There was a slightly higher degree of preference reported for open vegetation than for a densely forested landscape with the trees and shrubs close together. There was no reported difference in preference for images that showed nearby vegetation casting shadows on the path surface than for those that indicated no shadows.

Although not a strong indicator, paths that were aligned to a road reserve were less preferred as riding environments than those that were either constructed away from a road or visually separated from traffic by a substantial barrier.

The presence of open bodies of water, regardless of whether in the form of ocean, river, lake or pond, was not a strong factor in determination of preference. Based on the findings from the literature review and the in-situ component of this research that suggested water as being a key element in route perception due in part to its ability to present a constantly changing and interesting environment, it is theorised that this lack of influence resulted from the use of a static image to deliver stimuli severely limited the participant's ability to discern action.

Associated features

The recall of public artwork was stronger during the photo-surrogate route assessments than it was for the in-situ route assessments. This may be the result of absorption of the static image of an element as opposed to the fleeting nature of observation when in motion on a bicycle. Those items of artwork or of an interpretative nature that appeared large in the images had a greater awareness level and higher preferential rating than smaller items.

There was also a clear preference for items that were presented in a vertical or erect format than those embedded in, or near, the path surface.

Several respondents found the absence of other path users in most of the images depicting all five routes worthy of comment. When this factor was probed more deeply by the researcher, it became apparent that the appearance of deserted paths and trails invoked a complex mix of feelings. On the one hand it gave the impression of 'perfect' routes where the imagined rider was free fully experience the features, aspects and elements. On the other hand, it raised questions in the minds of respondents about why other people had not recognised the experiential potential of a particular route.

6.4 Results of entire route evaluation

This section provides an analysis of various riding environments in their entirety and how specific elements link together to create a riding experience. Descriptive terms emerging from the research were matched to verbal descriptors used in established perceptual models including Russell (1980), Czikszentmihalyi (1997) and Myers (2006) to establish a uniform measure of assessment.

6.4.1 In-situ routes assessment

Route 1

The coastal riding environment produced the highest degree of deviation in preference among the research participants. Several respondents highlighted the fact that this route seemed to be the longest by a considerable margin, despite it being geographically similar to the other four. When probed about this aspect, the respective respondents reported the long uninterrupted sightlines along the coast as being a possible factor. The visual impact of ocean views alone was not particularly strong however, the level of positive awareness increased significantly when the image was accompanied by other relevant sensory feedback such as the smell of salty air and the sound of waves crashing.

Another important characteristic mentioned by some of the respondents was the apparent irreconcilable relationship between the natural and anthropogenic aspects of the riding environment. Despite being in close proximity to the wide open expanse of the Indian Ocean, the opposing landscape is one of high density human development and this caused some respondents to acknowledge that the riding environment “felt very built up” and “disconnected”. This reaction may confirm the concept of a need for environmental coherence (Kaplan, 1987; Herzog, 1987) with the beach and urban development creating a perceptual conflict for those riding a thin path between both.

This route includes sections where the path alignment came very close to a major road (West Coast Drive) and other sections where it leaves the road reserve by some distance. This change in proximity that created a buffer between rider and road was duly noted by several respondents, with the latter alignment being universally preferred.

Route 2

The rating of the inner suburban route that incorporated greenways was consistent across most respondents and did not engender any extremes of view. Although not a problem at first, the adjacent rail line in the initial section of the route began to detract from the overall riding experience after a while, as did the concluding section alongside a major road.

A common response was dislike for changes in path texture or composition with an emphasis on the use of paving slabs that created an uneven ride.

Manicured vegetation near the path, including low hedges and canopy-forming broadleaf street trees, received high satisfaction ratings by most respondents. Further prompting revealed that these elements promoted a ‘relaxed’ riding environment that encouraged riders to proceed at a slower pace and therefore experience more their surroundings. Respondents also reported a desire to continue riding along the route after the designated finish point.

Route 3

The outer suburban route was perceived in a negative or neutral light by the majority of respondents. Key phrases classified under this route included “nothing to see” and “no reason for using it”. Although all respondents reported that the quality of the path surface was very high, this feature was unequivocally insufficient to alleviate the overall impression of boredom and an experientially-poor riding environment.

Despite indirect prompting by the researcher, none of the respondents mentioned the towering power pylons that follow the path alignment. These pylons vary in proximity to the path, being either part of the mid-distance landscape (200 metres to 1 kilometre) or the distant landscape (1kilometre or more). This lack of response to any features, either positive or negative, that are remote from the riding environment was consistent across all route assessments.

Interpretive signage near the conclusion of the route proved to be too indistinct to register interest with any of the riders.

Route 4

The riverside suburban route was generally perceived in a very positive light by all but one of the respondents. The most frequently mentioned characteristic by these individuals was the favourable presence of experiential variety that produced a pleasant riding environment. Through deeper discussion it emerged that this variety stemmed from a combination of individual features, different mercurial landscapes and a path alignment that presented a large number of sightlines. Further interest was garnered from the presence of nearby recreational activity among adults, children and animals.

This route was perceived as having two distinct halves, with the first being dominated by other infrastructure, such as buildings, roads and a rail corridor, and the second presenting a park-based riding environment. As with Route 1, there was notable preference for the portion of the route that featured a substantial distance buffer from roadways.

The latter half of the route was praised for the intermittent shade canopy, manicured gardens and provision of public artwork. However, it is noteworthy that only a small percentage of the individual pieces of artwork and interpretive/educational features along the route drew comment as a result of the visibility issues already mentioned.

Route 5

In common with Route 1, the natural surface trail provoked a significant deviation in perceptual preference among respondents with overall perception ranging from “boring” at one extreme of the scale, to “magnificent” at the other extreme. In some instances, accessibility seemed to be a major factor in determining the level of preference with respondents expressing initial reservations about the trail’s gravel surface. For one person, this reaction appeared to overwhelm any other experiential input.

This route appeared to provide respondents with the most non-visual stimuli. This may have been the result of there being a wider selection of stimuli in the vicinity of the riding environment, or the presence of less common forms of stimuli. A frequently mentioned sentiment was that the sudden and brief appearance of a road and subsequent motor vehicle traffic at two points along the route had “spoilt the ambience”. A similar comment was received from a couple of respondents with regard to the untimely appearance of a telephone exchange cable box.

The direct and immediate link between the route’s historical significance and the experiential cues presented to riders was noted and enjoyed. This perception was summed up by one respondent who stated that the trail “had a story to tell and I wanted to listen to it”. Specific features such as hand-carved rock face cut-aways and elements of railway history integrated into the alignment itself gave the trail a deeper significance for several of the riders.

The clear relationship between artwork and interpretative features along this ride, and the historical/cultural aspects of the route (being built on an old rail line used to transport timber during colonial times) was recognised and appreciated by more than half of the respondents. This in turn was reported as having led to a greater awareness of more subtle elements, such as the cutaways mentioned above. Further discussion saw descriptive phrases emerge such as “I could visualise just how hard it must have been for the builders” and “by riding the route I felt I was honouring their achievement.” These could be indications of an underlying narrative for this trail.

6.4.2 Photo-surrogate routes assessment

Route 1

This route, incorporating a selection of landscapes and features, received the highest overall rating from respondents. The large piece of public artwork, the functional gateway and the historic reproduction rest stop all received unprompted favourable comments from the majority of respondents. The eclectic appearance of the route generated descriptive phrases from respondents, including “it just looks like a fascinating ride” and “there was a surprise around every corner”. Accordingly, there was no specific element of the route that raised the ire of respondents or was considered to have detracted from the overall enjoyment. The only respondent who rated this route poorly did so because of specific psychological dislike of narrow bridges.

Route 2

This route using a mix of path treatments and a varied landscape invoked some diverse opinions among respondents. The most frequently mentioned characteristic by respondents was the use of vegetation to ‘frame’ the path forward of the rider’s immediate position. Both the historic building incorporating a water feature and the stonework interpretative display received several favourable responses. This aforementioned feature was the same mysterious one that was reported by those people completing the in-situ route 2. One of the key phrases reported during the interviews was “the lack of a theme”. Although specific features such as the stonework interpretative display were well received at a visual level, it also contributed to the feeling of a somewhat disjointed riding environment that on one level was appealing and on the another lacking in flow. The horizontal commemorative artwork initially caused some confusion among respondents, but was well accepted when the researcher described its purpose.

Route 3

This inner to mid-suburban route with little overall variation was widely perceived as the least interesting and visually enticing of the five photo-surrogate riding environments. Key phrases noted during the assessment included “you would only ride it with a destination in mind” and “too sparse”.

Following further discussion, two of the respondents characterised the route as being ‘military paths’. The infrastructure was basic and functional and probably cheap to build. In other words, it gave the appearance of local government building a path in order to meet minimum standards or expectations rather than to actually provide a riding environment and experience.

The final sequential image that depicted the route traversing a manicured park was singled out by several respondents as it created such a stark contrast with the rest of the route and offered potential. This one image however, was insufficient to act as an antidote for the experientially poor perception produced by the overall route. This route was the only one to draw comment about the proximity of the riding environment to roads.

Route 4

The riverside suburban route which mirrored the fourth in-situ route was generally received in a positive light by the majority of respondents. One person found the highly manicured nature of the route to be less interesting than some of the other routes with less distinct edges and travelling through a more natural landscape. Others found the route pleasant but visually a bit repetitive.

The interpretive signage depicting birdlife and the vicinity of an open body of water to the path or manmade freshwater feature were all noted by respondents, but they were not mentioned as important determinants of overall preference for the route. Several respondents were disappointed that two other informational signs were difficult to read though they persevered and eventually gained the knowledge they were seeking. It should be noted that the size and clarity of the signs appearing in the images were deliberately manipulated by the researcher so as to reflect their readability by someone actually riding on the real path.

Route 5

In common with the in-situ route that it mirrored, the natural surface trail photo-surrogate route splintered respondent opinions between positive and negative perceptual preferences. Some individuals were immediately attracted to the natural landscape depicted in the photographic sequence. Others were unsettled by the lack of infrastructure or the heavy shade that appeared to pervade some of the images. This may have been a direct result of the widely acknowledged inherent perspective-related problems of using two-dimensional photographs to capture the essence of three-dimensional natural scenes (Zube et al., 1987).

In a similar manner to the response provided to the visual aspects of Route 3, some respondents used descriptive phrases such as “uninviting” and “not my cup of tea”. Of all the photo-surrogate routes, this was the one that respondents would have required some background information about its cultural and/or environmental significance. This was in contrast to routes 1, 2 and 4 where individual features were able to stand alone and have a purpose in the minds of respondents.

6.5 Results of route comparison evaluation

This section provides a comparative analysis of various riding environments in their entirety with an emphasis on preferred riding experiences. After assessing the riding environments, the respondents were asked to imagine that all five in-situ or photo-surrogate routes were equally accessible to them. The researcher suggested that each route started at the front door of the respondent’s residence. The respondents were then asked to provide feedback about the most and least preferred of the routes.

6.5.1 In-situ routes assessment

The research revealed clear favourites among respondents for the most preferred and least preferred riding environments examined during the in-situ component (Table 6.1).

Table 6.1: Summary of the most and the least preferred in-situ routes

	Route 1	**Route 2**	**Route 3**	**Route 4**	**Route 5**
Most preferred	RM2; RM6	RM1; RM5		RF1; RF2, RF5; RF6; RM4	RF3; RM3; RF4
Least preferred	RM3; RM6; RF4		RF1; RF2; RF3; RM2; RF5; RF6; RM5		RM1; RM4

Route 4 incorporating a riparian outlook clearly provided the highest degree of preference for riders. Similarly, the outer suburban Route 3 situated alongside a major highway was widely considered to be the least enjoyable riding environment. This aversion by research participants to the lowly-rated route was best summed up with the often-cited statement: “I would never ride that path again.”

In between these two extremes, the remaining three routes received a mixed reception. It was evident that personal affinity with either a very natural or a predominantly artificial landscape playing a part in these mid-range responses. The dense forest environment hosting Route 5 proved to be an exciting psychophysical experience for some riders while leaving others bored or anxious.

Rather than the experiential impact of specific aspects, features and elements along the course of this route, the overriding factor in determining preference was the individual’s relationship to the Australian bush. Similar sentiments could explain the heavily divided response to Route 1, with people who are drawn to the coastal lifestyle being far more likely to rate the riding experience highly. This outcome may also manifest itself through the individual’s degree of sensory appreciation. Both of the two male respondents who ranked the coastal route as the most preferred route, both mentioned the distinctive sounds and smells of the environment in addition to the visual aspects. The only two routes from the research that resulted in recall of strong sounds and smells were routes 1 and 5.

Variety and complexity, or the lack of both, was mentioned by most respondents in relation to all of the assessed in-situ routes. Routes 2 and 4 provided the greatest amount of experiential variety for the widest number of people.

As mentioned in the previous section, the presence of an ocean vista had less of an effect on route preference than did visual exposure to sources of fresh water on other rides. The coastal route, which provided riders with many glimpses and lengthy views of the Indian Ocean, was not among the most preferred riding environments. Only one of the respondents found the saltwater environment to be experientially equivalent to the freshwater environment of Route 4.

The presence of traffic noise on some routes, but not for others, had a clear impact on overall preference of riding environments. Routes 1 and 3 had the highest amount of ambient noise during the length of the ride and they were reported by the majority of respondents as the least preferred riding environments. Routes 2 and 4 included sections that required the cyclist to ride in the near vicinity of roads, but these had low traffic volumes and did not produce any declared negative influence on respondents.

The amount of recreational activity occurring in view of the path varied significantly across the five routes. High amounts of activity were reported on Routes 1 and 4. Participants reported moderate levels of activity along Route 2 and low levels on Route 5. No participants reported any significant activity along Route 3. Much of the activity was reported as occurring in the vicinity of the riding environment rather than the on the path itself. The coastal route (Route 1) went against this trend however, with several respondents admitting that the busy traffic along the route had a negative impact upon their overall preference.

Table 6.2: Overview of respondents' route assessment based on a descriptor scale derived from Russell (1980) and Czikszentmihalyi (1997)

	Route 1	**Route 2**	**Route 3**	**Route 4**	**Route 5**
RM1	Pleasant	Flow	Boredom	Pleasant	Boring
RF1	Unpleasant	Pleasant	Apathy	Pleasant	Relaxing
RM2	Arousal	Apathy	Boredom	Pleasant	Arousal
RF2	Anxious	Flow	Anxious	Pleasant	Apathy
RM3	Boredom	Pleasant	Control	Pleasant	Pleasant
RF3	Arousal	Arousal	Boredom	Pleasant	Arousal
RM4	Pleasant	Pleasant	Gloomy	Flow	Boredom
RF4	Anxious	Anxious	Boredom	Pleasant	Pleasant
RM5	Pleasant	Pleasant	Gloomy	Pleasant	Pleasant
RF5	Apathy	Pleasant	Boredom	Pleasant	Apathy
RM6	Pleasant	Pleasant	Boredom	Arousal	Pleasant
RF6	Pleasant	Pleasant	Apathy	Pleasant	Pleasant

6.5.2 Photo-surrogate routes assessment

In common with the in-situ component, the photo-surrogate assessments research revealed a clear leader in the determination of least preferred riding environment. By contrast, however, the establishment of the most preferred riding environment was less than definitive (Table 6.2).

Route 3 was widely viewed as offering little or no value in terms of riding experience. Although the alignment and apparent path surface did not unduly concern any of the respondents, they reported that these aspects compared unfavourably with most of the other photo-surrogate routes. A lack of variety was a common complaint with almost the entire route using basic concrete paths and a road reserve alignment. The relationship between visual variety and perceived variety of the riding experience was very strong for this route.

In a similar manner to the in-situ routes, variety or complexity was an important factor in establishing preference for a particular photo-surrogate route over another.

The more restricted range of responses from participants to the photo-surrogate routes compared to their in-situ counterparts indicated that the photo-surrogate could not deliver a multi-sensory experience provided by the in-situ rides. The difference in sensory input provided by the in-situ and photo-surrogate routes became particularly evident during the assessments of the natural surface trail. A percentage of respondents in both assessments immediately disliked the trail route and for the photo-surrogate participants this opinion did not vary throughout the activity. However, several of the in-situ participants garnered more affinity for the trail route as they progressed. Indeed, two respondents who began the ride feeling anxious and emotionally disconnected reported a feeling of mild elation at the end. This passage was then reflected in their overall assessment of the riding environment.

Table 6.3: Summary of the most and the least preferred photo-surrogate routes

	Route 1	**Route 2**	**Route 3**	**Route 4**	**Route 5**
Most preferred	VF1; VF5; VM1; VM4	VM3; VM6	VF3	VF4; VM5	VF2; VM2; VM7
Least preferred	VF1		VF2; VF4; VF5; VM1: VM2; VM4: VM6; VM7	VM3	VF3; VM5

6.6 Socio-demographic effects and group differences

This section provides an analysis of the reported differences in the experiential perception of riding environments across common socio-demographic groupings and those groups identified by authorities as important target audiences for the promotion of greater cycling participation.

The most clearly defined group difference emerging from the route assessments was related to gender. Findings from the in-situ component of the research indicated a significant divergence in preference for certain riding environments and aspects. Female respondents reported a high recall for traffic noise on most routes which resulted in a negative perception of those routes. This auditory awareness of motor vehicles extends to strong preference for paths that have some physical separation and sound barriers from roadways. In contrast, the photo-surrogate route assessments revealed little recognition of the correlation of traffic awareness and route preference with no mention made even when considering the riding environments with visible vehicles (Routes 2 and 3).

Male respondents reported a greater affinity for riding environments that provided the rider with visual, auditory or olfactory awareness of the ocean. Although both genders showed a significant preference for landscapes that included water, females only reported this response to open-bodied freshwater resources such as lakes, rivers and water fountains. Males also reported more awareness of signage than did females, though this may be a product of familiarity as the former group ride more often than the latter.

More than half of the female respondents indicated a liking for activity occurring (in-situ assessments), or a desire to see activity (photo-surrogate assessments), in the vicinity of the riding environment being traversed. This factor clearly added interest to the overall riding experience and this may result from the fact that the women tended to see a riding environment as an opportunity to observe the world as a spectator. Males did not demonstrate such a strong correlation between near-path activity and route preference. It is also interesting to note that the positive attitude to near-path activity did not extend to the path itself, with respondents preferring quiet paths with any activity occurring nearby and not interfering with the journey.

On a broader level, female respondents who completed the in-situ routes generally reported a wider range of sensory experience from their rides than did their male counterparts.

Another gender-related difference was noted in the experiential preferences according to level of openness to experience.

According to the research, age appeared to have little effect on a respondent's experiential range and depth, nor on their preference for a particular riding environment. The only caveat to this finding was the reported tendency for older riders to place slightly greater emphasis on the historical and cultural aspects of a route.

The research was not able to establish any correlation between level of educational attainment as almost all of the respondents were tertiary qualified.

6.7 Summary of research outcomes

This section provides an overview of the key results arising from the assessment of in-situ and photo-surrogate riding environments conducted as part of this research project.

Based on the frequency, scope and level of responses, the most significant finding emerging from the route assessments was a strong preference for riding environments that offer experiential variety. There was also clear indication that a sufficient level and frequency of such variety could overcome perceived negatives and lead to the production of an enticing and successful cycling route. This variety can refer to the mix of individual features, the types of landscape or to path alignments, such as meanders, that offer variations in the rider's field of vision.

The other highly significant factor that emerged from both the in-situ rides and the photo-surrogate presentations was the favourable response to the presence of water. In some cases, this presence could be the highlight of a riding environment. This preference was particularly strong in relation to artificial open bodies of water, both artificial and natural and less so for marine environments.

Less clear, but nevertheless significant, was the preference for vegetation that provides some degree of shade to the path and the rider or trail-user. This functionality had a higher influence on respondent attitudes than did any aesthetic aspects, and in turn, calls into question the appropriateness of landscape preference models that predict a relatively high preference for mid-distant and distant vegetation. The Shafer model is based on data obtained from photographically-presented environments and would therefore fail to take into account factors such as user comfort and changes in light intensity. It also has to be noted that the in-situ component of this research was conducted during the warmest months of the year and this may have affected the results.

Although non-visual sensory input such as sounds and smells did not present as environmental attractors on their own, there was some evidence from the in-situ assessments that they could intensify the positive experiential impact of visual stimuli. This outcome was considerably stronger when combined with the sound of wave action and the distinctive smell of the beach. There did not seem to be a significant preference for dynamic water-based landscapes over static ones as reported in other previous environmental preference studies, such as Brown and Daniel (1991). This may relate to the fact that Brown and Daniel used video technology to display moving water while the participant remained stationery. The relative effect on preference of having the participant in motion, such as a cyclist, to that study is not known.

Interestingly, one source of sound was clearly shown to be a strong detractor. Traffic noise and the sounds emitted by heavy vehicles, such as trucks in particular, was a powerful, preferential disincentive. Somewhat surprisingly, the visual experience of traffic received much lower acknowledgement than the auditory experience. It could be surmised that this is the result of a psychophysical response common to cyclists who innately react to the threat posed by a large vehicle approaching from behind them. The negative impact of traffic was strongest for the natural surface riding environment

Mild undulations appear to add interest by providing a slight challenge while not being enough to detract from the ride for occasional riders. The effectiveness of other factors, such as mystery, playfulness and harmony, were hinted at but not clearly determined by the research. This could be a direct result of their apparent sub-conscious nature and the lack of awareness of them during the riding experience. This was borne out by the frequent need for the researcher to offer prompts to questions relating to feelings about aspects of routes. In a number of instances the respondents needed to spend time contemplating their ride experiences in order to understand their experiential reactions.

Apart from a definite preference for historical links between the riding environment and the immediate surroundings, what is also unclear is the impact of separate features associated with riding environments. Public artwork only appeared to affect rider experience if it was located in the direct line of movement.

An overarching need for some form of coherence appeared to slowly emerge and must be taken seriously by path and trail designers. Regardless of the elements, features and perceived benefits of a riding environment, it must be viewed as an holistic experience and one where the individual pieces fit together.

An important finding for future path development is the observation that the functional quality of a riding environment does not equate to the preference for a specific riding environment. The respondents represented a cross-section of the cycling public and included individuals who ride predominantly for recreation and individuals who ride for utility purposes.

The static nature of the stimuli used during the photo-surrogate route component of the research meant that respondents were unable to experience activity near a path or trail. Accordingly, they generally allocated a lower preference rating for photo-surrogate routes than similar in-situ routes.

It would appear that the principles of Gestalt theory discussed in Chapter 2 had an application in the photo-surrogate route assessments, with respondents filling in the perceptual gaps between static images and thereby manifesting a self-induced coherence and narrative. The in-situ riders would struggle to achieve this same level of coherence unless the riding environment was designed to enable it to happen. A continuous video of a route would reduce this tendency to self-organise, but this may be counterproductive if the actual coherence of the riding environment is lacking.

Chapter 7 Discussion, implications and conclusions

The following chapter considers the results obtained throughout the course of the research project in terms of the study's original research questions and objectives. The chapter also includes a detailed list of recommendations for incorporating the findings into current path and trail design practice, along with an overview of future research needs.

7.1 Research questions

This section considers and summarises the most significant research findings for each of the study's core research questions as outlined in Chapter 1.

Which experiential design aspects of bicycle paths and their surrounds affect the riding experience and influence route choice? A number of indicators have emerged from the qualitative research component of this project which may provide insight into the experiential design aspects of riding environments that have the potential to increase participation rates.

Perhaps the key element to a successful riding experience is the presence of experiential variety, or experiential complexity. This can be as simple as not allowing a sense of boredom to take hold during a ride. Variety can be achieved through the placement of elements or composition of landscape and often only requires small changes, adjustments or modifications in the path, surroundings or associated features to achieve a satisfying effect.

The power of variety also depends upon the ability of a rider to actually perceive it. A combination of curves and reverse curves that create a meandering alignment are effective at changing the rider's point-of-view and to offer a better angle of visual acuity for objects or features located near the path or trail. Changes in the vertical alignment are also able to change the rider's point-of-view, but this ability needs to be weighed against the perceived negative effect that overuse of undulations can have on rider comfort.

The degree of experiential impact of meandering routes on cyclists may be limited by physical barriers. Myers (2006) found in a quantitative study of motorists using the Blue Ridge Parkway that the curving nature of the road was considered exhilarating by 27% of respondents with a further 40% rating it as pleasant. Although a number of comments emerging from the in-situ assessments of this research project also indicated that curves created a pleasant riding environment, none concluded that they produce a level of exhilaration. This apparent difference in degree of experience between motorists and cyclists may result from the former moving at a faster travel speed and therefore gaining a higher and more sustained sensory input from the alignment.

Other aspects of the riding experience, such as playfulness and mystery, can provide the rider with a sense of variety, although these factors may not operate at a conscious and easily observable level. Playfulness is best achieved by making the riding experience a mild psychophysical challenge. Mystery can be created through the use of physical delaying tactics, such as gateways, meanders and anchors. These two factors appear to be strongest when in combination, with the ideal levels of skill and challenge creating a sense of flow.

A second key element of a successful riding experience appeared to be the presence of coherence within the riding environment which, in turn, resulted in a satisfying state-of-flow. Although specific features or aspects of a route can stand-alone as attractors, they must fit the overall riding environment. The established landscape design principles and elements can assist practitioners to achieve this sense of coherence.

Water in the vicinity of a path or trail appears to be an almost universal predicator of route attractiveness. There are at least two distinct reasons for this preference:; 1. water itself is an attractive feature; and 2. water provides a constantly changing environment that offers variety and avoids repetition. Given the choice however, people prefer views of freshwater that are in motion over ocean scenes.

The composition of the path surface makes a contribution to the overall riding experience. A riding environment that includes a smooth and light-coloured surface is most preferred. Standard grey concrete or individual paving bricks are clearly less preferred.

The absence of traffic noise, and to a lesser extent that of the sight of traffic, are strong factors in the establishment of a preferred riding environment. The results from the in-situ assessment component of the research supported the findings of Anderson et al. (1983) that found the presence of traffic noise had a significant negative impact on perceived landscape preference and the work of Goossen and Langers (2000) who identified the importance of tranquillity for cyclists riding in rural areas. It also correlated closely with a small-scale survey in the United Kingdom reported by Downward & Lumsdon (2001) that found a preference among recreational cyclists for quiet, traffic-free routes.

Although the occurrence of specific sounds and smells in isolation could not be considered to have a clear positive influence on a person's riding experience, there was evidence that they could intensify the positive experiential impact of associated visual stimuli. Two examples of this catalytic effect are 1. the sound of waves and the smell of the beach combining to strengthen an ocean view and; 2. birdsong and floral perfume combining to strengthen a landscape that includes vegetation in bloom.

The presence of recreational activity near the path assists in the development of environmental variety and helps to establish an ambience or sense of place. In contrast, activity actually on the path or trail itself is not considered a preferred characteristic.

There is strong evidence that the proximity of vegetation and the provision of intermittent shade can engender a preferred riding experience. The vegetation can be native or of a exotic broadleaf variety, but needs to be within 20 metres of the path edge and of sufficient height to create shade on the path surface. If not native, it has a stronger presence if well-maintained.

The research findings conclude that public artwork and interpretative or educational exhibits can add to the experiential variety of a riding environment. Most importantly, these features can assist to create or support an environmental narrative that in turn gives an emotional component to the riding experience. To have any chance of being effective, items need to located within the rider's visual field of acuity and be of sufficient physical size to enable immediate interpretation. Features that have a direct relationship to the path alignment, historical significance or surrounding landscape are more likely to be successful in assisting to create a favourable riding experience.

What are the best means of communicating the benefits and aspects of particular riding environments to the community?

The full multi-sensory nature of the bicycle riding experience is very difficult to adequately convey using two dimensional delivery platforms such as publications, videos and websites. In order to so, it will be necessary for the producer to carefully consider the prevailing mix of content, focus and style.

All communication strategies developed to promote riding environments should outline the experiential benefits as these have been shown to be major contributors to route selection. Ideally, the promotional material should not only highlight the visual aspects of a path or route but also attempt to describe the sounds, smells and textures, particularly if they can be directly linked to the images. Such attention to the multi-sensory nature of a route has been shown to heighten visual impact.

Based on the research outcomes from this project, routes that can incorporate a narrative or routes that have historical, cultural and environmental relevance to the immediate area should be the focus of promotional efforts. Taking the potential rider on a imagined journey enables the promoter to appeal to their intrinsic need for environmental coherence and legibility.

Results from the photo-surrogate assessment component of this research project suggested that static depictions (in publications) of certain riding environment aspects could prove to be effective communication tools. These included public artwork, gateways, bridges and some simpler forms of interpretative signage. In many cases, photographs accompanied by appropriate text enables the potential path user to study the feature or element in greater detail than even a rider moving past the real version.

However, published material is unable to illustrate some attractive aspects of riding environments, such as nearby recreational activity and moving water. The use of short, web-based video files with relevant commentary that portray these features could be effective in supplementing publications.

Using photographs to display deviations in path alignment, such as curves and meanders, can also be problematic. The use of static images shot from overhead or via helmet video cameras may provide a solution. Similarly, wide panoramic images could be useful in revealing the wider surrounds of a riding environment without excluding the path or trail itself from the photograph.

Whichever avenue of communicating the aspects, features, elements and benefits of a riding environment is chosen, it would be wise to establish some degree of intrigue by not revealing all possible details to the potential rider. The research has indicated that people enjoy a level of self-exploration when using a path or trail. Keeping some descriptive details vague, yet enticing, will assist in the encouragement of this characteristic.

Although the promotion of a riding environment should focus on the existing overt features, it can also mention the absence of potentially negative aspects. For example, the quietness of a route that is free from traffic noise should be highlighted where possible.

What are the key factors affecting the local path and trail design process?

The answer to this question has been obtained from data collected during the key informant interviews and, to a lesser extent, the formal assessment of riding environments. These are explored more fully in the next section outlining recommendations for optimising the design process.

Firstly, the researcher contends that there is evidence for the notion that all cycling is essentially recreational, with a percentage having a specific destination. The activity involves an investment of energy and an unavoidable sensual exposure to the world around. This raises the value of the riding experience to an equivalent level with the need for safety and function.

The attitude of most key design decision-makers spoken to during this research project reflected this lack of experientially-relevant training. Statements such as “we are not paid to be innovative” and “safety is what we are ultimately judged on” demonstrated a mindset in which bicycle paths and trails are perceived as cold, sterile objects, rather than dynamic human platforms.

Many of the smaller authorities with responsibility for building bicycle infrastructure in Western Australia only allocate the minimum amount of human resources to the project. Often the design of a riding environment is the project of a one-person team. In these instances, the individual involved (usually a civil engineer):

- focuses on safety and function;
- lacks professional training in experiential design;
- is a one-man design ‘team’;
- lacks community input into the design process;
- works on a project whose cost-benefit implications are not fully recognised by planners.

There is a greater understanding of the importance of the riding experience among the designers of natural surface trail than exists for those responsible for paved paths. However, the trail design process may not be able to exploit this higher awareness. Funding is often much more limited for trails than for paved paths and the process for developing the latter does not appear to be significantly constrained by budget priorities or political intervention, particularly in the actual design stage. Instead, it is the decisions of designers, engineers and project managers who lack understanding about the benefits of incorporating aspects that enhance the riding experience which lead to paved paths that do not deliver. By contrast, the straight alignment of rail trails is often left untouched because they provide natural surface trail designers with an inexpensive means of constructing a route.

7.2 Recommendations

It is worthwhile briefly revisiting the original equation for a successful path that was posed in the introduction to this thesis:

SAFETY + FUNCTION + RIDE EXPERIENCE = A SUCCESSFUL PATH

Based on the findings of the literature review and subsequent emerging trends from the route assessments of this research project, the abovementioned three elements must all be present in a riding environment for it to be rated highly by cyclists of all types and persuasions. This is regardless of the facility's main purpose. Participants with a commuting background only differed marginally in preference for experientially-rich riding environments from those with a recreational background.

The form of cycling that could benefit most from the design of experientially effective riding environments is that of bicycle tourism. For a cycle tourist, the functionality of a path or trail is entirely aligned to the riding experience itself. It could be concluded that they are one and the same.

Emerging from the research findings is a strong preference among user groups for environmental variety or complexity. So-called picturesque landscapes may be appropriate in some circumstances, but the experiential nature of riding a bicycle is complex and environments need to stimulate the senses. They have to be experientially-rich rather than just pretty. Accordingly, path designers need to introduce variety into the riding environment as a matter of priority. This can be done through the introduction of external features, the highlighting of existing features and most importantly, the provision of a path alignment that maximises this experiential potential. Specific guidelines such as limiting the length of straight sections (e.g. no more than 200 metres) and the curve radii of meanders would assist to develop consistency in experientially appropriate path and trail design.

Although not as experientially effective as curves, some degree of mystery can also be introduced to a riding environment through the inclusion of mild undulations (vertical changes in height along the path topography). However, research has clearly shown that hilly terrain can discourage recreational cycling, therefore the undulations should not be sufficiently large to require a change of gear or additional pedalling effort.

The importance of thorough conceptualisation cannot be overstated. Designers need to leave the office and walk/ride through prospective routes at the earliest possible time. The Parker test of experiential quality (Parker, 2004), context sensitive design checklists and the sensory mapping process (Shire of Nillumbik, 2007) are all examples of practical assessments that could be conducted by design teams during the early planning stage of a riding environment. A ‘coherence audit’ may also be considered at a later stage of the design process in order to ensure that independent features, aspects and elements of a riding environment fit together and do not clash resulting in a reduction of their experiential effectiveness.

Designers should, where possible, locate routes near areas of recreational activity and overt open-bodied sources of freshwater. If such sources are not available, the introduction of artificial water features that involve moving water such as fountains and waterfalls, need to be considered by the designer. Metal fences should be avoided and replaced with timber barriers if required for safety or functional reasons.

If natural vegetation is not available near the path or trail, sufficient exotic broadleaf trees should be established that can produce intermittent shade along a significant proportion of a route. This may be a practical example of how Gestalt principles can make sporadic planting along riding environments a viable option and negate the need for expensive landscaping incorporating dense tree coverage.

Establishing a sound barrier between the riding environment and any surrounding roads that cater for heavy vehicles is vital to achieving a successful path or trail. Simply allowing for physical separation from a road or road reserve is not enough. The distance has to be sufficient to reduce the decibel level of traffic noise to a comfortable level. If this separation is not possible, some other form of sound-proofing needs to be considered.

Path-building authorities should consider using only smooth, light-coloured surfaces for riding environments. Wherever possible, plain concrete should be avoided in favour of a more textured, fine bitumised treatment. This should not be a problem in most circumstances as the red bitumen composition is becoming favoured among designers for reasons of cost and functionality.

Recognition that although cycling and walking have similar aesthetic needs, the two activities have different experiential needs and this should be considered when shared infrastructure is being designed. The visual angle of acuity of pedestrians is greater than that of cyclists because of the slower travel speed. This suggests that the former group would have more opportunity to perceive and process features that are located at right angles to the path alignment. For example, in-path artwork that is adequate for walkers may be wasted on cyclists as they are moving at a faster speed. However, the psychophysical perceptual needs of cyclists must take precedence as they form the largest user-group.

Public artwork, educational features and interpretive signage need to be location-specific and fully visible to a moving cyclist. For this latter reason, the effectiveness of artwork forming a physical part of the path or trail surface must be considered low.

Engineers need to recognise that, unlike travelling in a motor vehicle, riding a bicycle is never just about getting from point A to point B. It is a multi-sensory activity that requires an investment of energy from the participant.

The following framework uses all previously mentioned findings and observations as the basis to create a conceptual tool that path designers can use when beginning the design phase.

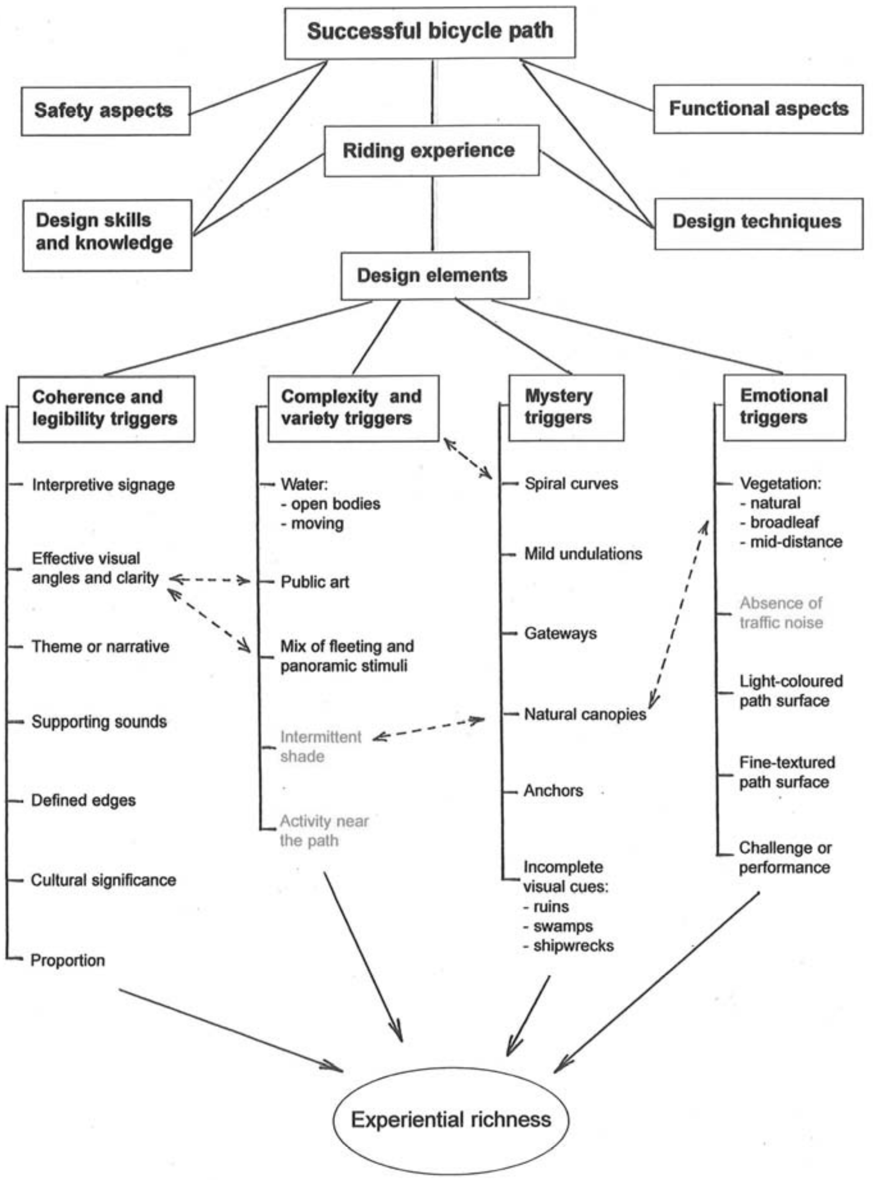


Figure 7.1: Conceptual framework for experientially-rich riding environments

The one-size-fits-all philosophy that currently pervades the development of bicycle infrastructure in Australia is ripe for analysis. For the continued growth of cycling, socio-demographic factors may need to be considered in the design process. For example, females in all age groups are currently statistically underrepresented in cycling participation rates across Australia (Zappelli & Rounce, 2009). Authorities and organisations responsible for the promotion of community-based cycling have responded to this low representation by developing strategies that specifically target women, such as the Glamour Push in Western Australia and the Brunetti Coffee Club Ride in Victoria. This strategic promotional segmentation may need to be supported by the development of suitable cycling infrastructure if it is to be effective. It is evident from the route assessments conducted as part of this research project that female riders have significant differences in preferred riding environments to those of males. In particular, factors such as creating some physical separation of bicycle paths from adjacent roads, the provision of shade for riders and the locating of riding environments that are close to areas of recreational activity should be considered for incorporation into path and trails by designers in an effort to attract female riders.

An inevitable discussion about the need for civil engineers to design to a greater extent for people is probably well overdue. Architecture courses all around the world routinely include units that either partly or wholly investigate the human perspective in the design process. Civil engineers seem to avoid this requirement during their formal training.

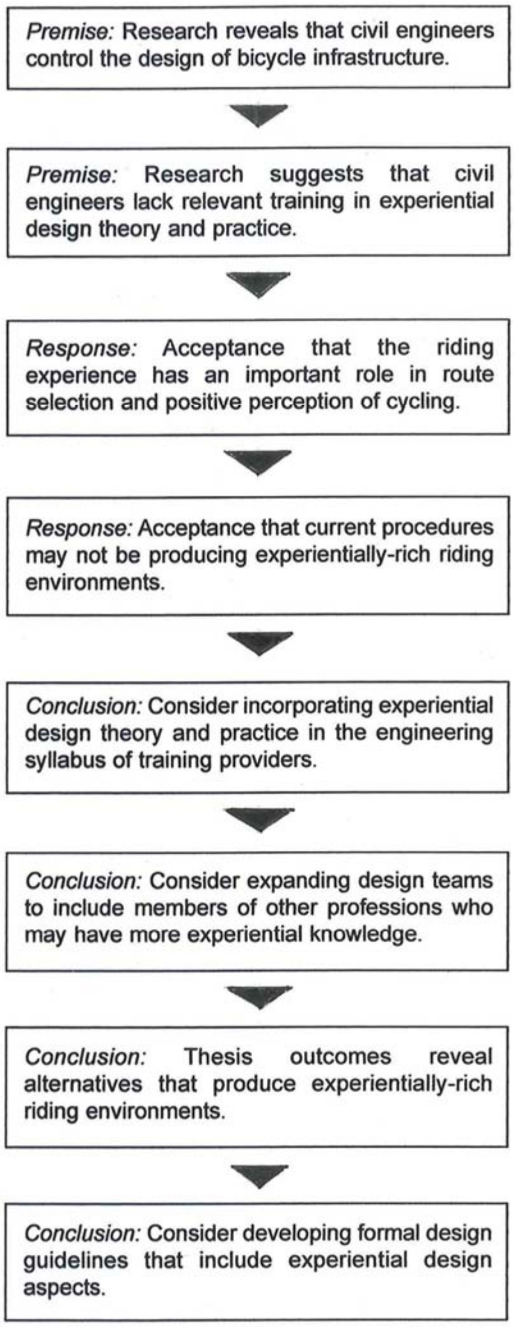


Figure 7.2: Hierarchy of path design practice

Although few engineers today would dispute the importance of aesthetics, most of them have a singular lack of understanding of the subject and still tend to see aesthetic design as a simple extension of engineering design. In addition, their knowledge of other psychophysical attributes of cycling and the riding environments inhabited by cyclists appears to be non-existent. This lack of understanding can be attributed to the separation of disciplines in most universities and the extremely broad scope of civil engineering in modern society.

Until recently, engineers received no formal education or training in the arts and values of aesthetics. Most engineering curricula do not offer courses that integrate the process of design with aesthetics or other experiential considerations. Engineering schools developed curricula that decisively cut whatever bond had previously existed between those who made architectural forms and those who began to make new engineering forms (Wolfe, 1996). This can be partly explained by the breadth of information contained in the average civil engineering course. As undergraduate students are expected to gain a grounding in such a vast array of different structures or facilities including roads, bridges, tunnels, canals, dams, harbours, railways, airports, public parks and sewer systems, due to time constraints, other items such as bicycle paths simply do not feature. There appears to be a pressing need to develop more specialist streams, perhaps at a postgraduate level, that cover these missing or forgotten aspects in sufficient detail to enable practitioners to gain a full understanding of effective design protocols and solutions.

There is no better example of this than the Blue Ridge Parkway in the United States. The project head Stanley Abbott was a landscape architect, rather than the traditional engineer. His professional background meant the human element was at the forefront from the very beginning of the design work.

In a personal communication to the researcher, a leading American authority on scenic roads, Mary Myers, had the following to say about this exact issue:

> There are significant differences in the approaches of engineers and landscape architects. One profession has a problem-solving approach which defines problems narrowly. The other has a more holistic and design-centred approach which defines problems very broadly. Unfortunately, it is the engineering profession which has had, and continues to have, primary responsibility for transportation design. I don't see that as changing in the USA but it is possible with the shift toward green design.

Civil engineers and even urban planners appear to view paved bicycle paths as either a form of low-speed road or an extension of the road reserve. This is a key issue as roads and paths are not the same with the major difference being their intended purpose. Roads are, in most instances, designed to allow the movement of traffic in an efficient manner from location to location. The 'motoring experience' is only considered in a few notable tourist routes, such as the Blue Ridge Parkway. Accordingly, designers focus on safety and functionality when planning a road and pay no attention to the experiential aspects as they are deemed to be irrelevant. This fact is sensible considering that the vast majority of roads are used solely for that purpose. However, the problem arises when these same engineers, who often have responsibility for designing roads and bicycle paths, assume that both forms of infrastructure have the same purpose. We know from attitudinal research that, in Australia, bicycle paths are used primarily for leisure or recreation, yet they are generally designed for transport. Even in countries where the bicycle is seen far more as a standard form of transport, such as Denmark and the Netherlands, the majority of trips made by bike are for recreation or leisure, rather than commuting.

Just as the training of civil engineers may require re-assessment, allied professionals, such as landscape architects, also need to accumulate a better understanding of how their designs can influence human behaviour. As proposed by Fischer et al. (2000), landscape architects can provide an important link between hard engineering concepts and community needs with the proviso that they learn and adhere to well-defined experiential rules to complement the established structural design rules. Myers (2002) contends that for this to happen, landscape architects also need to be able to speak the language of engineering and be educated in the elements of transport infrastructure design.

This raises a second important point which needs to be considered when addressing the issue of user perception. Even if design professionals are adequately trained in aesthetics and experiential aspects, they may not be the best-placed people to make decisions about those aspects. Kent (1993) notes that his study of the attributes, features and reasons for enjoyment of scenic routes indicated that transport engineers and planners did not consider the experiential and cognitive aspects of travelling scenic routes as important as other participants. In particular, Kent found key differences between the people who could make decisions regarding which routes attain scenic status and average citizens who form the majority of users. This finding of perceptual differences gives credence to the assertion made by Kaplan & Kaplan (1982), that public input into landscape planning process has value.

Raising the level of experiential design skills among professionals will only achieve maximum effectiveness if the project management process is able to properly exploit those skills. At present, the crucial role of project manager for local cycling infrastructure development is almost entirely filled by members of the civil engineering profession. This dominance of the design process coupled with a disregard or unawareness of the experiential aspects of paths makes it unlikely that new facilities will be created that have the required balance of safety, function and riding experience to achieve maximum patronage and therefore cost-effectiveness.

Often this individual is autonomous and has a primary role in the planning and design of bicycle paths, with only limited input from other professionals. From the key informant interviews conducted as part of the research, it is clear that this entrenched process creates significant frustration among those who feel they have something important to offer, but no means of making a contribution. It could be argued that a better management model for the development of successful bicycle paths and trails would be one that was more inclusive, responsive and interdisciplinary. Historical movements such the German school of architectural design known as the Bauhaus that flourished in the 1920s could provide a template for this revised process. Bauhaus was based on the principle that good designs must pass the test of both aesthetic standards and sound engineering practice. It also discouraged the dominance of any one aspect of design over any other (Droste, 2002). This culture of cooperation and respect for design contributors may be a far more effective method of delivering experientially rich civil projects such as bicycle infrastructure.

The modern roles of architect and engineer in the field of architecture may also offer some important insight for the project management of paths and trails. Civil and structural engineers readily acknowledge that they have a limited role in the design of buildings, even though they are civil structures (Peters, 2008). This recognition reflects the importance of the human element in architecture and that civil engineering is not academically equipped to design for those needs. The findings from this research project point to a similar set of circumstances for the design of bicycle paths and trails. Could the experiential aspects of paths and trails also be significant enough to also preclude the deep involvement of engineers? Just as architects have an unquestioned management role in the design and construction of buildings, should landscape architects or some other profession with knowledge of the human experience have the primary role in the design and construction of bike paths? It has to be noted that the analogy is probably not that clear cut because there is an undeniable technical component in the design of all bicycle infrastructure that requires the skills of a civil engineer.

The research has also revealed a secondary issue for path and trail design teams to consider during the initial design stage – the benefit of site walk-throughs. Even though the latest geographical information technology can provide designers with an excellent analogue of existing environments, it relies almost entirely on visual input.

The development of experientially-rich riding environments may have a significant role in the improvement of community health, but the data required to facilitate that development is not yet be available. For example, existing research investigating the impact of the built environment on health outcomes has tended to focus on a strict quantitative analysis of user preference. The findings from this thesis reveal that a substantial part of the riding experience may occur at the sub-conscious level and this can only be fully explored using in-depth qualitative techniques.

Finally, this project has highlighted why and how formal design standards for bicycle paths and trails need to better reflect the complex nature of cycling.

The following section addresses how this integration of new ideas and existing standards could be achieved.

7.3 Integration with existing design standards

In order for the findings from this research project to achieve a high level of usefulness, they need to be widely available to those people charged with the task of designing bicycle paths and trails. One method of achieving this is to incorporate them into the existing design standards and guidelines followed by a majority of practitioners.

As previously mentioned in Chapter 2, the Austroads-published *Guide to Traffic Engineering Practice Part 14 Bicycles* is the principal reference used by engineers and other path designers. It is currently in the process of being superseded by assorted sections of the new Austroads *Guide to Road Design* which retain much of the previous information. These technical standards provide a thorough coverage of the safety and functional aspects of design, but do not deal at all with the riding experience. An obvious solution to this deficit would be to include a number of the experiential findings raised by this research project in forthcoming editions, in either the main text or as appendices. This will not be easy as Austroads is an asset / design / construction / management-based industry organisation comprised almost entirely of professional engineers and the fundamental concept of experiential design is likely to be considered esoteric or obscure.

However, the executive officer of the Australian Bicycle Council, which currently forms part of the Austroads organisational structure, has personally indicated a willingness to investigate the outcomes from this research project and suggest how they may be best integrated into the design standards.

Even if the political hurdles are overcome, there are specific items dealing with safety such as the maintenance of adequate sightlines that may directly impinge on experiential aspects and will need careful consideration. For example, if the experientially-based concepts, such as mystery and playfulness, are to be incorporated into the existing standards, they will, by necessity, have to comply with minimum recognised sight distance requirements as outlined in section 6.3.7 of the *Guide to Traffic Engineering Practice Part 14 Bicycles* (Standards Australia, 1999), or the relevant path-related sections of the new *Guide to Road Design* (Austroads, 2009a; 2009b).

The creation of mystery in a riding environment also has to be a compromise with perceived and real personal security risks, such as the potential danger of muggings or assaults. Solo riders in particular have reported a negative response to paths in urban areas that have sightlines heavily reduced by vegetation or buildings that are close to the edge of the path, rather than by curvature in the path itself. If designers want to introduce mystery into these urban riding environments, and also meet user requirements, they will have to create mystery without impacting upon perceived or real personal security. Although this can be done in many instances, it is often going to be a balancing act.

For safe travel cyclists must be able to see across the inside of horizontal curves and over vertical crest curves from a sufficient distance to enable them to stop or take evasive action if necessary to avoid another cyclist, a pedestrian or an obstacle in their path. Within these constraints, curves and undulations can still be incorporated into a route-design providing these important minimum requirements are met.

There is an ongoing debate within the engineering profession about whether a predictable transport environment, such as a road or path, is safer than one with a level of uncertainty. It is true that under certain conditions it is possible to make an environment safer by making it more predictable. However, it is equally true that one can make other environments safer by increasing uncertainty. The key to safety is to reduce the differential between actual and perceived risk. There is no doubt that a designer can make a freeway safer by reducing elements of uncertainty as this reduces the gap between the certainty promised and the certainty delivered. Theoretically it is also possible to make city residential streets safer by making them more predictable. However, unless they also reduce the number of spontaneous events that the motorists may be exposed to, all they have done is create a false sense of security which diminishes safety. The question therefore becomes whether it is socially acceptable to reduce the spontaneous events that the user is exposed to.

The integration of experiential-based design guidelines into existing natural surface trail construction standards is likely to be an easier task. The standards themselves are less formally constrained than the paved path equivalents and the designers involved are generally more open to an infrastructure-derived riding experience.

In addition, the majority of natural surface trails are used primarily for recreational and tourism purposes, in turn meaning the notion of riding experience plays are more significant role in their function. Designers of these trails are therefore likely to recognise the value of using features or principles that enhance the riding experience in the design process, provided safety is not compromised.

The International Mountain Biking Association has traditionally had a flexible approach with regard to the design of natural surface trails and extending new concepts into best practice. It should therefore be possible to incorporate the preferred experiential aspects identified in this research project into the design process for trails.

At a local level, the lead agencies responsible for planning and constructing natural surface trails in Australia have indicated a willingness to incorporate the findings of this research project. At the present time, South Australia is the only government authority in the country to have published formal design guidelines for trail-building practitioners (Government of South Australia, 2007).

The findings of the research project could also have significance for the promotion of cycling at a broader policy level throughout Australia. All states and many larger local government authorities have formal ‘Bicycle Plans’ in place and these can act as a long-term planning tool for developing and integrating bicycle infrastructure within a particular jurisdiction. Effective bike plans consist of several key elements including: a route plan; designs and standards; a schedule of works; a maintenance schedule; and a review mechanism (Government of Western Australia, 1996). They share a focus on safety and functionality with the engineering standards.

Furthermore, there may also be an opportunity to incorporate some of the findings from this research project in other widely read planning guidelines, such as Liveable Neighbourhoods and Streetscape Improvements. It is often much easier and cheaper to build innovative and well-designed cycling infrastructure from scratch in a green field site than it is to retrofit it later. Accordingly, it would be wise to include experiential design aspects, such as those identified in this study, into the policies guiding new housing developments.

Finally, agency-specific path and trail design guidelines, such as those produced by Main Roads Western Australia and soon to be produced by the Western Australian Department of Environment and Conservation, could include some of the findings related to factors influencing the riding experience from this research project.

7.4 Future research

This is the first known academic study that attempts to investigate the topic. It should therefore be viewed as a preliminary study that is open to discussion and to enabling others to delve deeper into the various issues that have been raised. In particular, there is an opportunity for government agencies to commission full-scale research projects as almost all bicycle infrastructure is funded by various levels of government, so they must be the drivers of further research.

Resources can be allocated to an in-situ riding research program with a much larger sample size and wider selection of riding environments than was possible for this project. This would enable researchers to gain insight into hitherto unexplored aspects of path design. In particular, the impact of combining features and elements and a rider’s response to those combinations has not been dealt with to any great extent in this research project and is worthy of further investigation.

Although some valuable work has been conducted into the visual experience of motor vehicle occupants, there are no comparable studies investigating this performativity in cyclists. Specifically, it would be interesting to develop a dynamic visual acuity reference chart for riders moving at recreational speeds of between 15 and 25 kilometres per hour. In addition to these studies, there is also a need for research examining the average amount of eye-swing displayed by cyclists travelling through a variety of riding environments. High quality research has been conducted to ascertain the impact of external sounds on environmental preference. However, there has been no similar study of the affect from sound produced by the participant, such as a cyclist themselves. Such data may assist path designers to develop surface textures that maximise experiential satisfaction.

Similarly, it would be useful to ascertain what minimum duration of exposure to visual stimuli is sufficient to result in cognition and interest for a cyclist in motion at average riding speed. Such data would enable designers to better fine-tune path alignments and the size, location and position of specific aspects of a riding environment.

There is considerable scope for further research that investigates other aspects of the riding experience, such as the effect of group dynamics on aesthetic and experiential outcomes. The researcher duly acknowledges the fact that many recreational and leisure cycling trips are made in the company of others. This study specifically focussed on the experiences of an individual cyclist, though many people choose to ride in groups of two or more and this may or may not have a significant effect on how they experience the ride.

Much more could be done to investigate the impact that specific features associated with path and trail infrastructure can have on various types of bicycle rider. For example, the provision of public artwork has to date been a haphazard process based on little more than guesswork. While this study has added important information about the location, orientation and accessibility of public artwork associated with paths and trails, it was not possible within the scope of the project to analyse what types of artwork work best in various environments. This task will require the investment of considerable resources to achieve any meaningful outcomes. Even the management of major path infrastructure networks, such as the National Cycle Network in the United Kingdom that incorporates a substantial body of public artwork, readily acknowledge this current deficiency in evaluation data and the need to invest in future research.

This project used a variety of routes that incorporated a range of attributes, features and elements. Accordingly, it was not possible to fully isolate specific aspects and analyse their individual impact on respondent perception. It is conceivable that one attribute, feature or element may have a magnifying or negating effect on another. It is therefore recommended that further research be conducted to clearly establish these relationships with a view to developing the most effective riding environments.

The so-called 'Line of Grace' that appears to feature strongly in successful transport infrastructure projects, such as the Blue Ridge Parkway, remains hard to define. Independent research that could quantify the precise alignment, particularly for bicycle paths and trails, would no doubt be welcomed by many designers.

Riding environments in close proximity to roads have been found to be less favoured by cyclists in a number of empirical studies, including this one. However, no data is available regarding the minimum distance between path and road where this effect ceases to be significant. New studies identifying this distance would be extremely useful for designers seeking to develop path alignments that attract riders. This research should also investigate the point at which the loudness of traffic noise in decibels begins to adversely affect rider preference. Such data could be used to determine appropriate use of barriers to, or distance from, the noise source. It may be productive to include the experiential design aspects of riding environments in the ongoing development of established policy-based movements that involve traffic calming strategies such as the European shared space project.

The well-established landscape design principles and elements outlined in Chapter 2 (line, form, texture, colour, scale, unity, balance, proportion, sequence and rhythm) are widely acknowledged and followed by professionals around the world. However, they have been traditionally based upon a stationary viewpoint. Riding environments are experienced in motion and it would be useful to know if a moving viewpoint has an effect on a person's perception of landscape design principles and elements with regard to fundamentals of dynamic visual acuity.

This concept of a viewer in motion may also have specific implications for the findings of this research project. While the presence of water, and moving water in particular (Brown & Daniel, 1991), has been found to be a strong variable in preferred riding environments, this premise is based on a stationary viewer. Although this research project has partially confirmed the same effects for a moving cyclist, the study is small and needs to be repeated on a larger scale.

Formal path and trail planning guidelines, such as those published by the Government of South Australia (2007), highlight the importance of correctly designing and siting associated aspects, such as interpretative infrastructure, and that specific skills are required to achieve a successful outcome. Although designers and planners have access to a limited range of resources to assist with this process, such as the work done by Gross, Zimmerman and Buchholz (2006), the strategies outlined in these resources have not been formally evaluated. This lack of empirical knowledge needs to be rectified before those given the task of successfully designing and placing interpretative infrastructure can do so with any degree of confidence.

Some interesting work has been done in the field of environmental perception which indicates that the amount of sensory stimulation or richness provided by an environment can affect a person's sense of time (Ahn et al., 2006; Sadalla & Staplin, 1980). However, no research has been conducted to establish if this affect can influence the choice of whether to seek out a particular environment. If this data was available, it may offer an insight into route selection.

Other aspects such as the sounds generated by the cyclist themselves (bicycle tyres on the ground) may offer insight into the selection of preferred surface textures.

Bicycle paths and trails are rarely the sole form of infrastructure in riding environments. Some form of on-road facility often connects paths within a wider network and it would therefore be wise to include these sections in any future research. In particular, it would be useful to identify what percentage of on-road infrastructure can be included in a riding environment or network without negatively impacting upon the appeal of an entire route.

Studies of environmental perception by researchers such as Nasar and Purcell (1990), the Kaplans (1989), and Kent (1993) have demonstrated significant attitudinal differences between design professionals and the lay people they are designing for. This difference in view between the two parties has the potential to influence how new functional environments, such as bicycle paths, are created and how well they meet the needs of the majority of potential users. In addition, there is anecdotal evidence revealed by this research project indicating that civil engineers and other path designers who are regular cyclists may have a different outlook on what does or does not constitute a satisfying riding environment than those design professionals who do not cycle. Accordingly, further research should be conducted to determine the extent of these perceptual differences. If the results of such research show a high deviation in path and trail design priorities, some remedial action will be required to ensure the experiential needs of end-users of these facilities are being met within the design process.

While it is acknowledged that riding environments that possess a combination of natural and anthropogenic features, aspects or elements can be appealing to various types of rider, there has been insufficient research to calculate what ratio of each will create the most preferred routes.

One of the surprising outcomes from the interviews with key informants approached during the research has been the lack of understanding of the potential economic benefits that can result from design of infrastructure that delivers effective aesthetic and experiential experiences to the maximum number of users. Transport infrastructure is an expensive drain on the public purse and any initiatives that can improve the cost benefit ratio needs to be an integral part of the planning and decision making process. To get the attention of the leaders of this process requires hard financial data and that data is sorely lacking. Authorities would do well to invest in research that attempts to establish the value of specific design principles, elements and features.

The results of this project point to a significant user preference for some form of transition or spiral curve in the layout of bicycle paths and general recreation trails. However, Mary Myers, a leading educator in the field of landscape architecture, acknowledges there is currently an absence of published empirical research on the exact nature and extent of the experiential effect of these curves. Accordingly, designers do not have access to meaningful mathematical information that would enable them to calculate the most appropriate amount of curvature to encourage maximum perceptual response. There may not be an exact radii that produces uniform acceptance, but even if a numerical range could be established in which preference levels were high for the majority of riders this would be a useful technical guide.

It is important to note that although roads incorporating the theory of spiral curves in their construction such as the Blue Ridge Parkway can offer a useful insight into experiential design, they are usually designed for a viewer travelling at a speed of between 80 km/h and 100 km/h. By contrast, the majority of cyclists using paths and trails travel at speeds of between 10 km/h and 30 km/h and will therefore be expected to experience the effect of a curve differently than the occupant of a motor vehicle. There is an obvious need to conduct trials using precise measuring equipment to establish the most preferred angle of curvature for cyclists in various situations.

Finally, with many bicycle paths and trails in Australia being shared with pedestrians, and with this scenario likely to continue for the foreseeable future, it would be wise to include that user group in any further research regarding use of these facilities.

This list of recommended research is by no means exhaustive. However, it does provide a foundation on which further contributions to knowledge and practice can be made.

References

Abello, R.P. & Bernaldez, F.G. (1986). Landscape preference and personality. *Landscape and Urban Planning*, *13*, 19-28.

Abello, R.P., Bernaldez, F.G., & Galliano, E.F. (1986). Consensus and contrast components in landscape preference. *Environment and Behavior*, *18*(2), 155-178.

Ahn, H., Liu, M.W., & Soman, D. (2006). *Memory for time: A cognitive model of retrospective duration and sequence judgements*. Retrieved September 21, 2009, from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=897933

Akbar, K.F., Hale, W., & Headley, A.D. (2003). Assessment of scenic beauty of the roadside vegetation of northern England. *Landscape and Urban Planning, 63*(3), 139-144.

Alexander, C (1977). *A Pattern Language: Towns, Buildings, Construction*. Oxford University Press.

Alexander, C (1979). *The Timeless Way of Building*. New York: Oxford University Press.

Amati, M. (Ed.). (2008). *Urban Green Belts in the Twenty-first Century*. Aldershot: Ashgate Publishing Limited.

Anderson, L. (2006). Analytic autoethnography*. Journal of Contemporary Ethnography*, *35*(4), 373-395.

Anderson, L.M. & Schroeder, H.W. (1983). Application of wildland scenic assessment methods to the urban landscape. *Landscape and Planning*, *10*(3), 219-237.

Anderson, L.M., Mulligan, B.E., Goodman, L.S., & Regen, H.Z. (1983). Effects of sounds on preferences for outdoor settings. *Environment and Behaviour*, *15*(5), 539-566.

Andrews, M. (1990). *The search for the picturesque: Landscape, aesthetics and tourism in Britain, 1760-1800*. Stanford University Press.

Antonakos, C.L. (1994). *Environmental and travel preferences of cyclists*. Transportation Research Record, *1438*, 25-33.

Aoki, Y. (1999). Review article: trends in the study of the psychological evaluation of landscape. *Landscape Research*, *24*(1), 85-94.

Appleton, J. (1996). *The experience of landscape* (Rev. ed.) Chichester; New York: Wiley.

Arnheim, R. (1969). *Visual thinking*. Berkeley: University of California Press.

Auge, M. (1995). *Non-Places: Introduction to an anthropology of supermodernity*. London: Verso.

Austroads. (2009a). *Guide to Road Design Part 6A: Pedestrian and Cyclist Paths*. Sydney: Austroads.

Austroads. (2009b). *Guide to Road Design Part 6B: Roadside Environment*. Sydney: Austroads.

Babbie, E. (1992). *The practice of social research*. Belmont: Wadsworth.

Ball, K., Bauman, A., Leslie, E., & Owen, N. (2001). Perceived environmental aesthetics and convenience and company are associated with walking for exercise among Australian adults. *Preventative Medicine*, *33*, 434-440.

Balling, J.D. & Falk, J.H. (1982). Development of visual preference for natural environments. *Environment and Behaviour*, *14*(1), 5-28.

Bauman, A., Wallner, F., Miners, A., & Westley-Wise, V. (1996). *No ifs no buts Illawarra physical activity project: Baseline research report*. Commonwealth Department of Health and Family Services, NSW.

Bell, S. (2001). Landscape pattern, perception and visualisation in the visual management of forests. *Landscape and Urban Planning*, *54*(1), 201-211.

Bernaldez, F.G., Gallardo, D., & Abello, R.P. (1987). Children's landscape preferences: from rejection to attraction. *Journal of Environmental Psychology*, *7*, 169-176.

Bicycle Victoria. (2005). *Health benefits of cycling* [Fact sheet]. Bicycle Victoria, Melbourne, Victoria.

Bishop, I.D., Wherrett, J.R., & Miller, D.R. (2001). Assessment of path choices on a country walk using a virtual environment. *Landscape and Urban Planning*, *52*(4). 225-237.

Bloch, A.M. (1969). Remembrance of feelings past: A study of phenomenological genetics. *Journal of Abnormal Psychology*, *74(*3), 340-347.

Blum, A. & Jana, R. (2005). Architectural wonders: Building innovation. *Business Week*, Nov. 2005.

Bohle, W. (2000). Attractiveness of bicycle facilities for the users and evaluation of measures for the cycle traffic. *Traffic Safety on Two Continents Conference.*

Bolton, R. (1979). *People skills*. New York: Simon and Schuster.

Bonham, J. (2006). Transport: Disciplining the Body that Travels. *Sociological Review*, *54*(1), 57-74.

Booth, N.K. & Hiss, J.E. (2007). *Residential landscape architecture*. New York: Prentice Hall.

Bornstein, R.F. (1989). Exposure and affect: Overview and meta-analysis of research, 1968-1987. *Psychological Bulletin*, *106*, 265-289.

Boudreau, L. (2006). A divided highway. *Spacing: Understanding the Urban Landscape.* Retrieved May 17, 2009, from http://spacing.ca/art-roadsworth.htm

Bourassa, S.C. (1991). *The aesthetics of landscape*. London; New York: Belhaven Press.

Bourdieu, P. (1990). *The logic of practice*. Cambridge: Polity Press.

Bovy, P.H.L. & Bradley, M.A. (1985). Route choice analysed with stated-preference approaches. *Transportation Research Record*, *1037*.

British Columbia Ministry of Transportation (1991). *Manual of Aesthetic Design Practice.* Ministry of Transportation and Highways, Canada.

Brown, T.C., Daniel, T.C., Richards, M.T., & King, D.A. (1988). Recreation participation and the validity of photo-based preference judgements. *Journal of Leisure Research*, *20*(4), 40-60.

Brown, T.C. & Daniel. T.C. (1991). Landscape aesthetics of riparian environments: Relationship of flow quantity to scenic quality along a wild and scenic river. *Water Resources Research*, *27*(8), 1787-1795.

Brown, K. & Spinney, J. (2009). *Catching a glimpse: the value of video in evoking, understanding and representing the practice of cycling.*

Buhyoff, G.J., Miller, P.A., Roach, J.W., Zhou, D., & Fuller, L.G. (1994). An AI methodology for landscape visual assessments. *AI Applications* 8: 1-13.

Burke, E. (1958). [1757]. *A philosophical enquiry into the origin of our ideas of the sublime and the beautiful*. Edited by J.T. Boulton. London: Routledge.

Carlson, A. (2001). Aesthetic preferences for sustainable landscapes: seeing and knowing. In S. R. J. Sheppard & H.W. Harshaw (Eds.), *Forests and landscapes: linking ecology, sustainability and aesthetics*. Wallingford: CABI Publishing.

Chang, C., Chen, P., Hammitt, W.E., Machnik, L., & Su, W. (2008). Psychophysiological responses and restorative values of natural environments in Taiwan. *Landscape and Urban Planning*, *85*(2), 79-84.

Chang, H. (2008). *Autoethnography as method*. Walnut Creek: Left Coast Press.

Chang, H.L. & Chang, H.W. (2005). Comparison between the differences of recreational cyclists in national scenic bikeway and local bike lane. *Journal of the Eastern Asia Society for Transportation Studies*, *6*, 2178-2193.

Chhetri, P., Arrowsmith, C., & Jackson, M. (2004). Determining hiking experiences in nature-based tourist destinations. *Tourism Management*, *25*, 31-43.

Choker, B.A. & Mene, S.A. (1992). An assessment of preference for landscapes in the developing world: Case study of Warri, Nigeria, and environs. *Journal of Environmental Management*, *34*, 237-256.

Chon, J. & Shafer, C.S. (2009). Aesthetic responses to urban greenway trail environments. *Landscape Research*, *34*(1), 83-104.

Chown, E., Kaplan, S., & Kortenkamp, D. (1995). Prototypes, location and associative networks (PLAN): Towards a unified theory of cognitive mapping. *Cognitive Science*, *19*, 1-51.

Chuang, M.C. & Ou, L.C. (2001). Influence of holistic color interval on color harmony. *Color Research and Application*, *26*, 29-39.

City of Tempe (n.d.). *Sidewalk and Bike Path Enhancements* [Fact sheet]. Tempe Municipal Arts Commission, Tempe, Arizona.

Clarke, G. (1932). The Mount Vernon Memorial Highway. *Landscape Architecture*, *22*(3), 179-189.

Clawson, M. (1966). *Economics of outdoor recreation*. Chicago: Rand McNally & Company.

Connolly, P. (1967). Visual considerations of man, the vehicle and the highway Part 2. *Society of Automotive Engineers Transactions*. *75*, 843-903.

Context Sensitive Solutions. [n.d.]. Retrieved January 28, 2010, from the Scenic America site: http://www.scenic.org/transportation

Coolican, H. (2004). *Research methods and statistics in psychology (4th edition).* London: Hodder & Stoughton.

Corti, B., Donovan, R., & Holman, C. (1996). Factors influencing the use of physical activity facilities: Results from qualitative research. *Health Promotion Journal of Australia, 6*, 16-21.

Cox, P. (2006). *Conflicting agendas in selling cycling*. Velo-city 2005, Dublin, Ireland May 31-June 3.

Cresswell, T. (2006). *On the move: Mobility in the modern western world*. New York: Routledge.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper and Row.

Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life*. New York: Basic books.

Cycling Promotion Fund. (1998). *Bicycle sales 2008*. Sydney. Cycling Promotion Fund.

Cycling Promotion Fund. (2009). *Bicycle sales 2008*. Sydney. Cycling Promotion Fund.

Daniel, T. C. (1990). Measuring the quality of the natural environment: a psychophysical approach. *American Psychologist, 45*(5), 633-637.

Daniel, T.C. (2001). Whither scenic beauty? Visual landscape quality assessment in the 21st century. *Landscape and Urban Planning*, *54*(1), 267-281.

Daniel, T.C. & Ittelson, W.H. (1981). Conditions for environment perception research: Reactions to Ward and Russell. *Journal of Experimental Pyschology*, *110*, 153-157.

David Lock & Associates (2005). *Shared trail signage for the Greater Shepparton bicycle strategy*. Melbourne: David Lock & Associates.

Dearden, P. (1984). Factors influencing landscape preferences: an empirical investigation. *Landscape and Planning*, *11*(4), 293-306.

Dearden, P. (1989). Societal landscape preferences: A pyramid of influences. In: Dearden, P. and Sadler, B. 1989 *Landscape evaluation: Approaches and applications*. Western Geographical Series. Vol.25, Dept. of Geography, University of Victoria, Canada.

de Certeau, M. (2002). *The practice of everyday life*. Los Angeles: University of California Press.

de Jonge, D. (1967). Applied hodology. *Landscape*, *17*(2), 10-11.

Denzin, N. K. & Lincoln, Y. S. (Eds.). (2000). *Handbook of qualitative research* (2nd ed.). Thousand Oaks: Sage Publications Inc.

Downward, P.M. & Lumsdon, L. (2001). The development of recreational cycle routes: An evaluation of user needs. *Managing Leisure*, *6*(1), 50-60.

Driver, J. & Spence, C. (1998). *Attention and the Crossmodal Construction of Space*. Trends in Cognitive Sciences, *2*(7), July 1998.

Droste, M. (2002). *Bauhaus: 1919 to 1933.* Taschen.

Drottenborg, H. (1999). *Aesthetics and safety in traffic environments*. Bulletin 176. Lund, Sweden: Lund Institute of Technology.

Earth Policy Institute. (2007). *Bicycle Indicators*. Retrieved May 18, 2009, from http://www.earthpolicy.org/Indicators/Bike/index.htm

Edensor, T. (2003). M6 Junction 19-16: Defamiliarising the mundane roadscape. *Space and Culture*, *6*(2), 151-168.

Edensor, T. (2007). Mundane mobilities, performances and spaces of tourism. *Social and Cultural Geography*, *8*(2), 199-215.

Engwicht, D. (2005). *Mental speed bumps: The smarter way to tame traffic*. Sydney: Envirobook.

Evans, M. (2004). *Becoming a local to the train-line wallpaper: Graffiti and questions of non-place*. Alternative Mobilities Futures Conference, Lancaster, United Kingdom January 9-11.

Everett, M. (1990). The determinants of mass bicycle commuting revisited. *Journal of the Transportation Research Forum*, *30*, 360-366.

Eysenck, H.J. (1941). A critical and experimental study of color preferences. *American Journal of Psychology*, *54*, 385-394.

Faulks, P., Ritchie, B., & Fluker, M. (2009). *Cycle tourism in Australia: An investigation into its size and scope*. Southport: Sustainable Tourism Cooperative Research Centre.

Fielding, N.G. & Lee, R.M. (1998). *Computer analysis and qualitative research*. London: SAGE.

Fischer, E.E., Hohmann, H., & Marriott, P.D. (2000). Roadways and the Land: The Landscape Architect's Role. *Public Roads*, *63*(5), 30-34.

Fitzpatrick, J. (1980). The *bicycle and the bush*. London: Oxford University Press.

Fontana, A. & Frey, J.H. (2000). The Interview From Structured Questions to Negotiated Text. In N. K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research*. Thousand Oaks, Sage Publications Inc..

Forester, J. (1996). How to make biking a real alternative. *Transportation and Environment*, *21*, 59-61.

Forester, J. (2006). *Bicycle Transportation: A Handbook for Cycling Transportation Engineers*. MIT

Foster, D.H., Nascimento, S.M.C., Craven, B.J., Linnell, K.J., Cornelissen, F.W., & Brenner, E. (1997). Four issues concerning colour constancy and relational colour constancy. *Vision Research*, *37*(10), 1341-1345.

Fournel, P. (2003). *Need for the bike*. (A. Stoekl, Trans.). Lincoln: University of Nebraska Press.

Gardner, G. (1998). *Transport implications of leisure cycling*. TRL Report 347, Crowthorne: Transport Research Laboratory.

Gehl, J. (1971). *Life Between Buildings: Using Public Space.* Danish Architectural Press.

Gehl, J. (1996). *Public Spaces Public Life.* Danish Architectural Press.

Giblett, R. (1996). *Postmodern wetlands: Culture, history, ecology*. Edinburgh: Edinburgh University Press.

Giblett, R. (2004). *Living with the earth: Mastery to mutuality.* Cambridge: Salt Publishing.

Giblett, R. (2008). *Sublime communication technologies.* Houndmills: Palgrave Macmillan.

Gibson, J.J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin.

Gibson, J.J. (1977). The theory of affordances. In *Perceiving, acting and knowing.* R. Shaw & J. Bransford , (Eds.). p. 76-82

Gibson, J.J. (1979). *The ecological approach to visual perception*. Boston: Houghton Miffin.

Gifford, R. (1987). *Environmental psychology: Principles and practice.* London: Allyn and Bacon.

Gilmore, L. (2001). *The limits of autobiography: Trauma and testimony*. Ithaca, New York: Cornell UP.

Gobster, P.H. (1988).Urban bicycle trails: Use patterns and user preferences. *Trends*, *25*(3), 21-25.

Gobster, P.H. (1995).Perception and use of a metropolitan greenway system for recreation. *Landscape and Urban Planning*, *33*, 401-413.

Gobster, P.H. & Chenoweth, R.E. (1989). The dimensions of aesthetic preference: A quantitative analysis. *Journal of Environmental Management*, *29*, 47-72.

Goeft, U. & Adler, J. (2000). Mountain bike rider preferences and perceptions in the southwest of Western Australia. *CALMScience, 3*(2), 261-275.

Goodyear, S. (2009, November 23). Brasilia's pathways of desire. Article posted to: http://www.streetsblog.org

Goossen, M. & Langers, F. (2000). Assessing quality of rural areas in the Netherlands: Finding the most important indicators for recreation. *Landscape and Urban Planning*, *46*(4), 241-251.

Government of New South Wales (2003a). *Bridge aesthetics: Design guidelines to improve the appearance of bridges in NSW*. Roads and Traffic Authority, Sydney.

Government of New Zealand (2004). *Cycle network and route planning guide*. Land Transport Safety Authority.

Government of South Australia (2005). *Cycling: Summary report number 4*. Adelaide: Physical Activity Council.

Government of South Australia (2007). *Guidelines for the Planning, Design, Construction and Maintenance of Recreational Trails in South Australia.* South Australian Trails Coordinating Committee.

Government of the United Kingdom (2007). *National Travel Survey: 2006*. London: Department for Transport.

Government of Western Australia (1995). *Perth Metropolitan Transport Strategy 1995 to 2029*. Perth: Department of Transport.

Government of Western Australia (1996). *Bike Ahead: Bicycle Strategy for the 21st Century*. Perth: Department of Transport.

Government of Western Australia (2007). *Liveable Neighbourhoods: A Western Australian Government sustainable cities initiative*. Perth: Western Australian Planning Commission.

Government of Western Australia (2010). *Minimising conflict on paths and trails* [Fact sheet]. Department of Transport, Perth, Western Australia.

Government of Western Australia (n.d.). *There is more to a shared path than meets the eye* [Fact sheet]. Department for Planning and Infrastructure, Perth, Western Australia.

Govert, J. (1998). *Spiritual pilgrimages and sacred places: Applying Feng Shui to trails and greenways*. Paper presented at the 14th National Trails Symposium, Tucson, Arizona.

Grant, R.W. & Sugarman, J. (2004). Ethics in human subjects research: Do incentives matter? *Journal of Medicine and Philosophy*, *29*(6), 717-738.

Green, M. (2008). *The landscape has an effect on driving*. Nordic Roads. Sweden VTI.

Green, R. (1999). Meaning and form in community perception of town character. *Journal of Environmental Psychology, 19*, 311-329.

Greig, R. (2010). *Limitations on the word 'cyclist' to describe people who ride bicycles.* Paper presented at The Australian Cycling Conference, Adelaide, Australia, January 17-18.

Groat, L. & Wang, D. (2002). *Architectural research methods*. New York: John Wiley & Sons.

Gross, M., Zimmerman, R., & Buchholz, J. (2006). *Signs, trails, and wayside exhibits: Connecting people and places*. Uw-Sp Foundation Press.

Grounds, B. (2007). *The barriers and enhancers to using active transport in the Illawarra*. Wollongong: Healthy Cities Illawarra Inc.

Hall, C.M. & Page, S. (1999). *The geography of tourism and recreation: Environment, place and space*. Routledge.

Hammitt, W.E. (1981). The familiarity preference components of on-site recreational experiences. *Leisure Sciences*, *4*, 177-193.

Hard, A. & Sivik, L. (2001). A theory of colors in combination – a descriptive model related to the NCS color-order system. *Color Research and Application, 26*, 4-28.

Hartig, T. (2005). *Toward understanding the restorative environment as a health resources*. Institute for Housing and Urban Research, Uppsala University.

Hartig, T., Mang, M., & Evans, G.W. (1991). Restorative effects of natural environment experiences. *Environment and Behaviour*, *23*(1), 3-26.

Haynes, R. (1980). *Geographical images and mental maps*. London: Macmillan.

Heerwagen, J.H. & Orians, G.H. (1993). Humans, habitats and aesthetics. In S.R. Kellert & E.O. Wilson (Eds.). *The Biophilia Hypothesis*. Island Press.

Heft, H. & Nasar, J. (2000). Evaluating environmental scenes using dynamic versus static displays. *Environment and behaviour, 32*(3), 301-322.

Herzog, T.R. (1985). A cognitive analysis of preferences for waterscapes. *Journal of Environmental Psychology, 5,* 225-241.

Herzog, T. R. (1986). A cognitive analysis of preference for field-and-forest environments. *Landscape Research, 9*, 10-16.

Herzog, T. R. (1987). A cognitive analysis of preference for natural Environments: Mountains, canyons and deserts. *Landscape Journal, 6*, 140-152.

Herzog, T.R. (1989). A cognitive analysis of preference for urban nature. *Journal of Environmental Psychology, 9*, 27-43.

Herzog, T.R. & Kirk, K.M. (2005). Pathway curvature and border visibility as predictors of preference and danger in forest settings. *Environment and Behaviour*, *37*(5). 620-639.

Herzog, T.R. & Smith, G.A. (1988). Danger, mystery and environmental preference. *Environment and Behavior*, *20*(3), 320-344.

Hetherington, J., Daniel, T.C., & Brown, T.C. (1993). Is motion more important than it sounds? The medium of presentation in environmental perception research. *Journal of Environmental Psychology*, *13*(4), 283-291.

Hoffman, D.D. (1998). *Visual intelligence: How we create what we see*. New York: W.W. Norton & Company.

Hodgson, R.W. & Thayer, R.L. (1980). Implied human influence reduces landscape beauty. *Landscape Planning*, *7*, 171-179.

Hogarth, W. (1997). *The analysis of beauty*. 1753 original publication. New Haven: Yale University Press.

Hollenhorst, S., Schuett, M.A., Olson, D., & Chavez, D. (1995). An examination of the characteristics, preferences, and attitudes of mountain bike users of the national forests. *Journal of Park and Recreation Administration*, *11*(3), 41-51.

Hopkinson, P.G. & Wardman, M. (1996). Evaluating the demand for new cycle facilities. *Transport Policy*, *3*(4), 241-249.

Horton, D., Rosen, P., & Cox, P. (2007). *Cycling and society*. Ashgate Publishing Limited.

Hull, R.B. (1992). Brief encounters with urban forests produce moods that matter. *Journal of Arboriculture*, *18*, 322-325.

Hull, R.B. & Stewart, W.P. (1995). The landscape encountered and experienced while hiking. *Environment and Behaviour*, *27*(3), 404-426.

Hull, R.B. & Stewart, W.P. (1992). Validity of photo-based scenic beauty judgements. *Journal of Environmental Psychology*, *12*(2), 101-114.

Humpel, N., Owen, N., Iverson, D., Leslie, E., & Bauman, A. (2004). Perceived environmental attributes, residential location and walking for particular purposes. *American Journal of Preventative Medicine*, *26*, 119-125.

Hunt, J. & Abraham, J. (2007). Influences on bicycle use. *Transportation*, *34*, 453-470.

Hunt, J.D. & Willis, P. (1988). Eds. The *genius of place: The English landscape garden 1620-1820.* Cambridge, MIT Press.

Institution of Public Works Engineering Australia (2009). *Local government guidelines for subdivisional development*. Sydney: IPWEA.

International Mountain Bicycling Association (2007). *Managing Mountain Biking: IMBA's Guide to Providing Great Riding.* International Mountain Bicycling Association, Boulder Colorado.

Iowa Department of Transportation (2000) *Spiral curve design*. Iowa Department of Transportation Office of Design.

Jackson, J.B. (1997). *Landscape in Sight: Looking at America*. (H. Horowitz, Ed.). New Haven: Yale University Press.

Jimenez, P.R. (1985). Participant observation. In M. Bautista & S. Go (Eds.), *Introduction to qualitative research methods*. Manila: De La Salle University Research Centre.

John, O.P., Donahue, E.M., & Kentle, R.L. (1991). *The Big Five Inventory: Versions 4a and 54*. Berkeley, California: University of California Institute of Personality and Social Research.

John, O.P. & Srivastava, S. (1999). *The Big-Five Trait Taxonomy: History, measurement and theoretical perspectives*. University of California at Berkeley.

Jones, P. (2005). Performing the city: A body and a bicycle take on Birmingham UK. *Social and Cultural Geography*, *6*(6), 813-818.

Jones, G.R., Ady, J., Gray, B.A., Utevsky, F., Hendrickson, P., & Wilfert, G. (1976). Scenic and recreational highway study for the State of Washington. *Landscape Planning*, *3*, 151-302.

Kaplan, R., Kaplan, S., & Ryan, R.L. (1998). *With people in mind: Design and management of everyday nature*. Washington DC: Island Press.

Kaplan, S. (1987). Aesthetics, affect and cognition: environmental preference from an evolutionary perspective. *Environment and Behaviour*, *19*(1), 3-32.

Kaplan, S. & Kaplan, R. (1982). *Cognition and environment: Functioning in an uncertain world*. New York: Praeger.

Kaplan, S. & Kaplan, R. (1989). *The experience of nature: A psychological perspective.* New York: Cambridge University Press.

Keates, N. (2007). *Building a better bike lane*. New York: The Wall Street Journal

Kennedy, J.M., Richardson, B.L., & Magee, L. (1980). In *The perceptions of pictures Vol. 2*. M. Hagen (Ed.). New York: Academic Press.

Kent, R.L. (1989). The role of mystery in preferences for shopping malls. *Landscape Journal*, *8.* 28-35.

Kent, R.L. (1993). Attributes, features and reasons for enjoyment of scenic routes: A comparison of experts, residents and citizens. *Landscape Research. 18*(2), 92-101.

Keuning Institute (2005). *Shared space: Room for everyone: A new vision for public spaces*. Leeuwarden, The Netherlands.

Kilpatrick, K. (2001). Tandem cycling: A breath of fresh air for the visually impaired. *Better Bicycling*, Summer 2001. Retrieved May 20, 2009, from http://www.safecycling.ca/BetterBicycling/2001Summer/tandem.shtml

Kohler, W. (1947). *Gestalt psychology: An introduction to new concepts in modern psychology*. New York: Liveright Publishing Company.

Krizek, R.L. (2003). Ethnography as the excavation of personal narrative. In R. Clair (Ed.), *Expressions of ethnography: Novel approaches to qualitative methods* (pp. 141-152) New York: Cornell University Press.

Kroh, D.P. & Gimblett, R.H. (1992). Comparing live experience with pictures in articulating landscape preference. *Landscape Research*, *17*, 58-69.

Lamb, R.J. & Purcell, A.T. (1990). Perception of naturalness in landscape and its relationship to vegetation structure. *Landscape and Urban Planning*, *19*, 333-352.

Langdridge, D. (2006). *Phenomenological psychology: theory, research and method*. Harlow: Pearson.

Lange, E. (2001). The limits of realism: perceptions of virtual landscapes. *Landscape and Urban Planning*, *54*(1-4), 163-182.

Laurie, M. (1986). *An Introduction to Landscape Architecture*. Elsevier Science Publishing, 2nd edition.

Lefebvre, H. (1991). *The production of space*. Oxford: Blackwell.

Little, C.E. (1990). *Greenways for America*. Baltimore: John Hopkins University Press.

Lohr, V.I. (2006). Responses to scenes with spreading, rounded, and conical tree forms. *Environment and Behaviour*, *38*(5), 667-688.

Louv, R. (2005). *Last child in the woods: Saving our children from nature-deficit disorder*. Chapel Hill: Algonquin Books.

Lue, C., Crompton, J., & Fesenmaier, D. (1993). Conceptualization of multi-destination pleasure trips. *Annals of Tourism Research*, *20*(2), 289-301.

Lumsdon, L. (2000). Transport and tourism: Cycle tourism – a model for sustainable development? *Journal of Sustainable Tourism*, *8*(5), 361-377.

Lyons, E. (1983). Demographic correlates of landscape preferences. *Environment and Behaviour*, *15*(4), 487-511.

McClelland, L.F.(1993). *Presenting nature: The historic landscape design of the National Park Service 1916 to 1942*. Washington DC: United States Department of the Interior, National Park Service.

McClintock, H. (1992). Post-war traffic planning and special provision for the bicycle. In H. McClintock (Ed.) *The Bicycle and City Traffic*. London: Belhaven Press.

McClintock, H. (2002). *Planning for cycling: Principles, practice and solutions for urban planners*. Woodhead Publishing, Cambridge, United Kingdom.

Macia, A. (1979). Visual perception of landscape: Sex and personality differences. In G.H. Elsner and R.C. Smardon (Eds.) *Our National Landscape*, United States Forest Service General Technical Report, 279-285.

McCrae, R.R. & Costa, P.T. (2004). A contemplated revision of the NEO Five-Factor Inventory. *Personality and Individual Differences*. *36*(3), 587-596.

McKee, B. (2005, April 28). Growing up denatured. *New York Times*. Retrieved August 18, 2009, from http://www.gtcd.org

McKenna, J. & Whatling, M. (2007). Qualitative accounts of urban commuter cycling. *Health Education*. *117*(5), 448-462.

Maine Department of Transportation (2001). *Bicycle tourism in Maine: Economic impacts and marketing*. Office of Passenger Transportation.

Mak, M.Y. & Ng, S.T. (2004). The art and science of Feng Shui: A study on architects' perception. *Building and Environment*, *40*(30), 427-434.

Mandler, G. (1967). Organisation and memory. In *The psychology of learning and motivation*. K. Spence and J. Spence (Eds.). (pp 327-372). New York: Academic Press.

Merriam, S.B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage Publications.

Miller, S.B. (2009). The piano stairway: The fun theory. *St Louis Post Dispatch*. Retrieved 20 October, 2009, from http://www.stltoday.com

Myers, M.E. (2002). Variety and interest: What makes the Blue Ridge Parkway beautiful? *Landscape Architecture Magazine*. *92*(3), 71-73, 93-95.

Myers, M.E. (2003). Bluegrass harmony. *Landscape Architecture Magazine*. May 2003, 83-103.

Myers, M.E. (2004). The line of grace: Principles of road aesthetics in the design of the Blue Ridge Parkway. *Landscape Journal, 23*(2), 121-140.

Myers, M.E. (2006). Power of the picturesque: Motorists' perceptions of the Blue Ridge Parkway. *Landscape Journal, 25*(1), 38-53.

Naderi, J.R. (2003). *Landscape design in clear zone: Effect of landscape variables on pedestrian health and driver safety*. Washington D.C.: Transportation Research Board 1851.

Nasar, J.L. (1992). *Environmental aesthetics: Theory, research and applications*. Cambridge: Cambridge University Press.

Nasar, J. (1994). Urban design aesthetics: The evaluative qualities of building exteriors. *Environment and Behaviour, 26*(3), 377-401.

Nasar, J.L., Julian, D., Buchman, S., Humphreys, D., & Mrohaly, M. (1983). The emotional quality of scenes and observation points: A look at prospect and refuge. *Landscape Planning*, *10*, 355-361.

Nasar, J.L. & Li, M. (2004). Landscape mirror: the attractiveness of reflecting water. *Landscape and Urban Planning, 66*, 233-238.

Nasar, J.L. & Purcell, A.T. (1990). *Beauty and the beast extended: Knowledge, structure and evaluation of houses by Australian architects and non-architects*. International Association for the Study of Persons and Their Surroundings, Ankara, Turkey July 8-12.

Nassauer, J.I. (1995). Messy ecosystems, orderly frames. *Landscape Journal*, 161-170.

NC Natural. (2006). Blue Ridge Parkway travel guide: Parkway history. Retrieved May 17, 2009, from http://ncnatural.com/Parkway/BRP-History.html

Neuman, W.L. (2006). *Social research methods: Qualitative and quantitative approaches*. New York: Pearson Education Inc.

Newman, P. & Kenworthy, J. (1999). *Sustainability and cities: Overcoming automobile dependence*. Washington: Island Press.

Norcliffe, G. (2001). *The Ride to Modernity: The Bicycle in Canada 1869 to 1900*. University of Toronto Press.

Neuman, W.L. (2006). *Social research methods: Qualitative and quantitative approaches*. Boston: Pearson.

Oregon Department of Transportation (1995). *Oregon Bicycle and Pedestrian Plan*. Portland: Oregon Department of Transportation.

Orians, G.H. (1986). An ecological and evolutionary approach to landscape aesthetics. In E. Penning-Rowsell & D. Lowenthal (Eds.), *Landscape meanings and values*. London: Allen and Unwin.

Osgood, C.E., Suci, G.J., & Tannenbaum, P.H. (1957). *The measurement of meaning.* Chicago: University of Illinois Press.

Parker, T.S. (2004). *Natural Surface Trails by Design.* Natureshape, Boulder Colorado.

Parsons, R. (1991). The potential influences of environmental perception on human health. *Journal of Environmental Psychology*, *11*, 1-23.

Passonneau, J. (1996). Aesthetics and other community values in the design of roads. Transportation Research Record no. 1549.

Paunonen, S.V. & Ashton, M.S. (2001). Big five factors and facets and the prediction of behaviour. *Journal of Personality & Social Psychology*, *81*(3), 524-539.

Peters, T.F. (2008). Intertwining histories of building professionals. *Building Research and Information*, *36*(6), 677-679.

Petty, R. (1996). *Women and the wheel: The bicycle's impact on women.* In Van der Plas (Ed.) Proceedings, 7th International Cycle History Conference. Anaheim, California, p.112-131.

Pikora, T., Giles-Corti, B., Bull, F., Jamrozik, K., & Donovan R. (2003). Developing a framework for assessment of the environmental determinants of walking and cycling. *Social Science & Medicine*, *56*, 1693-1703.

Pocock, D.C.D. (1982). *The view from the bridge: Experience and recall of landscape.* Durham: University of Durham.

Popay, J., Williams, G., Thomas, C., & Gatrell, T. (1998). Theorising inequalities in health: The place of lay knowledge. *Sociology of Health and Illness*, *20*, 619-644.

Porteous, D. (1982). Approaches to environmental aesthetics. *Journal of Environmental Psychology*, *2*, 53-66.

Pow, C.P. (2000). Sense and sensibility: Social-spatial experiences of the visually impaired in Singapore. *Singapore Journal of Tropical Geography*, *21*(2), 166-182.

Pring, R. (2000). *Philosophy of educational research*. London: Continuum.

Purcell, A.T. (1992). Abstract and specific physical attributes and the experience of landscape. *Journal of Environmental Management*, *34*, 159-177.

Qu, X. & Nussbaum, MA. (2009). Evaluation of the Roles of Passive and Active Control of Balance using a Balance Control Model. *Journal of Biomechanics, 42*(12), 1850-1855.

Rathke, D.M. & Baughman, M.J. (2009). *Recreational Trail Design and Construction*. University of Minnesota.

Raymond, J.E., Fenske, M.J., & Tavassoli, N.T. (2003). Selective attention determines emotional responses to novel visual stimuli. *Psychological Science*, *14*, 537-542.

Real, E., Arce, C., & Sabucedo, J. (2000). Classification of landscapes using quantitative and categorical data, and prediction of their scenic beauty in North-Western Spain. *Journal of Environmental Psychology* 20: 355-373.

Reeh, H. (2004, June). *Experiencing the street: tactile versus visual perception*. Paper presented at the 5th International Conference on Walking in the 21st Century. Copenhagen, Denmark.

Richards, L. & Richards, T. (1987). Qualitative data analysis: Can computers do it? *Australian and New Zealand Journal of Sociology*, *23*(1), 23-35.

Rock, I. (1975). *An introduction to perception*. New York: Macmillan Publishing Company.

Rosnov, R. L. & Rosenthal, R. (1996). *Beginning behavioral research: A conceptual primer.* (2nd ed.). Upper Saddle River: Prentice Hall.

Rothman, A.J. (2000). Toward a theory-based analysis of behavioural maintenance. *Health Psychology*, *19*, 64-69.

Russell, J.A. (1980). A circumplex model on affect. *Journal of Personality and Social Psychology, 39*(6), 1161-1178.

Rutten, A., Abel, T., Kannas, L., von Lengerke, T., Luschen, G, Rodriguez Diaz, J., Vinck, J., & van der Zee, J. (2001). Self reported physical activity, public health, and perceived environment: Results from a comparative European study. *Journal of Epidemiology and Community Health*, *55*, 139-146.

Ryback, R.S. & Yaw, L. (1976). The magic of water. *Man-Environment Systems*, *6*(2), 81-83.

Sadalla, E.K. & Staplin, L.J. (1980). The perception of traversed distance. *Environment and Behaviour*, *12*(2), 167-182.

Sarantakos, S. (1994). *Social Research*. South Melbourne: MacMillan Education.

Saw, R. & Osborne, H. (1960). Aesthetics as a branch of philosophy. *The British Journal of Aesthetics*. *1*, 8-20.

Saw, R. & Osborne, H. (1968). Aesthetics as a branch of philosophy. In: Osborn, H. (Ed.), *Aesthetics in the Modern World*. New York: Weybright and Talley.

Scheurer, J. (2005). Achieving mode share targets in Australian cities through policy integration: Are we on track? *Urban Policy and Research*, *23*(4), 525-530.

Schmidhuber, J. (1997). Low-complexity art: Leonardo. *Journal of the International Society for the Arts, Sciences and Technology*, *30*(2), 97-103.

Schroeder, H.W. & Cannon, W.N. (1987). Visual quality of residential streets: Both street and yard trees make a difference*. Journal of Arboriculture*. 236-239

Seamon, D. (1979). *A geography of the lifeworld*. New York: St. Martin's.

Seamon, D. (1993). Review of Stephen C. Bourassa, *The Aesthetics of Landscape* (New York: Halsted Press, 1991). In *Annals of the Association of American Geographers*, *83*(3), 523-525.

Shafer, C., Lee, B., Turner, S., & Hughart, M. (1999). Evaluation of bicycle and pedestrian facilities: User satisfaction and perceptions on three shared use trails in Texas. *Southwest Region University Transportation Center*, Report SWUTC/99/472840-00021-1: 89.

Shafer, E.L., Hamilton, J.F., & Schmidt, E.A. (1969). Natural landscape preference: A predictive model. *Journal of Leisure Research*, *1*(1), 1-19.

Shahan, Z.D. (2007). *The relationship between bicycling facilities and bicycle travel: A comparative study in the United States and the Netherlands.* Masters dissertation, University of North Carolina, North Carolina.

Sheth, J.N. & Frazier, G.L. (1982). A model of strategy mix choice for planned social change. *Journal of Marketing*, *46*(1), 15-26.

Shire of Calliope (2003). *Turtle Way User Survey 2002*. Calliope: Shire of Calliope.

Shire of Nillumbik (2007). *Sensory-rich trails: A design framework*. Government of Victoria.

Shuttleworth, S. (1980). The use of photographs as an environmental presentation medium in landscape studies. *Journal of Environmental Management*, *11*, 61-76.

Skinner, E. & Skinner, C. (2004). *Bicycling the Blue Ridge: A guide to the Skyline Drive and the Blue Ridge Parkway*. 4th ed. Menasha Ridge Press.

Smith, R.A. (1972). *A Social History of the Bicycle*. American Heritage Press

Solnit, R. (2000). *Wanderlust: a history of walking*. Viking. New York.

Sommer, (1997). Further cross-national studies of tree form preference. *Ecological Psychology*, *9*, 153-160.

Spen Valley Greenway [n.d.]. Retrieved September 12, 2009 from the Sustrans website: http://www.sustrans.org.uk

Spinney, J. (2008). Cycling between the traffic: Mobility, identity and space. *Urban Design Journal*, *108*, 28-30.

Spinney, J. (2009). Cycling the city: Movement, meaning and method. *Geography Compass*, *4*,

Stamps, A.E. (1990). The use of photographs to simulate environments: A meta-analysis. *Perceptual and Motor Skills*, *71*, 907-913.

Stamps, A.E. (1999). Demographic effects in environmental aesthetics: A meta-analysis. *Journal of Planning Literature, 14*(2), 155-175.

Stamps, A.E. (2000). *Psychology and the aesthetics of the built environment*. Boston: Kluwer.

Stamps, A.E. (2007). Mystery of environmental mystery: Effects of light, occlusion and depth of view. *Environment and Behaviour*, *39*(2), 165-197.

Standards Australia (1999). *Guide to Traffic Engineering Practice Part 14 Bicycles*. Austroads, Sydney.

Standards Australia (2001). *Walking tracks - Part 2: Infrastructure design*. AS2156.2.

Sternberg, R.J. (2002). *Cognitive Psychology*. Belmont: Wadsworth Publishing.

Still, A., Fourie, P., & Ghantous, P. (2007). *Review of the Perth Bicycle Network Stage 3: Community and stakeholder consultation*. Prepared for the Department for Planning and Infrastructure, Western Australia.

Stinson, M. & Bhat, C. (2003). Commuter bicyclist route choice: Analysis using a stated preference survey. *Transportation Research Board*, *1828*, 107-115.

Stripling, S. (1995, August 24). The possible dream: Riding with a blind cyclist reveals the prowess and independence of disabled athletes. *The Seattle Times*. Retrieved May 20, 2009, from http://community.seattletimes.nwsource.com/archive/?date=19950824&slug=2138061

Strumse, E. (1994). Perceptual dimensions in the visual preferences for agrarian landscapes in western Norway. *Journal of Environmental Psychology*, *14*(4), 281-292.

Suddaby, R. (2006). From the editors: What grounded theory is not. *Academy of Management Journal, 49*(4), 633-642.

Sustrans (1999). *Cycle Tourism*. Bristol, UK.

Sustrans (2009). *Connect2 and Greenway Design Guide*. College Green, UK.

Sustrans (1997). *The National Cycle Network: Guidelines and Practical Details*. College Green, UK.

Sustrans. (n.d.). *Economic appraisal of local walking and cycling routes* [Brochure]. College Green, UK.

Texas A&M University (2007). *Elements and principles of landscape design*. College Station, Texas: Instructional Materials Service.

The European Greenways Association (2009). *European greenways award 2009*. General Presentation Regulations.

The possibility of mobility. Retrieved May 20, 2009, from http://xroads.virginia.edu/~UG02/hendrick/women.html

Tilden, F. (1957). *Interpreting our heritage*. Chapel Hill: University of North Carolina Press.

Tourism Queensland (2000). *Innovation in interpretation.* Brisbane: Tourism Queensland.

Transportation Environmental Research Program. [n.d.]. Retrieved June 17, 2009, from the United States Department of Transportation web site: http//www.fhwa.dot.gov/terp/prog.htm#I19

Troped, P.J. & Cromley, E.C. (2005). *Path environment audit tool*: *Instruction manual for conducting path/trail observations.* West Lafayette: Purdue University Press.

Troped, P., Saunders, R., Pate, R,. Reininger, B., Ureda, J., & Thompson, S. (2001). Associations between self-reported and objective physical environment factors and use of a community rail trail. *Preventive Medicine*, *32*, 191-200.

Troped, P., Saunders, R., Pate, R., Reininger, B., & Addy, C. (2003). Correlates of recreational and transportation physical activity among adults in a New England community. *Preventative Medicine*, *37*, 304-310.

United States Department of Transportation (2008). *National survey of bicyclist and pedestrian attitudes and behaviour: Summary report*. Washington DC: National Highway Traffic Safety Administration.

United States Department of Transportation (2001). *Iron and Asphalt: the Evolution of the Spiral Curve in Railroads and Parkways* Public Roads, *65*(2), September/October 2001.

United States Department of Transportation (1990). *Visual impact assessment for highway projects*. Washington DC: Office of Environmental Policy.

United States National Park Service (2001). *Ice Age national scenic trail: A handbook for trail design, construction and maintenance*. Madison, Wisconsin: United States Department of the Interior.

University of Minnesota. [n.d.]. *Context Sensitive Design: The Road Best Traveled*. Center for Transportation Studies. http//:www.cts.umn.edu

Ulrich, R.S. (1986). Human responses to vegetation and landscape. *Landscape and Urban Planning*, *13*(1), 29-44.

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*, 201–230.

Unwin, K.K. (1975). The relationship of observer and landscape in landscape evaluation. *Transactions of the Institute of British Geographers*, *66*, 130-134.

Urry, J. (2000). *Sociology beyond societies: Mobilities for the twenty-first century*. London: Routledge.

van Beers, R.J., Sittig, A.C. & van der Gon, J.J.D. (1998). The precision of proprioceptive position sense. *Experimental Brain Research*, *122*, 367-377.

Weller, R. (2009). *Boomtown 2050: Scenarios for a rapidly growing city*. Crawley: UWA Publiching.

Whisnant, A.M. (2006). *Super-scenic motorway: A Blue Ridge Parkway history.* University of North Carolina Press.

Whitfield, T.W.A. & Wiltshire, T.J. (1990). Color psychology: A critical review. *Genetic, Social and General Psychology Monographs*, *116*(4), 385-411.

Wilkinson, L. & The Task Force on Statistical Inference. (1999). Statistical methods in psychology journals: Guidelines and explanations. *American Psychologist*, *54*(8), 594-604.

Williams, R. (1973). *The country and the city.* London: Chatto and Windus.

Willson, G.B. & McIntosh, A.J. (2007). Heritage buildings and tourism: An experiential view. *Journal of Heritage Tourism*, *2*(2), 75-93.

Wilson, A. (1991). *The culture of nature: North American landscape from Disney to the Exxon Valdez*. Toronto: Between the Lines.

Wilson, E.O. (1984). *Biophilia*. Cambridge: Harvard University Press.

Wolf, K.L. (2003). Public response to the urban forest in inner-city business districts. *Journal of Arboriculture*, *29*(3), 117-126.

Wolfe, U. (1996). *The need for aesthetics in civil engineering education*. Undergraduate Engineering Review 1996 ed.

Yang, B.E. & Brown, T.J. (1992). A cross-cultural comparison of preferences for landscape styles and landscape elements. *Environment and Behaviour*, *24*(4), 471-507.

Yu, K. (1995). Cultural variations in landscape preferences: Comparisons among Chinese sub-groups and Western design experts. *Landscape and Urban Planning*, *32*, 107-126.

Zacharias, J. (2001). Path choice and visual stimuli: signs of human activity and architecture. *Journal of Environmental Psychology*, *24*(2), 1-12.

Zajonc, R.B. (2001). Mere exposure: A gateway to the subliminal. *Current Directions in Psychological Science*, *10*, 224-228.

Zajonc, R.B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist*, *35*(2), 151-175.

Zappelli, R. & Rounce, A. (2009, May). *Cycling attitudinal segmentation demographic profiling*. Poster session presented to Department for Planning and Infrastructure staff, Perth, Western Australia.

Zappelli, R., Rounce, A., & Deng, J. (2008). *Track of cycling behaviour and attitudes*. Prepared for Department for Planning and Infrastructure. Perth: TNS Social Research.

Zion, L.C. (1996). Making sense: Kinesthesia. *ETC: A Review of General Semantics*, *53*(3), 300-314.

Zolomij, R.W. (1972). *Vehicular circulation*. American Society of Landscape Architects Foundation.

Zube, E.H. & Pitt, D.G. (1981). Cross-cultural perceptions of scenic and heritage landscapes. *Landscape and Planning*, *8*(1), 69-87.

Zube, E.H., Pitt, D.G., & Evans, G.W. (1983). A lifespan developmental study of landscape assessment. *Journal of Environmental Psychology*, *3*(2), 115-128.

Zube, E.H., Sell, J.L., & Taylor, J.G. (1982). Landscape perception: research, application and theory. *Landscape and Planning*, *9*(1), 1-33.

Zube, E.H., Simcox, D.E., & Law, C.S. (1987). Perceptual landscape simulations: history and prospect. *Landscape Journal*, *6*(1), 62-80

Appendix 1. Glossary of terms and abbreviations

Alignment
The course or configuration of a path or trails. Refers to the horizontal plane (curves) and the vertical plane (undulations).

Composite view shed
The composite of overlapping areas visible from a continuous linear sequence of viewpoints along a path, or a network of viewpoints surrounding a path.

Desire line
A route chosen by cyclists irrespective of the presence of a route, path or other facility.

Ephemeral influences
Transitory elements or features that produce fleeting experiences. Examples include meteorological conditions, lighting conditions, reflections and animal occupancy.

Grade separation
The use of facilities such as overpasses or underpasses to reduce or eliminate the need for path users to negotiate roads, rail lines or other paths that would otherwise cross the route.

Gradient
The angle or steepness of a particular slope, path or trail.

Hybrid bicycle
A multi-purpose bicycle that has a basic design profile that sits between that of a road bike and a mountain bike. It is suitable for riding on both paved and natural surfaces.

Interpretative infrastructure
Facilities that seek to engage or entertain a path or trail user, in addition to imparting information.

Off-road cycling
Any riding environment that is not paved. It does not include bitumen, concrete or brick paved paths.

PBN
see Perth Bicycle Network

Perceptual field
All the elements of the external environment that a person perceives or experiences as they encounter them.

Perth Bicycle Network
A network of interlinked shared paths, bicycle lanes and designated low-traffic streets that covers most of the Perth metropolitan area.

Principal shared path
A major path for cyclists and pedestrians that is situated along transport corridors such as freeways, highways and railways.

PSP
see principal shared paths

Rail trail
An off-road trail constructed on the hard base of a disused railway reserve, often for the use of cyclists, walkers and horse riders.

Shared path
A paved path used by more than one type of user. Most often refers to a facility used by both cyclists and pedestrians. Also known as a dual-use path.

Sightline
Distance that a cyclist can see ahead unimpeded by curves, crests or environmental features.

Singletrack
A natural surface trail is only wide enough for one person or bicycle.

Spiral curve
A design feature used to move between a circular curve of a specific radius and degree of curvature, and a straight tangent. Also referred to as a transition or easement curve.

Tread
The base of a natural surface trail that users travel upon. It can consist of rocks, soil, imported aggregate, wood or grass.

Trip attractor
A facility or feature that acts as destination for a bicycle rider.

Viewshed
All of the surface area visible from an observer's viewpoint

Appendix 2. Interview questionnaire

Provisional data collection tools

These data collection tools relate to the photo-surrogate and in-situ rides to be conducted during the third phase of the research project. They are still in the preliminary stage of development and may be amended as a result of the outcome of the full literature review, autoethnography and key informant interviews.

Part A Demographic information

Interviewer to determine first name and record gender.

Q1. In what suburb/postcode do you reside?

Q2. What age group do you belong to?
- 18 to 35
- 36 to 55
- 56 and over

Q3. What is your country of birth?
- Standard census categories

Q4. Are you colour-blind?
- Yes
- No
- Don't know

Q5. Do you have any uncorrected hearing impairment?
- Yes
- No
- Don't know

Q6. What is the highest educational level you have attained?
- Standard census categories.

Part B Cycling activity information

Q1. How often do you ride a bicycle?

More than three times per week
Once or twice per week
Once or twice a month
Less than once a month

Q2. How many kilometres do you ride on an average journey?

Q3. What is the main purpose of your rides?

Commuting
Recreation
Family ride
Shopping

Q4. What would your average riding speed be?

Q5. What type of bicycle do you use?

Road
Hybrid
Mountain
Folding
Electric
Tandem
Tricycle

Q6. Which of these accessories do you have on your bike?

Computer
GPS
Mirrors
Bell
Cargo rack

Q7. What percentage of your riding would be done on the following types of infrastructure?

Path
Trail
Bike lane
Road

Q8. Have your cycled in any other country?

Yes - probe for details
No - go to Question 9

Q9. Do you wear audio headphones when riding?

Always
Sometimes
Never

Q10. What percentage of your riding would be done alone?

All
75%
50%
25%
None

Q11. Whenever you ride in a group of two or more (family, friends, club etc.), who chooses the route?

I do
Spouse
Children
Club leader
We vote on it
Other

Part C Personality profiling

A quick test of personality type will be performed in order to ascertain how open the participant is to perceptual experience. This data will be collected via a portion of the condensed version of the Revised NEO Personality Inventory (NEO-FFI) that is a standard test used widely by researchers in Australia. The section of test dealing with Openness to Experience will be used in this research project. This section consists of 10 questions and takes approximately three minutes to complete.

Here are a number of characteristics that may or may not apply to you. Please tick the box below the statement that indicates the extent to which you agree or disagree with that statement.

Q1. I am someone who is original and comes up with new ideas:

1 Disagree strongly	**2** Disagree a little	**3** Neither agree nor disagree	**4** Agree a little	**5** Agree strongly

Q2. I am someone who is curious about many different things:

1 Disagree strongly	2 Disagree a little	3 Neither agree nor disagree	4 Agree a little	5 Agree strongly

Q3. I am someone who is a deep thinker:

1 Disagree strongly	2 Disagree a little	3 Neither agree nor disagree	4 Agree a little	5 Agree strongly

Q4. I am someone who has an active imagination:

1 Disagree strongly	2 Disagree a little	3 Neither agree nor disagree	4 Agree a little	5 Agree strongly

Q5. I am someone who is inventive:

1 Disagree strongly	2 Disagree a little	3 Neither agree nor disagree	4 Agree a little	5 Agree strongly

Q6. I am someone who values artistic, aesthetic experiences:

1 Disagree strongly	2 Disagree a little	3 Neither agree nor disagree	4 Agree a little	5 Agree strongly

Q7. I am someone who prefers work that is routine:

1 Disagree strongly	**2** Disagree a little	**3** Neither agree nor disagree	**4** Agree a little	**5** Agree strongly

Q8. I am someone who likes to reflect and play with ideas:

1 Disagree strongly	**2** Disagree a little	**3** Neither agree nor disagree	**4** Agree a little	**5** Agree strongly

Q9. I am someone who has few artistic interests:

1 Disagree strongly	**2** Disagree a little	**3** Neither agree nor disagree	**4** Agree a little	**5** Agree strongly

Q10. I am someone who is sophisticated in art, music or literature

1 Disagree strongly	**2** Disagree a little	**3** Neither agree nor disagree	**4** Agree a little	**5** Agree strongly

Part D Assessment of riding environments (Semi-structured discussions)

This will consist of one-on-one semi-structured interviews immediately following exposure to photo-surrogate or in-situ stimuli. The questions are designed to investigate each participant's impressions and personal feelings about a selection of riding environments and there are no right and wrong answers.

One group of participants will be shown five riding environment scenarios that are shown in a random order. These riding environments are displayed in a video format from a rider's point-of-view. An alternative format using a series of photographs may also be used. Another group of participants will be invited to complete rides of five short routes in the Perth metropolitan area.

The interviewer will use prompts and probes to create discussion about the participant's feelings or perceptions regarding various riding environments. In particular, what they feel and why they feel that way.

Photo-surrogate and in-situ rides

Q1. What was your overall impression of the ride?

Q2. Which specific features can you recall, if any?

Q3. Did you want to slow down or stop to explore any element along the ride?

Q4. Did the journey seem to drag or were you keen to keep riding?

Q5. How did you feel at the completion of the ride (relaxed, stressed, bored, excited)

In-situ rides only

Q6. How did you feel about the path surface?

Q7. How did you feel about the path structure?

Q7. Did you notice any sounds?

Q8. Did you notice any smells?

Following completion of all rides

When all photo-surrogate or in-situ riding environments have been viewed or experienced, the participant will be asked to indicate which of the routes they would be most likely to use, given that they have uniform start and end points and are approximately the same length.

The participants will then be asked to explain their reasons for the ranking given to the most and least preferred rides.

Appendix 3. Questions for key informants

Interviews with key informants – potential questions

All of the key informants will be asked to provide a short summary of their professional background and the nature of their current role. Each informant will then be asked a similar set of questions that may be slightly modified according to their particular area of expertise or involvement in the field of study. This strategy will enable the responses to be compared and contrasted, while still allowing the individuals involved to contribute from their own particular perspective. The following questions and their respective rationale are provided:

1. **Did your professional training include a component that dealt with the aesthetics or attractiveness of infrastructure?**

Rationale: Question 1 seeks to explore the extent to which expert knowledge of aesthetics is available and used by decision-makers in the design of path and trail infrastructure. It also seeks to establish if there is uniformity and consistency in the professional training of designers.

2. **Do you call on other professionals who have that specific training?**

Rationale: Question 2 seeks to explore the multi-disciplinary aspects of path and trail design in Australia. The reliance on consultation and the relationship between professions involved in the path and trail design process.

3. **From a design perspective, how do you think bicycle paths/trails differ from other transport-related infrastructure such as roads and rail lines?**

Rationale: Question 3 seeks to discover if path and trail design is viewed by the professions and industry as a speciality requiring its own fundamentals or simply a segment of transport infrastructure that includes roads, bridges, railways and other major facilities.

4. **Of the three design aspects – safety, functionality and experience, which do consider to be the most important and why?**

Rationale: Question 4 seeks to explore the theoretical framework that supports the path and trail design process. An important outcome of this exploration is the apparent balance between design aspects.

5. **What current design guidelines do you refer to? Are they mandatory?**

Rationale: Question 5 seeks to understand and confirm the legislative and regulatory framework that governs the design of bicycle infrastructure in Australia.

6. **Where do you source path and trail design ideas from?**

Rationale: Question 6 seeks to fully explore the creative process behind the development of paths and trails. In particular, the question investigates how and why ideas are sourced for new projects.

7. **In terms of functionality, do you design facilities with a particular user group in mind or do you attempt to cater for multiple user types? If multiple, which types have priority and why?**

Rationale: Question 7 seeks to explore the practical considerations of designers when they are producing facilities for the general public.

8. **Do you use a cost/benefit analysis in the design process? If so, how do you make the necessary calculations and where do you source the data from?**

Rationale: Question 8 seeks to explore the economic considerations of designers when producing government-funded facilities for the general public. It also attempts to determine if there is an underlying imperative that impacts upon the use of aesthetic and experiential design elements.

Appendix 4. Participant information statement

INFORMATION SHEET – PhD Research Project

You are invited to participate in the following project that is being undertaken as part of the requirements of a PhD at Edith Cowan University.

Title of the project:

An analysis of how the aesthetic and experiential aspects of bicycle paths can influence rider perception and usage.

Researcher:

Tony Stephens
School of Communications and Arts
Tel: [redacted]
Email: awstephe@student.ecu.edu.au

Principal supervisor:

A/Prof. Rod Giblett
School of Communications and Arts
Tel: 9370 6051
Email: r.giblett@ecu.edu.au

Description of the project:

This research project aims to gain a better understanding of the non-technical design aspects (i.e. those not related to safety or function) of bicycle paths and trails that influence user attitudes and behaviours. These non-technical aspects impact on the look and feel of a path, trail or route and therefore help shape the overall riding experience.

The ultimate goal of the project is to develop a set of guidelines for path and trail designers to use when planning new infrastructure. In conjunction with existing Australian Standards, this best practice tool will enable designers to develop paths, trails and routes that are safe, functional and attractive to riders, thereby producing cost-effective facilities for all types of cyclist.

To assist with the research, a number of people will be approached and asked to participate in a series of extended in-depth interviews. The participants will represent various path/trail user groups including commuters, recreational riders and bicycle tourists.

During the interview process, participants will be asked to assess and comment on photographic, video and virtual reality representations of various riding environments. It is estimated that these interviews will be one hour in duration and held in a comfortable location.

Participants in the extended interview process will be compensated for their time by means of a small gift voucher.

Participation and confidentiality:

Participation in this research project is voluntary. No explanation or justification is required if potential participant chooses not to participate.

Participants are free to withdraw their consent to further involvement in the research project at any time. Any unprocessed data provided can also be withdrawn.

If you would like to participate in this research project, please sign the Informed Consent Document and return it to the researcher.

Only the first names and suburb of residence of participants will be recorded. Full names and addresses are not required for the purposes of the research.

The information provided by participants will only be used for this research project. Any research data will be retained for a period of 7 years after the date of publication. It will be securely stored under the supervision of the chief researcher.

Results of the research study:

Participants are welcome to request feedback regarding their specific results and the results of the study in general.

Data collected during the research study will be incorporated into a published thesis.

Further information:

If you have any further questions or require additional information regarding this research project, please feel free to contact the researcher by telephone or email.

This project has been approved by the Edith Cowan University Human Research Ethics Committee.

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Research Ethics Officer
Edith Cowan University
100 Joondalup Drive
JOONDALUP WA 6027
Tel: (08) 6304 2170
Email: research.ethics@ecu.edu.au

INFORMATION SHEET – PhD Research Project

You are invited to participate as a key informant in the following project that is being undertaken as part of the requirements of a PhD at Edith Cowan University.

Title of the project:

An analysis of how the aesthetic and experiential aspects of bicycle paths can influence rider perception and usage.

Researcher:

Tony Stephens
School of Communications and Arts
Tel: [redacted]
Email: awstephe@student.ecu.edu.au

Principal supervisor:

A/Prof. Rod Giblett
School of Communications and Arts
Tel: 9370 6051
Email: r.giblett@ecu.edu.au

Description of the project:

This research project aims to gain a better understanding of the non-technical design aspects (i.e. those not related to safety or function) of bicycle paths and trails that influence user attitudes and behaviours. These non-technical aspects impact on the look and feel of a path, trail or route and therefore help shape the overall riding experience.

The ultimate goal of the project is to develop a set of guidelines for path and trail designers to use when planning new infrastructure. In conjunction with existing Australian Standards, this best practice tool will enable designers to develop paths, trails and routes that are safe, functional and attractive to riders, thereby producing cost-effective facilities for all types of cyclist.

To assist with the research, a number of people who occupy important professional roles relevant to the research will be approached and asked to participate in formal interviews of about 60 minutes in duration. These key informants will be asked about training, design and administrative issues related to the research topic.

Participation and confidentiality:

Participation in this research project is voluntary. No explanation or justification is required if potential participant chooses not to participate.

Participants are free to withdraw their consent to further involvement in the research project at any time. Any unprocessed data provided can also be withdrawn.

If you would like to participate in this research project, please sign the Informed Consent Document and return it to the researcher.

Only the professional role of participants will be recorded. Full names and addresses are not required for the purposes of the research

The information provided by participants will only be used for this research project. Any research data will be retained for a period of 7 years after the date of publication. It will be securely stored under the supervision of the chief researcher.

Results of the research study:

Participants are welcome to request feedback regarding their specific results and the results of the study in general.

Data collected during the research study will be incorporated into a published thesis.

Further information:

If you have any further questions or require additional information regarding this research project, please feel free to contact the researcher by telephone or email.

This project has been approved by the Edith Cowan University Human Research Ethics Committee.

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Research Ethics Officer
Edith Cowan University
100 Joondalup Drive
JOONDALUP WA 6027
Tel: (08) 6304 2170
Email: research.ethics@ecu.edu.au

Appendix 5. Participant consent form

Edith Cowan University
Faculty of Education and Arts

PROJECT : **An analysis of how the aesthetic and experiential aspects of bicycle paths can influence rider perception and usage.**

Researcher:	Tony Stephens School of Communications and Arts Tel: 9216 8308 Email: awstephe@student.ecu.edu.au
Principal Supervisor:	A/Prof. Rod Giblett School of Communications and Arts Tel: 9370 6051 Email: r.giblett@ecu.edu.au

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.

2. I understand that my participation will involve an interview and observation and I agree that the researcher may use the results as described in the plain language statement.

3. I acknowledge that:

   (a) the possible effects of participating in the interview and observation have been explained to my satisfaction and any questions relating to the research have been satisfactorily answered;

   (b) I am aware that if I have any further questions relating to the project I can contact the research team;

   (c) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided;

   (d) the project is for the purpose of research;

   (e) the information provided by participants will only be used for this research project;

   (f) I have been informed that the confidentiality of the information I provide will be safeguarded and not disclosed without consent;

   (g) my name will not be referred to in any publications arising from the research;

   (h) I have been informed that a copy of the research findings will be forwarded to me, should I request this.

<u>I wish to receive a copy of the summary project report on research findings</u> □ yes □ no

Participant name: ______________________________

Participant signature: ______________________ Date: ______________

Edith Cowan University
Faculty of Education and Arts

PROJECT : **An analysis of how the aesthetic and experiential aspects of bicycle paths can influence rider perception and usage.**

Researcher: Tony Stephens
School of Communications and Arts
Tel: [redacted]
Email: awstephe@student.ecu.edu.au

Principal Supervisor: A/Prof. Rod Giblett
School of Communications and Arts
Tel: 9370 6051
Email: r.giblett@ecu.edu.au

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.

2. I understand that my participation as a key informant will involve an interview and I agree that the researcher may use the results as described in the plain language statement.

3. I acknowledge that:

   (a) the possible effects of participating in the interview have been explained to my satisfaction and any questions relating to the research have been satisfactorily answered;

   (b) I am aware that if I have any further questions relating to the project I can contact the research team;

   (c) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided;

   (d) the project is for the purpose of research;

   (e) the information provided by participants will only be used for this research project;

   (f) I have been informed that the confidentiality of the information I provide will be safeguarded and not disclosed without consent;

   (g) my name will not be referred to in any publications arising from the research, although my professional role may be mentioned for reference purposes;

   (h) I have been informed that a copy of the research findings will be forwarded to me, should I request this.

<u>I wish to receive a copy of the summary project report on research findings</u> ☐ yes ☐ no

Participant name: ______________________________

Participant signature: ______________________ Date: ______________