

**Infrastructure for Bicycling in Australia:  
A Review of Current Policy Issues**

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## Preface

Cycling has become a high-profile means of transportation in Australian cities in recent times. Promoted as part of sustainable urban transport systems, as well as offering the health benefits of active transport, cycling provides a low-cost means of covering short journeys in an era of rapidly escalating petrol costs. Local newspapers and radio programmes have given extensive coverage to the rise of the cycling commuter and mass participation events, especially in the larger cities, complete with celebrity participants. What might surprise many Australians is that actual cycling levels in Australia are low by any measure and, despite the boom in bicycle sales, the increase in cycle commuting has barely exceeded the growth in car commuting over the past three decades.

Many factors are involved in determining cycling rates at the household and at the urban scales. While the technology of non-motorized transport modes may be relatively simple, as an issue of transport research, cycling is in some respects no less complex an issue for policy makers than collective and motor vehicle modes. A national study by Bauman et al on barriers against, and means to facilitate, cycling found (2008: iii):

Although exceptions can be found, the overwhelming trend identified in this report is that well designed and connected bicycle infrastructure encourages participation and a lack of it is a major barrier for non-cyclists, infrequent cyclists, and even regular riders.

Many local, state, and national governments have invested in cycling infrastructure to promote cycling, with plans and strategies for further investments, although such spending has drawn criticism. One priority of *The Australian National Cycling Strategy 2005–2010* is to ‘Create integrated, effective and safe cycling networks within urban and rural communities that are consistent with national standards and support increased cycling for transport.’ A report on cycling by the federal Department of Health and Aging *Cycling: Getting Australia Moving* stated: ‘This report recommends the provision of high quality, integrated bicycle routes (on and off road) to meet the challenge of increasing participation in active travel and recreation,’ (Bauman et al, 2008: 21). Infrastructure provision is central to the cause of promoting greater cycling as transport. In this *GAMUT Working Paper* we examine the key issues in cycling infrastructure to promote cycling as urban transport. GAMUT has an earlier publication addressing bicycling infrastructure:

Low, N. (2007) *Towards a Bicycle Infrastructure Plan for Metropolitan Melbourne*, Australasian Centre for the Governance and Management of Urban Transport: Melbourne.

Available online at: <http://www.abp.unimelb.edu.au/gamut/>

Findings, views, and opinions expressed in this report are those of the author.

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## Introduction

Although as a technology for urban mobility, the bicycle predates the motorcar, Australian cities are car dependent and have been so largely since World War II. Only a minority of Australians alive today have any experience of Australian cities before the car became the dominant means of urban transport. Bicycling was far more common in the first half of the twentieth century and its popularity spanned the era of horse and trolley bus to that of suburban rail, declining in absolute terms as mass public transport and then mass private transport came to dominate the urban transport task. Data describing bicycle usage has always been sparse and particularly so for the period when bicycling was at its peak popularity, so our knowledge of cycling during this period and its subsequent decline is poor.

Contemporary Australians live in cities where routine life has become increasingly problematic for the health of its citizens and the condition of the environment, both locally and globally. Australians are rushing towards the ultimate immobilities of premature death and illness: we have become more mobile in motor vehicles and more sedentary in our habits. Advances in medical knowledge and health care services contend with increasingly mortality and illness caused by physical inactivity. For a raft of the most serious diseases, physical activity is a major risk factor amenable to change, notably cardiovascular illness – and the associated risk factors of diabetes, obesity, and hypertension. Motorized mobility itself is hardly without risk; in 2005 there were 1627 deaths and 30,574 serious injuries on our road system. Australia has recorded in excess of 1000 road deaths annually since the 1930s (ATSB, 2007).

Such have been the pleasures and the politics of motoring over the past century that only in the latter decades has there been a serious attempt to determine the environmental costs of the world's motor vehicles and associated road system. And while we still have only the broadest grasp of this impact, we now know that this has been nothing short of cataclysmic as the global community attempts to forge an international response to the crisis of global warming. While the nation has formally accepted their international responsibilities in curbing emissions of greenhouse gases under the Kyoto Protocol on climate change, it has yet to find the ways and means to curb the continual growth in transport emissions, especially those arising from ever-increasing urban mobility.<sup>1</sup> Although an exact reckoning of the effects of other transport pollutants is uncertain, there is no doubt that these too take a toll on human welfare, especially that of the young, infirm, and elderly living where roads and pollutants congregate.<sup>2</sup>

Even if there has been a litany of complaints over the impacts of motor vehicles and roadways in Australian cities for several decades now, particularly the inner-city freeway protests of the 1960s and 70s, the past decade has seen almost every major city investing spectacularly in new freeways and major roads that slice through the existing urban fabric, consume precious open space often preserved for much of Australia's urban history, and push outwards to the ever-expanding urban fringe. In the face of the common knowledge that road building never cures congestion,<sup>3</sup> such intuition has yet to enter into the reasoning of the multi-billion dollar road-building enterprise overseen by elected public officials responsible for the allocation of public funds. Public expenditure on transport infrastructure and service provision has been overwhelmingly been biased towards urban roads and against public and collective and active transport modes (see, e.g., Russell, 2008).

Before the private car became prevalent, Australian city dwellers routinely walked and cycled journeys of several miles – but no more. As a nation, the new 'norm' for journeys of short and sometimes incredibly short distances is to drive. Younger Australians are being introduced to motorized mobility at earlier ages, and there are worrying associations between the decline in children's independent mobility and the earlier onset of the illnesses associated with a lack of physical activity in the young. Around one-third of car trips in Australia's major cities are of less than three kilometres and around one-half are less than five kilometres.<sup>4</sup>

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<sup>1</sup> For evidence of rising greenhouse gas transport emissions, see, e.g., *National Inventory by Economic Sector 2006* (Australian Government, Department of Climate Change (2008).

<sup>2</sup> See, e.g., *Health Impacts of Transport Emissions in Australia: Economic Costs* (Bureau of Transport and Regional Economics, 2005) and *Transport, Environment and Health* (Dora and Phillips, 2000).

<sup>3</sup> An oft-quoted source on the phenomenon of 'induced traffic' is Goodwin (1996).

<sup>4</sup> See Appendix I.

One brighter element in the midst of this generally gloomy circumstance of Australian urban transport is a recent revival in interest in cycling as a viable means of urban transport. An array of reasons has been advanced for promoting greater use of bicycling in cities in public policy and, for the most part, there is little difference in expert opinion at the general level. Cycling – and walking – have the following benefits by:

- Causing few environmental costs: There are few direct adverse impacts on environmental values – such as bicycle use having no greenhouse gas emissions, other air pollutants, and noise – and generally, few indirect impacts
- Displacing motorized transport modes that have high environmental and social costs, thereby contributing to reducing the economic, social, and environmental losses these cause within cities and at greater scales
- Reducing resource consumption by the transport sector when substituted for motorized transport, particularly oil, thereby improving national energy security since Australia is an oil importer
- Contributing to physical activity and confers direct health benefits
- Providing greater independent mobility for children than motorized transport
- Reducing road congestion and overcrowding on public transport
- Offering low-cost mobility and can reduce household expenditure on transport when replacing motorized mobility
- Providing mobility in circumstances where motorized and public transport is unavailable, and
- Offering favourable journey speeds in cities compared to other modes for shorter distances.

Recent times have given rise to a resurgence in cycling. In 2005, there were 1,209,000 bicycles sold in Australia; this exceeds annual motorcar sales (Bicycle Industries Australia, 2006). Sales have been growing rapidly in recent years; in 1998, total sales were less than 700,000. Most bicycles are for adult use: for every four children's bicycles sold, seven adult cycles were sold. Both recreational cycling and bicycle commuting have increased, such as greater involvement in mass participation events and journey-to-work records of the national census. Cycling is now the fourth most popular participant exercise in Australia (Australian Sports Commission, 2007). Public authorities and advocacy groups are actively promoting bicycling, such as through *The Australian National Cycling Strategy 2005–2010* (Ausroads, 2005) and by strategies and plans for Australia's major cities and many local government areas. Considerable public investments have been made in infrastructure and educational and awareness campaigns.

Explaining bicycle use can involve many factors, including individual factors such as gender, income, age, and physical activity and socio-cultural factors covering such aspects as the influence of culture, ethnicity, and political beliefs. Then there are the factors that Rietveld and Daniel (2004) describe as the costs of cycling, including comfort, personal security, physical needs, monetary cost, risk of injury, and risk of theft. Against these factors are the competing costs of other transport modes – public transport services and private motor vehicles. To these Rietveld and Daniel (2004) add the influence of local authorities' policies, notably the provision of bicycle infrastructure, urban design, and the pricing of private car use.

Infrastructure provision is only one element in promoting cycling, but a critical one. Bauman et al (2008) used an ecological model of the barriers to increased cycling in *Cycling: Getting Australia Moving* that had individual behaviour as being influenced by: individual factors – such as health-related, confidence, motivations, knowledge and skills, time and opportunities, and perceived social norms; social environment – such as culture, socio-economic status; public and regulatory factors; and the physical environment – infrastructure. However, most studies of the range of barriers to cycling include or implicate infrastructure, although there are relatively few studies of the influence of infrastructure provision. Nelson and Allen (1997, quoted in Bauman et al, 2008) examined this issue in what was claimed as the first study of its kind and found from 18 US cities that the greater number of bicycle paths, the greater number of cycle commuters. A re-examination of this research by Dill and Carr (2003), analysing data from 35 large US cities, affirmed the earlier study, finding that higher levels of cycling infrastructure was correlated with higher cycling rates.

## **Why cycle? prominent reasons cited for and against cycling in Australian and international research**

### *Reasons for cycling*

- Convenience
- Enjoyment
- Fitness and exercise
- Flexibility
- Low cost
- Relative speed

### *Reasons for not cycling*

- Concern over personal safety
- Excessive journey distance
- Exposure to adverse weather
- Harassment from motor vehicle drivers
- Heavy vehicle traffic
- Inadequate fitness
- Low air quality
- Low social status of cyclists/ socially unacceptable
- Poor cycling terrain and excessive slope

Sources: Daley et al (2007), Goodman and Degnan (2008), McClintock and Cleary (1996), Rissel et al (2002), and Tolley (1997).

In its 2006 annual review of the bicycle industry, Bicycle Industries Australia states (2006: 9):

The upward trend in bicycle sales indicates that people are aware that cycling is fun, healthy and a great way to integrate physical activity into busy lifestyles.

However, cycling participation rates haven't kept pace with bicycle sales, showing that these new bicycles aren't being used to their full potential. Unfortunately the greatest barrier to cycling is still the lack of safe and accessible facilities.

People will only maintain a behaviour if it is easy, safe and enjoyable to do so. There are still too many barriers which can make cycling hazardous: cycle routes which end suddenly or don't link into population centres; hazards on bike routes; and lack of driver awareness and respect for bike riders all deter people from cycling.

Governments clearly share the general perspective of this industry group in identifying the importance of cycling infrastructure, for this attracts the bulk of public investment in cycling programmes by state and local government. Yet there is debate over many aspects of cycling infrastructure, such as its role in promoting cycling, determining what is appropriate infrastructure, and the question of its capacity to make cycling safer. In this Working Paper we examine these controversies in regard to the major implications for public investment, namely public expenditure on infrastructure for cycling. This Working Paper deals primarily, but not exclusively, with the promotion of cycling as a means of transport; the Dutch usefully call such 'non-recreational' cycling 'utilitarian' cycling.

This Working Paper has the following aims:

- To identify key policy issues concerning infrastructure for cycling in urban areas
- To describe and review current debate on these issues, and
- To interpret the significance of the debate for future policy development.

# 1 Key policy issues

## 1.1 Bicycling rates and journey types

Cycling in the era prior to the car's dominance met a wide range of journey types, but as its role diminished cycling became increasingly recreational and an activity for children. For all sorts of reasons, active transport was of little interest to officials and policymakers, so there are few records or measures of the extent of walking and cycling.<sup>5</sup> Our understanding of the place of cycling in contemporary urban transport systems is superior to our historical knowledge, but as Rissel and Garrard note (2006: 50):

Unlike other modes of transport, data on cycling as a means of transport is poor. National population census data are available for journey to work only, which represents travel on one day in the middle of the Australian winter. Travel surveys that include all forms of cycling for transport have been conducted in a limited number of Australian states, cities or regions. No consistent national data are available.

It follows that our capacity to assess the current status of cycling in Australia is limited by the paucity of relevant information.

Bicycle journeys are undertaken for many purposes, but the journey to work is the best documented and is the journey of primary interest to transport planners in cities because it dominates the overall transport task in terms of the time such journeys take, the demand it places on the capacities of the transport system, that such demand is concentrated in time, and that such trips have less discretion than many other trip types. Commuting by bicycle has therefore a direct effect in reducing commuting by the other modes.

Census data is collected on the journey to work in Australian cities. For this reason, cycle commuting can be compared between the capital cities. There has been considerable popular attention given to rising number of bicycle commuters and this is borne out by the census results, which show a near doubling over the past three decades (see Table 1). Half of all commuting by bicycle in Australia's capital cities, some 55,599 cyclists in 2006, occurs in Melbourne and Sydney.

**Table 1 ABS census count of the journey to work by bicycle, capital cities, 1976–2006: number of riders**

Year	Adelaide	Brisbane	Canberra	Hobart	Melbourne	Perth	Sydney	Total
1976	8263	2595	784	196	10,816	2959	4646	30,259
1981	8401	4086	2046	364	13,768	3971	8008	40,644
1986	8061	5063	2272	432	13,062	5066	9262	42,218
1991	7186	6742	2318	385	12,068	6126	8934	43,759
1996	4494	5719	2759	467	10,602	4690	8193	36,924
2001	4572	6788	3112	626	12,837	5580	9223	42,738
2006	6476	7951	3753	834	18,909	6790	10,886	55,599

Source: Abridged from: Mees, P., Sorupia, E. and Stone, J. (2007) *Travel to Work in Australian Capital Cities, 1976–2006: An Analysis of Census Data*, Australasian Centre for the Governance and Management of Urban Transport: Melbourne.

Encouraging as this increase may be to supporters of sustainable transport, in the context of the overall picture of commuting in Australia's capital cities, cycling makes at best, a minor contribution, accounting for just 1 per cent of all such journeys (see Table 2). Bell et al (2006) observed that active transport may be an important means of reversing declining public health, but such goals stood in

<sup>5</sup> Indeed, the ABS did not collect journey-to-work information in the national census until 1976.

contrast to Australia's low levels of cycling and walking. Some of the high growth rates in bicycle commuting are attributable to the low historical levels and the net increases are quite small. Population growth has played a major role in dampening the growth in the proportional mode share of bicycle commuting – or, alternatively, the growth in cycling has not managed to exceed overall population growth. In the decade 1996–2006, Canberra's count increased by less than 1000, in Perth this increase was 2100, and in the nation's largest city, Sydney, the increase was 2693 in a city of over four million inhabitants (see Table 2). As Mees et al (2007) point out, increases in cycling may not be reducing car use but may be substituting for walking and public transport use.

**Table 2 ABS census count of the journey to work by bicycle, capital cities, 1976–2006: as proportion of all modes (%)**

Year	Adelaide	Brisbane	Canberra	Hobart	Melbourne	Perth	Sydney	Total
1976	2.2	0.7	0.9	0.3	1.0	1.0	0.4	0.8
1981	2.4	1.1	2.1	0.6	1.2	1.2	0.6	1.1
1986	2.2	1.2	2.1	0.7	1.1	1.4	0.7	1.1
1991	2.0	1.4	2.0	0.7	1.1	1.6	0.6	1.1
1996	1.2	1.0	2.2	0.7	0.9	1.0	0.6	0.9
2001	1.2	1.1	2.3	1.0	1.0	1.1	0.6	0.9
2006	1.5	1.1	2.5	1.1	1.3	1.2	0.7	1.1

Source: Abridged from: Mees, P., Sorupia, E. and Stone, J. (2007). *Travel to Work in Australian Capital Cities, 1976–2006: An Analysis of Census Data*, Australasian Centre for the Governance and Management of Urban Transport: Melbourne.

Comparing the cycle commuting rates between these cities reveals a broad similarity, with the exceptions of Sydney (0.7 per cent) and Canberra (2.5 per cent), which are about one-half and twice the average of this group, respectively. In many respects these findings are at odds with the anecdotal accounts of the popularity of cycle commuting. Briefly, the situations in the capital cities for cycle commuting are as follows:

- Adelaide has seen a decline in cycle commuting; its 1976 rate exceeded every capital in contemporary times, except Canberra, but now its rate is about the national average
- Brisbane's cycling rates are relatively low and consistently so over these recent decades
- Canberra has shown almost continual but small growth in cycling commuting to become the nation's leader
- Hobart, while showing a lower overall rate, has shown the greatest growth of any listed capital, such was its very low rate in 1976
- Melbourne, which has by far the greatest number of cycling commuters, has not increased the rate of cycling much over 30 years which at odds with the profile that cycling commuting enjoys
- Perth is another city with high-profile cycle commuting, but as with Melbourne, the overall commuting rate is not significantly improved over the long term, and
- Sydney's cycling commuting has low popularity and, although it has increased since 1976, it appears to have been relatively stable since 1981.

Vicroads (2004) undertook some analysis of the census results for Victorian cycling from 1976–2001. As census day falls in June or August, the authors conclude that because of shorter days and lower temperatures during these months cycling levels will be higher in the September–May period. Quoting the Victorian Activity and Travel Survey (VATS) the authors note that in 1997–1999 there were 30 per cent more cycling trips in autumn than in winter. Rissel and Garrard (2006) reach a similar conclusion for Australia, believing that the census under-represents total cycling to work.



For Melbourne and Sydney there are data describing a range of other cycling factors. Cycling to work in Melbourne is dominated by the City of Melbourne LGA; over 50 per cent of trips were to destinations in the LGAs of Melbourne (which received 35 per cent alone in 2001), Port Phillip, and Yarra; Melbourne LGA had four times as many trips than any other LGA (Vicroads, 2004). Most bicycle commuters live in the inner city suburbs – notably the LGAs of Darebin, Moreland, Port Phillip, and Yarra (Vicroads, 2004). Rissel and Garrard (2006) used the 1997–1999 VATS results to find that 1.2 per cent of all trips in Melbourne were by bicycle, which made them higher than buses (1 per cent) and trams (1 per cent).<sup>6</sup> An average of 0.07 trips were made per person per day by bicycle in Melbourne – ranging from 3.7 per cent in central Melbourne, to 1.3 per cent in the inner suburbs, and 0.9 per cent in outer Melbourne (Rissel and Garrard, 2006). Some 75 per cent of cyclists were male and 49 per cent were less than 20 years old (Rissel and Garrard, 2006). Most (36 per cent) bicycle trips were up to 1km and 90 per cent were 5km or less, with commuting being the most popular trip type (Rissel and Garrard, 2006).

Of Australian capital cities, the best information on total cycling trips is currently available for Sydney. In a recent report, the Roads and Traffic Authority (RTA, 2008) stated that in Sydney there were 122,500 bicycle trips on an average weekday and almost 160,000 daily trips on the average weekend; there has been considerable growth since 2001, with 23 per cent and 58 per cent increases on weekdays and weekend days, respectively. Social and recreational cycling dominates cycling trip types in Sydney. For the most part, Sydney cycle trips takes less than 20 minutes, with weekend rides being longer (RTA, 2008). Thirty minute trips appear to mark a major demarcation in trip duration; there are relatively few trips in the time categories longer than this during the week; weekend rides are longer, but with the preference for less than 30 minute trips still evident (RTA, 2008).

Several capital cities have bicycle counts on popular routes. These data provide insights into local trends and have a role in facilities planning and management, but wider interpretation is difficult. Typically, these counts measure popular cycle commuting routes. In Melbourne, Vicroads has installed counters on several bicycle paths leading to the CBD; the popular Main Yarra Trail that runs alongside the Yarra River is used by 2000 cyclists daily with peak use occurring during commuting times. In Sydney, the RTA publishes the counts from 12 sites (RTA, 2008). South Australia's Department for Transport, Energy and Infrastructure posts on its website the counts of cyclists in Adelaide on Anzac Highway, Port Road at Thebarton, and Sir Donald Bradman Drive in west parklands.<sup>7</sup>

Cycling for purposes other than commuting or recreation is also low in Australia. There is a considerable research literature dealing with children's journeys to school and the steady decline of active transport – walking and cycling – and its replacement with the car.

There are a number of distinctive features of the cycling population and these are of particular interest in the quest to increase overall cycling rates. Recreational and utilitarian cycling is dominated by younger men; only 20 per cent of Australian cycling commuters are women (Bauman et al, 2008). A study by Garrard et al (2008) of cycling in Melbourne found that 20 per cent of observed cyclists at 15 sampled locations were women. According to the international comparison of Pucher and Buehler (2008), Australia's proportion of women cycling is the lowest of the USA, UK, Canada, Denmark, Germany, and the Netherlands – in ascending order of the proportion of women. Further, in those countries with high cycling rates not only is there greater equality in participation between men and women, but there is also a reasonably even spread between age groups, whereas in Australia, there is considerably less cycling by teenagers and young adult and the elderly than those in middle age (Bauman et al, 2008). Bauman et al (2008) also state that those in lower socio-economic groups participate less in physical activity and Milligan et al (2007) found that the willingness to undertake short journeys by walking or cycling increased with education level in their study of Western Australia.

While, arguably, any rise in physical activity in Australia is to be welcomed for its net health benefit and any additional bicycling is therefore to the national betterment, for sustainable transport goals bicycling is of value when it replaces motorized transport. Mere additional recreational bicycling does not, by itself, necessarily denote any change to the urban transport task. However, greater cycling

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<sup>6</sup> Results from these surveys are also available at: Vicroads (1999, 2004).

<sup>7</sup> Available online at:

[http://www.transport.sa.gov.au/personal\\_transport/bike\\_direct/facts\\_and\\_figures.asp](http://www.transport.sa.gov.au/personal_transport/bike_direct/facts_and_figures.asp)

overall can shift the modal mix. It might be argued that recreational bicycling displaces the time that might have been used for motorized transport, but this is speculative and is offset when bicyclists drive to their preferred cycling location.

#### **Key points**

- Our understanding of cycling rates and cycling journey types is relatively poor
- Historical accounts suggest that cycling was at much higher rates prior to car dependency in Australian urban life than since
- Cycling is most popular with younger men and unpopular with women and the older age groups; it is undertaken more frequently by those in higher socio-economic groups
- For commuting in the capital cities, cycling occurs at a very low rate, despite rapid growth in recent years
- While there is a considerable difference in commuter cycling rates between Canberra (high) and Sydney (low), the other major cities have similar rates
- Cycle commuting is predominantly an inner-city phenomenon
- Census data on commuting provides a winter sample; annual rates are probably somewhat higher
- It is likely that recreational cycling exceeds utilitarian cycling

### *1.2. Infrastructure for bicycling*

Cycling infrastructure provides physical resources to provide for bicycle transport. There is some variation between nations in terminology, design, and construction used for cycling mobility, but essentially there are the following common forms of cycling infrastructure.

#### **Cycling transport infrastructure**

- Public roads ('mixed use') – full sharing by all road vehicles
- Bicycle lanes on public roads – marked on-road cycle lanes
- Bicycle paths (off-road cycle lanes) – isolated paths or adjacent to roads with some form of separation at grade

*Public roads ('mixed use')*: Given that within Australia bicycles are a road vehicle, roads provide for bicycle movements and the state road laws contain provisions to cater for this need.<sup>8</sup> When special provisions are made for cyclists over and above the routine use of public roads, then changes to the road system or additional thoroughfares are involved. Declaration of particular roads and streets as 'bicycle routes' without any physical changes to these thoroughfares may be part of bicycle planning, and although this may not involve any physical changes, these routes become part of cycling-specific infrastructure.

Broadly, there are three types of (public) cycling-specific infrastructure to provide transport services<sup>9</sup>:

*Bicycle lanes on public roads – on-road bicycle lanes (see Photograph 1)*: These are lanes designated for bicycle use on normal roadways, usually with appropriate signage and often recognized in road law and regulation. Typically, these designated lanes are additions to existing roads and their maximum width is dictated by the need to allow for the motor vehicle lane(s) and often, for car parking, together with the bicycle lane. In some instances, the bicycle lanes are temporary, and become available for car parking, usually during off-peak periods. Nearly all Australian bicycle lanes flow in the same direction as the rest of the roadway; 'contra-flow' lanes are relatively rare, although they are a common feature in popular cycling cities in Europe.

<sup>8</sup> ATSB refer to the road as the 'road reserve' which is the entire reserve between abutting properties and includes footpaths and roads, where riding occurs as a right or a matter of custom.

<sup>9</sup> There are variations in terminology; we use these definitions throughout the report.



**Photograph 1 Bicycle lane, Chapel Street, Prahran, Melbourne**

Typical features include lane designated by white line, bicycle signage on road surface and on adjacent footpaths, car parking on the LHS and roadway on the RHS.

*Bicycle paths (see Photograph 2):* Essentially, these public paths are characterized by their exclusion of motorized vehicles, are physically separate, and are either: a) ‘Separated’ where cyclists have exclusive use – i.e., pedestrians and cyclists are separated; or b) ‘Shared’ – or ‘dual use paths’ – between cyclists and pedestrians and other non-motorized ‘vehicles’. In Australia, the most common form of off-road cycle path is a shared path with pedestrians.

*‘Copenhagen Lanes’ (see Photograph 3):* A more recent variant of the bicycle path which has attracted increasing interest in Australia are designated bicycle lanes typically aligned between footpaths and roads for exclusive bicycle use, made physically separate at the same grade by curbing or other form of divider. A cross section is shown in Figure 1. Given considerable publicity, these lanes are only one kilometre in length are being assessed on a trial basis. Used throughout Europe, such designated lanes provide a clear visual reference on the road surface for all road users, but the design challenges arise when integrating these facilities into the road network, particularly at intersections and junctions.



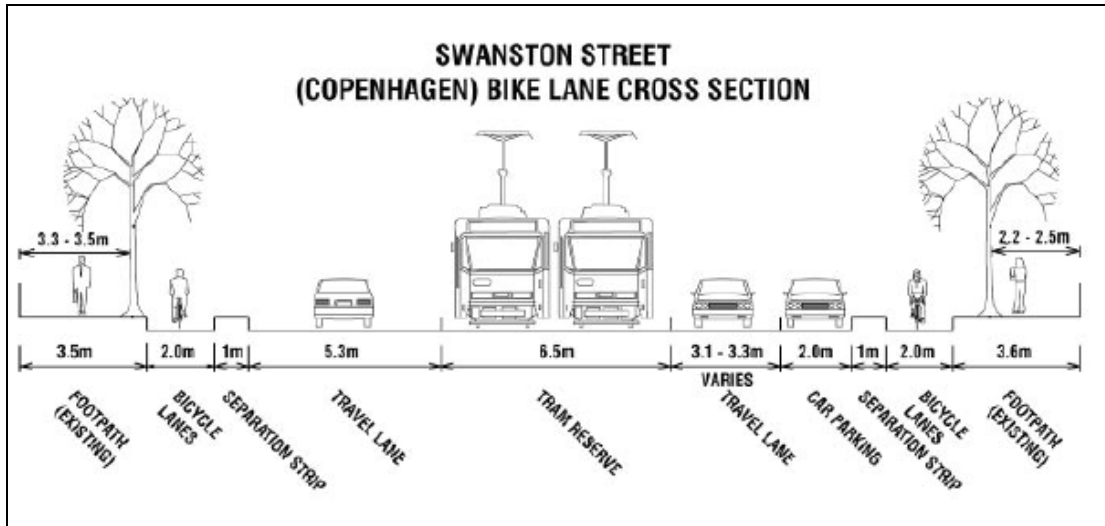
**Photograph 2 Bicycle path shared with pedestrians, Southbank Precinct, Melbourne CBD**

A example of a shared facility with traffic flows in multiple directions, signage and speed limits; many shared paths feature designated lanes for unidirectional travel; and some paths have separate lanes for cyclists and pedestrians.

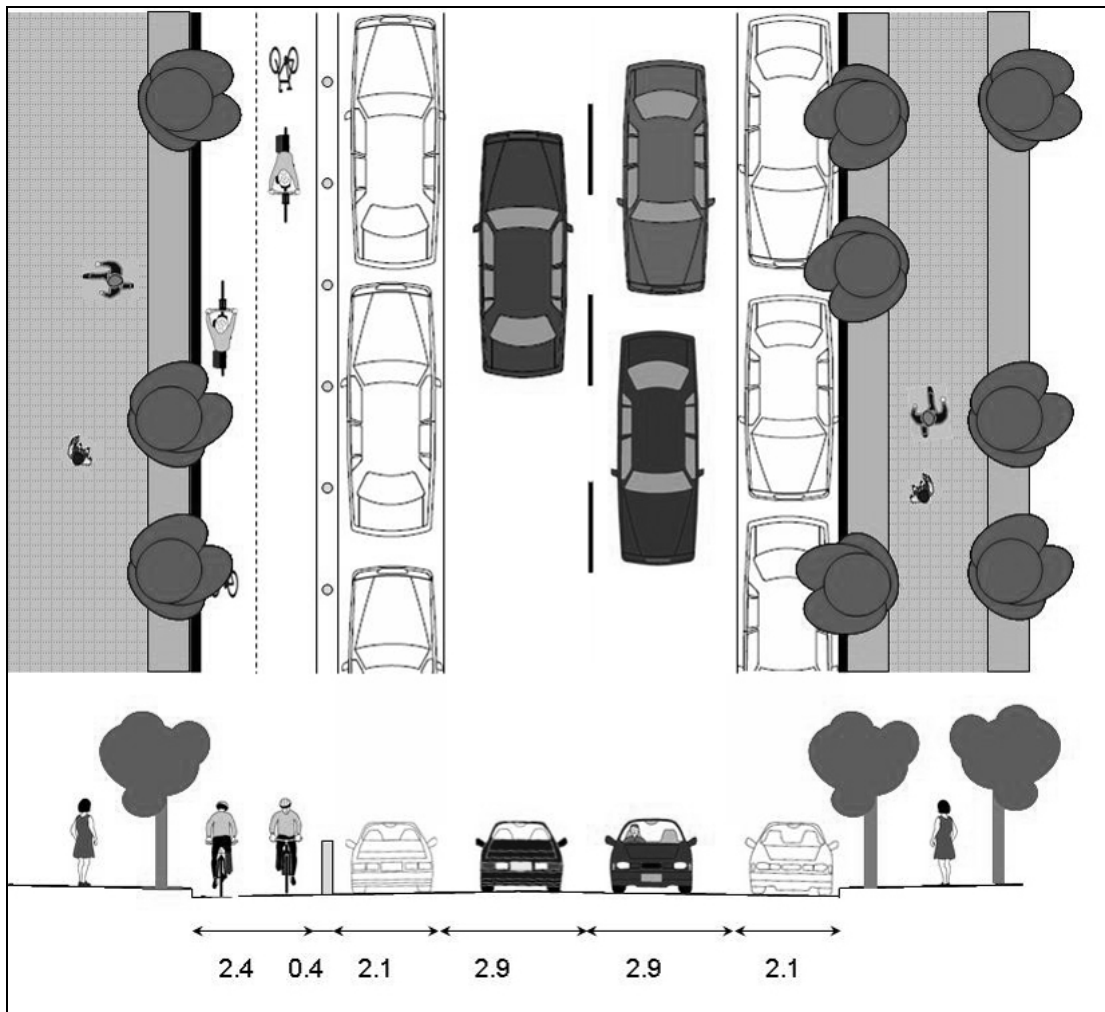


**Photograph 3 'Copenhagen Lane', Swanston Street, Melbourne**

Modal separation includes, from left to right: footpath, gutter, bicycle lane, raised median strip, parallel car parking, single lane roadway, and tram tracks; the right hand side of the road replicates this arrangement. Width of the bicycle lane is approximately 1.5m, and in this case, carrying one-way cycle traffic only in the same direction as the adjacent road traffic.



**Figure 1 A cross section of Melbourne’s bike separated lane**  
 Source: City of Melbourne. *Bike Separated Lanes Fact Sheet*. Available online at: <http://www.melbourne.vic.gov.au/info.cfm?top=70&pa=1154&pg=3476>



**Figure 2 A of Sydney’s Cycleway (directional separated bicycle road)**  
 Source: City of Sydney.

'Cycleways' are another recent variant of bicycle path in Australia. Sydney is set to open its first cycleway in the city's CBD. It will feature a two-way cycle lane separated from the adjacent roadway by a median strip and bicycle traffic lights (as shown in Figure 2). It is planned to become part of Sydney's cycling network, which plans to have 50km of such cycleways in a 200km cycling network. Cycleway projects are underway in the inner-city's King, Bourke, and College Streets, and Union and Missenden Roads.

Cycling infrastructure can aim to integrate cycling into the road system or to segregate cycling from other road users. Godefrooij (1997) and Dutch cycling planners have considered this issue closely; the differences between these infrastructure approaches is summarized in Table 3 below. Integration strategies focus on efforts to make different modes more compatible, and cover such issues as cycling on one-way and two-way streets, one-way streets with cyclists riding in the opposite direction, and restrictions on motor vehicle speeds. Segregation can take the form of 'visual segregation' using painted lines and bicycle logos and 'physical separation', such as one-way and two-way bicycle paths beside roads. Such physical separation can be achieved by fences, placement of verges, or grade separations.

**Table 3 Cycling infrastructure types: integration with vehicular traffic versus segregation from vehicular traffic**

<b>Integrated (on-road)</b>	<b>Segregated: visual</b>	<b>Segregated: physical</b>
Two directions - With restrictions on vehicles - No restrictions on vehicles	Bicycle lanes with logos	Bicycle paths
One-way street - With restrictions on vehicles - No restrictions on vehicles	Bicycle lanes without logos	Bicycle tracks alongside roads for motor vehicles - Unilateral: one direction - Unilateral: two directions - Two-sided: Both in one direction - Two-sided: Both in both directions

Source: After: Godefrooij, T. (1997) Segregation or separation for cyclists? The Dutch approach. In Tolley, R. (ed.), *The Greening of Urban Transport: Planning for Walking and Cycling in Western Cities*. Second Edition. Wiley and Sons: London, pp. 229–38.

Godefrooij (e.g., 1997) considers that both strategies have the advantages and limitations. Integration, he argues, aims at driver behaviour modification through reducing car numbers and lowering vehicle speeds. Where vehicle volumes and traffic speeds cannot be reduced, then integration is not advisable, and Godefrooij considers that some roads are required to carry large vehicles, high traffic volumes, and public transport. Segregation aims to give different modes their own space; cyclists enjoy better protection, motorists can pass cyclists more safely, and cyclists comfort is increased. However, he notes that cyclists movement can be restricted and motorists may be encouraged to speed. Importantly, bicycle lanes and paths crossing at road intersections are a concern for cycling safety. Cycle journeys on cycle paths may well be safer than on shared roads, but at the intersections between roads and bicycle paths, there is an increased risk of collision.

Associated fixed infrastructure includes:

- Traffic signals
- Signage specific to bicycle traffic
- Bicycle parking
- Bicycle storage, and
- Other 'end-of-trip' facilities, such as lockers and showers.

At present, there does not appear to be a consolidated inventory of the nation's cycling infrastructure. There are a number of state-based estimates of various facilities, but it is not known whether these data are comparable or the extent of their comprehensiveness.

Within the provision of bicycling there are many considerations to be taken into account and these are a mix of transport planning, land planning, and urban design elements. Criteria used to assess such facilities include:

- Safety: (use characteristics), width, turning controls, sightlines, cross traffic, vehicle and other encroachments, traffic management, signage, surface conditions
- Security: assault, theft
- Route directness and continuity
- Extent of interruptions
- Role of regulation in determining right-of-way (degree of ambiguity), and
- Aesthetics.

Of particular concern in the planning and design of these facilities are intersection points; at these locations collisions are more likely.

Making cycling infrastructure viable and worthwhile for all concerned requires the provision of other components of bicycle mobility. Such associated elements include: bicycle parking and storage, security and safety, and maintenance.

Responsibility for bicycling infrastructure in Australia is complex, as is seemingly the case with much transport infrastructure. In Victoria, for instance, there are several categories of bicycle infrastructure, each with a different management regime and responsible public authority, namely: Principal Bicycle Network, managed by Vicroads; municipal bicycle network, managed by local government, metropolitan trail network, coordinated by Parks Victoria, and the 'rail trails', managed by local communities and the Department for Sustainability and the Environment.

Pucher and Dijkstra (2003) identify six aspects that the Netherlands and Germany have used successfully to promote walking and cycling:

- Better facilities for walking and cycling
- Traffic calming in residential neighbourhoods
- Urban design oriented to people and not cars
- Restrictions on motor vehicle use
- Traffic education, and
- Traffic regulations and enforcement.

Of these, cycling facilities improvement relates directly to infrastructure; the authors note that from 1978–1996, bike paths in the Netherlands expanded from 9282km to 18,948km and in Germany the growth was from 12,911km to 31,236km. Both countries have an integrated and coordinated network of bike paths. Cities in these countries have designated 'bicycle streets' in which bicycles have right of way over cars. As the authors note (p. 1513):

The provision of separate rights-of-way is complemented by various other measures: special bike turn lanes leading directly to intersections, separate bike traffic signals for cyclists, bicyclist-activated traffic signals at key intersections, and modification of street networks to create deliberate dead ends and slow, circuitous routing for cars but direct, fast routing for bikes.

Additionally, the traffic calming measures and the role of urban design orientation involve infrastructure issues. Urban design can facilitate access to services, commercial and retail venues, and cultural facilities by cyclists – and pedestrians – such as occurs in the Netherlands and Germany.

### *1.3 Cycling infrastructure design and transport planning*

Australian and overseas research has identified many of the design, engineering, construction, and maintenance issues for bicycle paths and other cycling-specific infrastructure. Ausroads, for example, have a Guide to *Traffic Engineering Practice (Part 14)* on bicycles that deals with design and levels of service. They suggest, for example, that shared paths used for commuting have a desirable width of 3 metres and a recreational path, 3.5 metres (Ausroads, 2006).

Ausroads have considered the question of pedestrians and cyclists sharing paths (See Table 4). Of interest is the advice that shared paths are unsuitable for high-volume cycling, yet most off-road paths are shared paths and many of these form the busiest commuter routes.

**Table 4 Pros and cons of shared and separated paths**

Type of path	Pros	Cons
Shared	Suitable for most users	Not suitable for high use areas – may discourage walking among the young, seniors, and people with disabilities
	Lower construction costs than separated lanes	May be ineffective if thorough planning – consultation, observation, and demand estimation – has not been carried out
	Require less road reserve space	
Separated	Eliminates conflicts occurring between different user types	Ineffective if pedestrian movement along or across the bicycle path is not minimized
	Will allow the bicycle path to operate at a higher speed than in the case of shared paths, which may make it more desirable for commuter cyclists	Ineffective if both paths are not of a standard relative to the requirements of each type of user

Source: Ausroads (2006). *Minimising Pedestrian-Cyclist Conflict on Paths*. Information Note No. 1

A concept borrowed from road transport studies that can provide insights in bicycle infrastructure is the ‘level of service’ (LoS) provided by a roadway, typically as a measure of vehicular congestion. For bicycle use, the level of service can be a qualitative measure of speed and travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience (Ausroads, 2006). Ausroads has applied the LoS to Australian cycle paths according to a rating of A (Best) to F (Worst) based on the number of passing – pedestrian or bicycle – events in an hour. Level A service on two-way paths is passing 40 or fewer cyclists in an hour on a 2.4m-wide path or 90 or fewer cyclists on a 3m-wide path (Ausroads, 2006: Table 4). This assessment technique is modified where the direction of traffic is uneven – such as paths leading to the CBD.

An example of a systematic approach to meeting the needs of different types of cyclists is given in New Zealand’s Land Transport Safety Authority 2004 report *Cycle Network and Route Planning Guide* (as shown in Table 5). Here, the transport infrastructure needs of cyclists of different levels of competence are assessed. Children and novices ride most commonly to school and shops and ride for recreation, so that they need a safe local environment; ‘They cannot interact with traffic apart from on traffic-calmed neighbourhood roads.’ (Land Transport Safety Authority, 2004: 15). Those with basic competence can deal with quieter two-lane roads, merge across lanes and complete centre-of-the-road turns, but are ‘... not equipped to interact with faster traffic, multi-lane roads and multi-lane roundabout. They usually lack the confidence to defend a lane in narrow situations.’ (Land Transport Safety Authority, 2004: 15). Experienced cyclists are often making longer commuting trips, riding for sport, or undertaking cycle touring and are able to deal with on-road cycling: ‘They will defend a lane where there is not enough room, judge the merge across faster multi-lane traffic, use multi-lane roundabouts in most cases (though apprehensively), and will not usually divert to a cycle path.’ (Land Transport Safety Authority, 2004: 15). Based on these rider types, a range of cycling infrastructure can be determined (see Table 5).



**Table 5 Suitability of cycling facility option for different cyclist abilities**

Cycling facility Option	Child/ Novice	Basic competence	Experienced
Kerbside cycle lane	**	*****	*****
Cycle lane next to parking	*	****	****
Contra-flow cycle lane	*	****	*****
Wide kerb side lane	**	***	****
Sealed shoulder	**	*****	*****
Bus lane	*	**	****
Transit lane	*	**	****
Slow mixed traffic	***	****	*****
Paths	*****	****	***

Legend: \* Low benefit, \*\*\* Moderate benefit, \*\*\*\*\* Most benefit.

Note: Definition of Terms: *Kerbside cycle lane*: A cycle lane beside a kerb, cars (parked or moving) are excluded; *Cycle lane next to parking*: A cycle lane beside parked parallel car parking; *Contra-flow cycle lane*: Cyclists can ride in the opposite direction to the traffic on the adjacent road [While common Europe, the author knows of no Australian examples]; *Wide kerbside lane*: Can be beside parked cars, no formal lane markings for cyclists, insufficient width for formal cycle lane; *Sealed shoulder*: Sealed surface beside a road without curbing, usually rural; *Bus lane*: A lane shared by buses and cyclists [\*No Australian examples are known to the author]; *Transit lane*: A lane shared by many vehicles at specified times, no special recognition for cyclists; *Slow mixed traffic*: No formal bicycle facilities; *Paths*: Three types: exclusive for bicycles, shared with pedestrians, and separated sections for pedestrians and cyclists.

Source: Land Transport Safety Authority (2004). *Cycle Network and Route Planning Guide*. New Zealand: Table 6.1.

Network and route design can assess the cyclist type – whether local or neighbourhood, commuting, sporting, recreational, or touring – and consider the requirements and preferences of those most likely to be using the facilities. In the aforementioned New Zealand *Cycle Network and Route Planning Guide*, for instance, directness of routes is important for commuters but not for sport cycling, minimal delays are not of concern to recreational cyclists but are important to commuters and sporting cyclists, bicycle parking facilities near destinations are required by neighbourhood and commuting cyclists but matter little for sporting cyclists and so on.

#### 1.4 Social, economic, environmental and other benefits of bicycling

Bicycling confers an array of transport, environmental, and social benefits; there are many studies describing the advantages resulting from providing an increasing proportion of urban mobility using bicycles.<sup>10</sup> Here we provide an overview of these benefits.

##### *Improved access and equity in urban mobility*

Cycling offers urban mobility to those without immediate access to motorized and collective transport modes. Collective transport stops and stations become more accessible to cyclists than for those restricted to walking, thereby providing greater access to these services and, indirectly, to the benefits of services that can be reached that might be otherwise inaccessible or difficult to reach. Many urban households do not own a motorcar or the number of cars in each household is insufficient to meet all of its mobility demands; many urban locations are without adequate access to public transport services to meet the mobility needs of local communities, households, and individuals – thereby producing disadvantaged locations, individuals, and trips.<sup>11</sup> For children – above an age determined by parents – and younger teenagers are too young to drive and cycling offers a means for independent mobility and

<sup>10</sup> E.g., Dekoster and Schollaert (1999).

<sup>11</sup> In contrast to the US and UK where the issue of car access and social exclusion has been more thoroughly examined, such as by the UK's Social Exclusion Unit, Australia has few studies into this phenomenon, such as by Currie and Senbergs (2007a, b).

one way to alleviate the widespread trend of diminishing children's independent mobility. Australia has an 'aging' population as the baby boom generation (nominally 1946–64) moves into late middle age and old age with its accompanying diminution of driving due to age and increasing levels of disability. When urban locations isolate people without access to mobility services, we create deep social divisions and ensure that those without cars are 'second class citizens'. Cycling could offer an important source of mobility for those older Australians no longer able to drive. Car dependency in Australian cities imposes considerable individual and household burdens on those without access to cars and on those deprived of access to driving. Even for those with access to motor vehicles, there may be access and equity issues arising from car use – such as the costs of driving and parking – that can be alleviated if cycling is a transport option.

#### *Economic benefit*

Mobility can be a significant source of household expenditure. Associated with the aforementioned mobility disadvantage is social disadvantage; those on lower incomes tend to have less access to urban mobility. A different dimension of this issue is 'car dependency', whereby those without access to public transport own cars because they have no other viable mobility options, a social problem that afflicts many of lower socio-economic status.<sup>12</sup> Higher levels of car ownership by low-income households occur in locations with poor/absent public transport services. Bicycles are inexpensive to own, operate, and maintain. Replacing short car trips with bicycling produces a net economic gain and investments in bicycle paths have been shown to produce a net economic benefit. Lowering motor vehicle use will reduce oil consumption and lower national demand and improve national energy security by reducing demand for oil importation, especially as future domestic oil reserves approach exhaustion. Economic costs of road trauma, health impacts, and service provision, such as parking will be lowered. For households and individuals, cycling is a low-cost form of transport; increased cycling rates can reduce expensive car use and has the potential to reduce overall levels of car ownership and operation. Investments in cycling are usually cost-effective and offer public authorities cost-effective ways of providing mobility. As Tolley states (1997: 5) states: 'The provision of routes for bicycles gives people "freeways" for the price of footpaths'.

#### *Environmental values*

Mode-shifting from motorized transport to cycling can play a significant role in reducing the environmental costs of an urban transport system with a high proportion of motorized transport; there is a substantial literature on the subject of sustainable transport.<sup>13</sup> Reducing energy demand and fossil fuel consumption in the transport sector will lower urban pollution levels and contribute to reducing greenhouse gas emissions from the transport sector, which are currently continuing their historic trend of increase. Cycling consumes no fossil fuel, produces no emissions, and generates no noise. Other avoided or reduced environmental costs include the loss of lands for road infrastructure, water pollution, and noise pollution.

#### *Health*

An obvious health implication is that cycling is a form of exercise that can be integrated into daily life when used as transport. Increased physical activity will improve health and reduce the economic and social costs of ill health.<sup>14</sup> Risks of premature mortality and morbidity, notably cardiovascular disease, high blood pressure, diabetes (type 2), obesity, some cancers, and some mental health disorders, can be reduced through regular exercising. Health impacts of road trauma will be reduced through less motorized transport.

A great deal of urban travel by motor vehicle is for comparatively short distances and within a reasonable walking and cycling range for active adults and teenagers; here active transport can substitute for a portion of such trips. Such substitution can also reduce the demand for public transport, making these services available for those switching out of motorcars. Additionally, cycling can form

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<sup>12</sup> A recent study by GAMUT partners Jago Dobson and Neil Sipe *Shocking the Suburbs: Oil Vulnerability in the Australian City* (Dodson and Sipe, 2008) provides a quantitative assessment of the consequences of car dependency.

<sup>13</sup> See, e.g., Low and Gleeson (2003), Newman and Kenworthy (1999), OECD (1996), Whitelegg (1994, 1997), and WBCSD (2004).

<sup>14</sup> There is an considerable body of research attesting to the benefits of physical exercise in general and for active transport; see, e.g., two studies by Wen et al (2006) and Wen and Rissel (2008) which examined the rates of driving to work and obesity in New South Wales.

part of inter-modal travel when combined with public transport, whereby longer urban trips are possible without recourse to motor vehicles.

In affluent and developed national societies there is a general association between the levels of car dependency and motor vehicle crashes, so that highly motorized societies have higher levels of mortality and serious injury compared with societies with lower levels of car dependency – and correspondingly higher levels of active transport. In developing nations, a trend of rapid motorization of transport is usually associated with greatly increased road trauma levels.

#### *Urban quality of life*

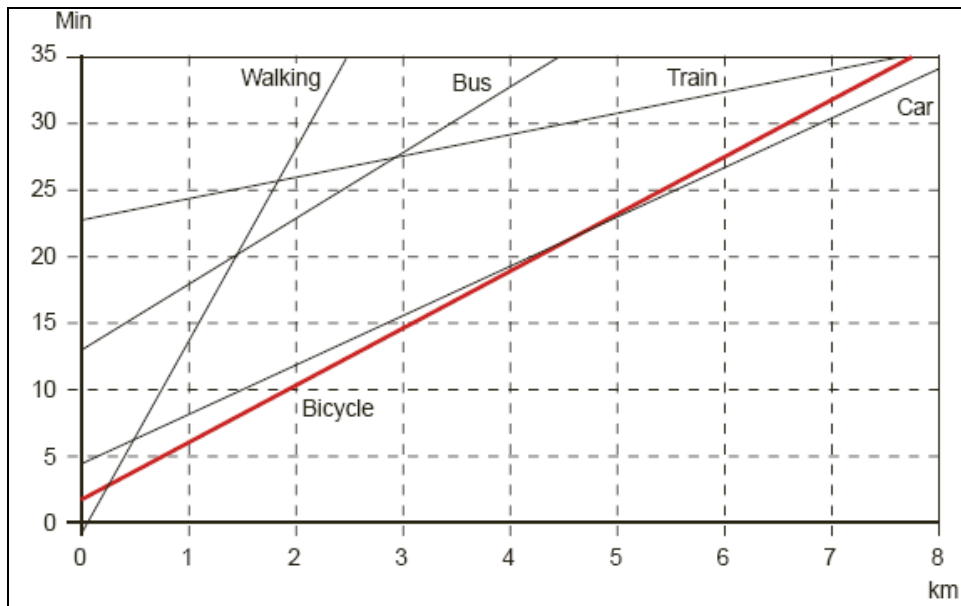
Greater and widespread cycling can provide opportunities for improving urban quality of life. When cycling replaces motor vehicle use, some of the general social and environmental benefits are expressed at the local level. Reduced motor vehicle use and traffic levels can improve local air quality and lower traffic noise. Cycling consumes far less valuable urban space than motorized vehicles when moving on roadways and for parking – 10–15 bicycles can be parked in a single car parking space. Lower demand for road use can allow a portion of road and parking space to be used to improve local urban amenity, such as the creation of streets restricted to walking and cycling. Measures for traffic calming and reduction of speed limits face less opposition in circumstances where traffic volumes are low. One of the contributions of the ‘new urbanism’ movement has been to shift the balance of interests in urban areas away from the requirements of motorcars and towards urban community amenity. Urban places designed for active transport can support local shops and services and make open space available for recreation and community services, areas that invariably become part of the service network in locations based on private motorcar use.

#### *Viability of cycling as an urban transport mode*

Journeys by bicycle are a viable form of urban transport for a range of utilitarian trips. There are particular advantages enjoyed by bicycling as a form of urban transport relative to other modes, most notably that it provides a time-efficient means for short journeys. Dekoster and Schollaert’s (1999) report on cycling in Europe showed that for journeys up to five kilometres, bicycles were quicker than walking and the motorized modes (see Figure 3).<sup>15</sup> Much of the time efficiency of cycling derives from the capacity for point-to-point journeys within cities. Short journey times for cycling short urban journeys result from the close proximity of bicycle parking, quicker parking, and the absence of waiting for public transport. Cycling allows for spontaneous and individual trips. Further, although bicycles do not reach the same vehicular speeds as motorized transport for much of the time when in motion, the vehicle speed disadvantage of bicycles is reduced when road traffic is slowed by congestion; slower potential vehicle speed of bicycles is offset by other factors that account for travel time. When combined with public transport, greater trip distances are possible, so that cycling and public transport can be mutually beneficial.

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<sup>15</sup> Paul Tranter (2004) produced a report to the federal government on ‘effective speed’ that estimated the loss of time for various modes that included the time required to meet the full costs of transport, such as that taken to earn the money to pay these costs; John Whitelegg in similar studies has used ‘social speed’ as a concept to capture the costs of paying for transport. Tranter found (2004: 13): ‘The concept of ‘effective speed’ should be seen as one (of many) ways in which to highlight the ineffectiveness of private motor vehicles as a form of mass transport, as well as highlighting the superiority of public transport (and cycling).’



**Figure 3 Travel Times by mode, based on a sample of European cities (minutes per kilometre journey)**

Source: Dekoster, J. and Schollaert, U. (1999). *Cycling: The Way Ahead for Towns and Cities*. Office for Official Publications of the European Community: Luxembourg

### 1.5. *Bicycling safety: crashes*

Cycling safety is no less complex than road accidents involving motor vehicles with many factors and the influences of circumstances determining the risk of cycling and the patterns of cycling crashes and the resulting trauma. Most authorities, such as the European Transport Safety Council, agree that (1999: 7): ‘... underlying all other problems is the fact that the modern traffic system is designed largely from a car-user perspective.’ Cyclists face a particular set of risks in using the traffic system (see box below).

#### **Key problems for pedestrians and cyclists in modern traffic systems: observations from Europe**

- *Vulnerability*: Even at low speed impacts, pedestrian and cyclists can be severely injured
- *Flexibility*: Pedestrian and cycling behaviour can be unpredictable to other road users
- *Invisibility*: Pedestrians and cyclists can be difficult to see, especially so in poor light
- *Differing abilities*: A portion are young, inexperienced, and the physically or mentally impaired
- *Consciousness of effort*: Pedestrians and cyclists are highly motivated to find and use the most convenient routes
- *Estrangement*: Traffic systems cater for motor vehicles, alienated from the needs of pedestrians and cyclists

Source: European Transport Safety Council (1999) *Safety of Pedestrians and Cyclists in Urban Areas*, Brussels.

Cycling safety can be assessed using available knowledge of the injuries resulting from crashes involving cyclists. However, such assessments in Australian and elsewhere must contend with highly deficient empirical knowledge base.

There are two sides to cycling safety; cyclists injured in crashes involving vehicles and cyclists causing injuries to other road users. Although the latter is a small issue, it is worth remembering that that the arguments about safety that compare motor vehicles and bicycles need to take into account the high level of injuries that motor vehicles impose on other road users. Motor vehicle occupants are safer than cyclists in collisions, but motor vehicles are far more dangerous.

Cyclists' deaths account for 2–3 per cent of annual Australian road fatalities (ATSB, 2006). Cycling has become safer in Australia as measured by annual fatal crashes over the period 1991–2005 (see Table 6). In the 1990s, annual cyclist fatalities were 40–80, which has fallen to 26–46 in the current decade (ATSB, 2006). This improvement has come for those aged less than 30 years, excluding infants, while fatalities have increased for those 30 and older. Excluding infants, of the 660 fatalities over the 1991–2005 period, exactly half were aged below 30 and the remainder were 30 and older. Over the periods 1991–1995, 1996–2000, and 2001–2005, fatalities in the under-30 cohort declined from 145 to 113 to 72 (excluding infants), while fatalities in the 30 and older cohort increased from 104 to 110 to 116 (see Table 6). In 1991–1995 the ratio between the most and least fatalities age groups was around 14:1 (i.e., the 10–14 y.o. and the 60–64 y.o. groups); in 2001–05 the ratio was around 4:1 (i.e., the 15–19 y.o. and the 60–64 y.o. groups) (see Table 6). Such is the evening out of this profile, that those aged 70 y.o. and over suffer a similar level of fatalities to teenagers aged 10–14 and 15–19.

**Table 6 Cyclist fatalities in road crashes, Australia, by age group, 1991–2005**

Age group	1991–1995	1996–2000	2001–2005
0–4	2	1	2
5–9	19	14	9
10–14	45	46	21
15–19	41	22	23
20–24	22	15	7
25–29	18	16	12
30–34	15	12	15
35–39	14	11	16
40–44	10	16	11
45–49	9	12	16
50–54	10	11	12
55–59	9	13	10
60–64	4	6	6
65–69	12	7	9
70+	21	22	20
Total	251	224	190

Source: Abridged from Table 1: ATSB (2006) *Deaths of Cyclists Due to Road Crashes*, Canberra.

This ATSB (2006) report – *Deaths of Cyclists Due to Road Crashes* – describes the factors associated with these events over the period 1991–2005. Results from this study (see Table 7) show that cyclist fatalities result primarily (86 per cent) from collisions with motor vehicles (i.e., cars, pick-up trucks, vans, and heavy transport vehicles). Also significant is that only 5 per cent of known fatalities did not involve a collision.

ATSB (2004) used the data from 2000 and 2001 and concluded that cyclists accounted for around 11 per cent of all fatal and serious injuries occurring in road crashes. Key findings of the 2006 report are: that in fatal road crashes (1996–2004) the most frequently assigned factor ‘Was the failure of cyclists and other road users to observe each other on the road’. Of these crashes, the most common type was the cyclist being struck from behind by a vehicle travelling the same lane and in the same direction (58 cases: 38 in rural areas).

**Table 7 Cyclist fatalities on Australian roads, 1997–2004**

Event	Counterpart	Cyclist fatalities (%)
Collision with:	Pedestrian	1
	Pedal cycle or other non-motor vehicle	0
	Car, pick-up truck, van or other motor vehicle	64
	Heavy transport vehicle	22
	Railway train or railway vehicle	1
	Fixed or stationary object	4
Not a collision		5
Unknown		3

Source: ATSB (2006) *Deaths of Cyclists Due to Road Crashes*, Canberra.

A report by the Monash University Accident Research Centre examined bicycle crash data involving 13,901 deaths and serious injuries from Queensland, South Australia, Victoria, and Western Australia for the period 2000–2004 (Watson and Cameron, 2006).

What caused cycling in Australia to become quickly and significantly safer for cyclists under 30 years old? During this time, Australian roads became less dangerous overall, with a decline in the national road toll. While some of the factors behind this improvement may have also made for marginally safer cycling, such as the reduction of drink driving and priority setting for spending on dangerous locations, it is unlikely that they played a great role in reducing cycling fatalities. Most commentators consider that compulsory helmet-wearing, which was introduced through state legislation across Australia states and territories during the period 1990–1992, to be the major factor in reducing cyclist fatalities in the following years.<sup>16, 17</sup> Significant reduction in total cyclists following the legislation accounts for much of the reduced injury rates, but injury reduction rates are above the levels of reduced cycling. Further, the absence of helmet-wearing is disproportionately associated with cycling fatalities; for example, between 1996–2000 one-third of all male cyclists killed were not wearing a helmet and in this period one-half of those males aged 10–19 who lost their lives were not wearing helmets, a rate far higher than the estimates of those not wearing helmets overall (ATSB, 2006).

Arguably, measuring fatalities is an imprecise way to assess the implications of bicycle crashes and a full picture requires adding serious and perhaps less serious injuries into these crash assessments. Putting this theory into practice is difficult because the measures of these injuries are uneven and imprecise. Nearly all serious crashes with motor vehicles resulting in serious injuries to cyclists are reported, but where motor vehicles are not involved, reporting rates are far lower, resulting in a difference between hospital and police reporting.

Berry and Harrison (2007) analysed a comprehensive data set on serious injuries – meaning that the injured were admitted to hospital and were discharged alive – arising from land transport accidents in Australia for 2003–2004. There were 48,862 such injuries, of which 28,782 were road traffic crashes (i.e., involving road vehicles) and a further 5243 were unspecified (Berry and Harrison, 2007). Of these, 28,782 serious injuries incurred in road traffic crashes and some 3676 were cyclists (2951 male and 725 female), see Table 8 (Berry and Harrison, 2007). Notably, the ratio of traffic-only injuries to cyclists to that of all modes is consistent across the states and territories. Comparing the ratio of traffic to non-traffic serious injuries to cyclists reveals that these are about equal in the states and territories, with the exceptions of the ACT and Western Australia, where there were about twice the number of non-traffic-related injuries to traffic-related injuries (see Table 8).

<sup>16</sup> Victoria: ATSB (2000), Carr et al (1995), and FORS (1997).

<sup>17</sup> There has been some controversy over the conventional view that helmets reduce injuries and this topic has been the most thoroughly examined of all subjects relating to cycling.

**Table 8 Serious injury cases in land transport by state and territory of usual residence, 2003–2004**

State and Territory	Cycles: traffic and non-traffic	Cycles: traffic only	Total: all modes
NSW	2434	1151	15,054
Vic	2002	1035	11,786
Qld	1685	749	9607
WA	793	281	3992
SA	540	253	3598
Tas	162	81	1001
ACT	141	41	587
NT	118	56	677
Other territories	5		55
Missing	49		505
Total	7929	3676	46,882

Source: Abridged from Tables 3.5 and 4.8 in Berry, J.G. and Harrison, J.E. (2007) *Serious Injury Due to Land Transport Accidents, Australia, 2003-04*. Injury Research and Statistic Series No. 38, Canberra: Australian Institute of Health and Welfare and Australian Transport Safety Bureau.

Cyclists have the overall least serious injuries of all the road user groups. Of the road user groups, seriously injured cyclists have the lowest ‘high threat to life’ proportions (17.8 per cent); this can be compared to the highest groups, namely pedestrians and car occupants (37.2 per cent and 27.4 per cent) (Berry and Harrison, 2007). Measured by (mean) length of stay in hospital of those injured in road vehicle traffic crashes, cyclists also the least stay of the major road using groups (pedestrians: 8.8 days; motorcyclists: 5.4 days; car passengers: 5.2 days; car drivers: 4.9 days; cyclists: 3 days) (Berry and Harrison, 2007). Among cyclists, most injuries were to the shoulder and upper limb (41.7 per cent), head (27.4 per cent), and lower limb (13.9 per cent) (Berry and Harrison, 2007). Time series data for the period 1999–2004 shows that serious injuries for cyclists have remained steady. Unfortunately, this report does not include cyclists in the data on injury rates per vehicle fleet and distance covered.

Several contrasts can be drawn between cycling fatalities and serious injuries, as shown by the Berry and Harrison findings, particularly as these relate to causal factors (see Table 9). It is noteworthy that as many serious injuries occur in traffic as not. For traffic injuries, collisions with vehicles are not more prevalent than non-collision accidents. And for injuries sustained in non-traffic situations, collisions of any sort are not the dominant cause.

**Table 9 Serious injury for cyclists, traffic and non-traffic, mechanism of injury, 2003–2004**

Counterpart in collision	Traffic injury	Non-traffic injury
Car, pick up truck or van	916	60
2- or 3-wheeled motor vehicle	6	-
Pedal cycle	62	-
Pedestrian or animal	16	27
Heavy transport vehicle or bus	40	91
Train	0	-
Other non-motor vehicle	-	-
Fixed or stationary object	157	249
Non-collision transport accident	1067	2974
Other and unspecified transport accidents	1410	552
Total	3676	3964

Source: Abridged from Table 3.6 in Berry, J.G. and Harrison, J.E. (2007) *Serious Injury Due to Land Transport Accidents, Australia, 2003-04*. Injury Research and Statistic Series No. 38, Canberra: Australian Institute of Health and Welfare and Australian Transport Safety Bureau.

Note: Totals don’t match previous table because some accidents aren’t specified as to traffic or non-traffic.

Cycling on roads and as a general activity entails fatalities and serious injuries. Although cycling comprises perhaps 1–2 per cent of trips in Australia, cycling fatalities account for 2–3 per cent of total fatalities (since the early 1990s) and for almost 13 per cent of serious injuries in road vehicle crashes in 2003–2004. Fatal crashes for cyclists invariably involve collision with a motor vehicle, whereas traffic injuries are just as likely to come from another cause as from collisions with vehicles. In the case of such injuries, cyclists are the least harmed overall of all traffic users. Despite the high-profile contestation from a minority, it is clear that legislation for compulsory helmet-wearing has significantly reduced fatality rates for cyclists, because the overall level of head injury has been reduced. Significantly, while cycling off-road ('non-road') produces few fatal crashes, it does produce as many serious accidents as road cycling.

#### Key points

- Cyclists' deaths account for 2–3 per cent of annual Australian road fatalities at present
- For on-road cycling, nearly all fatalities result from collisions with vehicles
- For on-road cycling, fatalities from collisions with stationary objects and pedestrians are rare
- Compulsory helmet-wearing has reduced cyclist fatalities since the early 1990s, particularly for children, teenagers, and younger adults
- Cyclists being struck from behind by a motorized vehicle is the most common type of cyclist fatality
- Collisions with vehicles are not the major cause of serious injury for on-road cyclists
- Cyclists accounted for about 13 per cent of serious road-only injuries in 2003–2004 nationally and about 8 per cent of all land transport serious injuries
- There are comparable levels of serious injury for on-road and off-road cycling nationally
- Cyclists have the shortest hospital stays of those injured in road crashes

### 1.6 *Bicycling safety: risk assessment*

It is difficult to express an evidence-based case regarding the safety of bicycling because of the paucity of data. Statistics are kept of deaths and major injuries of cyclists by the states and territories and Police reports of crash scenes provide additional data on the circumstances of these crashes.<sup>18</sup> There have been some analyses of these data and a very small number of international studies.

One of the main claims, perhaps the main claim, made for bicycling infrastructure is that it makes bicycling safer. Despite the strength of this belief amongst influential decision makers – after all it forms the rationale for considerable expenditure – there is surprisingly little evidence to support or discredit the claim that infrastructure increases bicycling safety. Assessing the risks of motoring can be done by determining the rate at which crashes occur, such as the number of annual incidents as a proportion of population or as an occurrence per passenger distance travelled. Geographical assessments are also undertaken to identify the most dangerous roads so that any specific problems can be identified and used as the basis for interventions of various types.

For cycling, there are obvious limitations for assessing safety using the conventional approaches applied to motor vehicles. To begin, the number of fatal and serious injury bicycle crashes is relatively low compared to motorcar crashes and drawing conclusions from a smaller number of cases is usually more tentative than when larger data sets are available. Second, there are difficulties in assessing the relative safety of bicycling compared to other transport modes when cycling is used for such a small volume of urban trips. To this limitation must be added the difficulty of estimating the distance covered by all cyclists; for Australia and elsewhere, it has proved extremely difficult to reach consensus on such estimates. Without knowing the distance cycled, cyclists' risk *exposure* is uncertain. Third, there is relatively little analysis of the causes of bicycle crashes, so our understanding of the causal factors is quite poor. It is almost superfluous to add that there is almost no Australian data on the safety of bicycle-specific infrastructure.

Knowing something of the incidence rates of these collisions does not axiomatically resolve the question of whether cycling is dangerous or not. As described above, an important aspect is

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<sup>18</sup> Here we observe the convention that these events are not 'accidents' in the true sense of the word, but events of widely varying probability where human decisions play a significant role (hence, the term 'accident' is avoided in this context).



establishing an appropriate reference point of similar experience so that cycling can be fixed within some form of ranking or hierarchy. But what is ‘appropriate’ and what is deemed to be a ‘similar experience’?

An ATSB discussion paper of 2005, *Cross Modal Safety Comparisons*, notes the difficulties of such comparisons due to limitations of the data and the use of single measures of risk, which can produce differing and misleading results. This paper compared available data for different transport modes and found that the fatality rate for cycling was several times higher than for car occupants but considerably less than motor cycles; on the basis of fatalities per trip, however, cycling and car occupants had the same fatality rates, and for vehicle passenger hours, car passengers has a slightly lower fatality rate than cyclists. Further, the paper showed that different studies had produced differing results of these modal comparisons.

Pucher and Buehler (2006) compared the US and Canada to European cycling fatality rates and found a variation from 1.03 fatalities per 100 million km cycled in Denmark to 5.74 f/100mkm in the US. They found Denmark, the Netherlands, and Sweden to have rates below 2.0 f/100mkm, with Canada, France, and Germany with similar rates, being between 2.0–3.0 f/100mkm (Pucher and Buehler, 2006). By way of comparison, Australia’s fatality rate for all road deaths was 0.8 fatalities per 100 million vehicle kilometres travelled (ATSB, 2007a).

In his review of British cycling safety, Wardlaw (2002) identifies the absolute risks for cycling and the cycling risks relative to other modes. Cyclists spend far less time travelling than motorists (100–120 hours/annum and 280 hours/ annum, respectively) and this causes a risk bias against cycling. Because, Wardlaw reasons, risk exposure for drivers increases by 30 per cent for a doubling of driving, the same ratio can be applied to cyclists and their risk reduced by 0.54 relative to drivers. Wardlaw also notes that cycling is dominated by children and young males with higher levels of risk taking than walking and driving (average age on serious injury/fatality: cyclist 24 y.o.; motorist: 34 y.o.). Estimates of cycling miss activity on footpaths, back streets, and country roads.

Comparing cycling and walking on the basis of fatalities per billion kilometres, Wardlaw finds; cyclists (deaths from motor traffic): 34 fatalities per billion kilometres and pedestrians, 49 f/bkm. On the basis of risks per hour, Wardlaw finds cycling to be riskier than the other modes, but these differences are small when the exposure cyclists and pedestrians is lifted to that of motorists (i.e., 280 hours annually). So a cyclist riding for 280 hours annually faces twice the risk of death as a motorist (0.25 fatalities per million hours’ use and 0.13 f/mhu). This translates into an additional risk to the cyclist compared to drivers of 0.2 per cent, prompting Wardlaw to comment (2002: 352): ‘The life-extending benefits of cycling are taken to compensate this burden 10–20 times over.’

Other studies have attempted to correct for some of the differences between road users likely to lead to misleading results. Dekoster and Schollaert (1999), for instance, describe the findings of Dutch study comparing the risks faced by cyclists and motorists which takes into account two factors. First, motorways were excluded from the motorists’ data because the risk was ten times lower than the rest of the road network and that there was no comparable factor for cyclists. Second, the difference in hazards presented to other road users between cyclists and motorists was taken into account. Finally, in interpreting the results – which found cyclists to face a marginally greater risk than motorists – the authors’ note that cyclists’ overall risks are higher because cyclists include children.

Jacobson (2003) examined the relationship between collision rates involving cyclists or pedestrians with motor vehicles in California, Denmark, the Netherlands, the UK, and a group of European countries and found that collisions become less likely when there are more cyclists and pedestrians.<sup>19</sup> And conversely, as the numbers of people cycling and walking fall (no pun intended), they are at greater risk. In discussing possible causal explanations, Jacobson considers that of human behaviour, roadway design, laws, and social mores, but offers that since changes were rapid for both increasing and decreasing levels of active transport, that of these factors that only human behaviour seemed the likely factor. Motorists’ speed tends to be positively related to falling pedestrian numbers, according to a study Jacobson quotes, and where active transport levels are higher there may be greater experience

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<sup>19</sup> Jacobson (2003) finds that across these studies that collectively collision rates decline with the numbers of walkers and cyclist to the power of 0.4; a doubling of walking and cycling reduces the risk of collision by 32 per cent (i.e.,  $2^{0.4} = 1.32$ ).

of motorists in engaging in these activities and they modify their driving to give greater consideration to cyclists and walkers.

Robinson (2005) conducted similar analysis of the numbers–safety relationship for Australia and found the exponential and inverse relationship between cycling rates and crash rates curve expressed in the international literature also applied domestically. A doubling of cycling levels is associated with a lower risk per kilometre of 43 per cent, whereas a halving of cycling rates increases the risk of crashes by 52 per cent (Robinson, 2005).

Cycling can also be assessed as risk-taking as physical activity. In the scheme of sporting injuries, cycling has relatively few injuries. Activities with relatively small participation levels and moderately high fatality and injury levels, such as mountaineering or parachuting, have far higher fatalities and injuries rates per million participants than cycling. A review by Thomson and Rivera (2001) in the *American Family Physician* identified the risk factors and injuries associated with bicycling in the US. Bicycle riding was ranked second in the US sports/recreation as a cause of serious injury and overall accounted for 900 deaths, 23,000 hospital admissions, 580,000 emergency department visits, and over 1.2 million physician visits annually in that country. Important risk factors were not wearing helmets, crashes involving motor vehicles, an unsafe riding environment, and being male.<sup>20</sup> Although the authors consider the following as likely to be significant in causing bicycle crashes, the contribution of each is unclear: rider error – covering losing control, speed, performing stunts, and inexperience; motorist error; environmental hazards; and mechanical failure. Higher speed seems to be proportional to injury and death, but the influence of trip distance and duration and riding on footpaths is not clear. Significantly they note (2001: 2008) ‘Although collisions with motor vehicles are relatively uncommon, they are responsible for the most serious injuries and fatalities.’

A net evaluation of the risks of cycling should include the positive benefits of participation of active exercise which offset the risks of cycling crashes. Such evaluations are not readily available in the research literature, although the aforementioned research by Wardlaw (2002) suggest that the risks of reduced health loss alleviated by cycling more than compensate for the risks of health trauma through cycling hazards. Comparative evaluations of the health gain/loss are not usually made by cyclists or potential cyclists and when made are subject to the influences of individual perception. As Hallsworth and Whitelegg (1997) explain, risk surveys reveal that the perceived risk of a traumatic event and the responses to such risks are usually overestimated, while the risks of failing to protect health and fitness are underestimated.

Finally, there is the role of cultural perception in understanding – or ‘framing’ – these risks. For, as Hillman observes (1997: 72): ‘Comparison of the relative risk of injury by each method of travel invariably then points to the conclusion that walking and cycling are ‘dangerous’, rather than the drivers of cars and lorries travelling at unsafe speeds.’ Improvement in road trauma rates (i.e., lower rates) are not indicative of safer roads, Hillman finds (1997: 72): ‘However, it is apparent that a far more influential explanation for the decline is that pedestrians and cyclists have had to alter their behaviour in the face of the growing threat from traffic.’ When cars and pedestrians collide, if pedestrians have not exercised sufficient care then drivers are exonerated from blame, yet ‘... carelessness on the part of pedestrians, especially children and old people, is a perfectly natural human failing: unlike driving a car, however, it rarely puts the lives of other road users at risk’ (Hillman, 1997: 73). There is much to consider here; frequently discussions of safety exclude those who behave carelessly on the roads, such as by acting illegally, wearing dark clothing at night, crossing the street while intoxicated, or are children, and consider only the ‘responsible’ road users as being indicative of the ‘true’ safety of the roads. It may be that it is this most vulnerable group of citizens that indicate the fundamental risks of mobility. Whether or not one shares Hillmans’s conclusions, the overall point serves to illustrate that that ‘success’ in road safety axiomatically takes the side of seeking to continue the routine motoring practices in cities and towns, often seemingly regardless of the implications for active transport.

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<sup>20</sup> Other listed risk factors are: Cyclist is 9–14 y.o., cycling in summer, cycling in late afternoon or early evening, cyclist from unstable family environment, cyclist has pre-existing psychiatric condition, cyclist is intoxicated, and cyclist is involved in competitive mountain-bike racing. However, the authors note that the influence of socio-economic factors is unclear and that most studies have not taken the amount of riding time into account.

### Key points

- Risk is meaningful only in context; the appropriate context for cycling is debated
- There is no definitive yardstick or assessment method for assessing the risks of cycling; it remains controversial
- There are many ways to assess the risks of cycling as transport
- Assessing cycling risks on the basis of exposure – either as distance travelled or trip time – is difficult due to poor data availability and other factors
- Some studies make allowance for differences between cycling and other modes with a view to removing alleged bias against cycling and find cycling to be not greatly dissimilar in risk to motorized transport
- It is established that the greater the number of cyclists the lower the rate of traffic-related injuries and that when cyclist numbers are reduced, injury rates increase
- There is little analysis available on the detailed causes of cyclist crashes

## 1.7 Public policy

As cycling for transport purposes is an activity that occurs mostly in the public domain, bicycling is subject to a broad array of public policy, with the responsibilities for governance being largely within the state and local government spheres. Across Australia, there are a great number of public policy strategies and plans to promote bicycling, and which direct the development of bicycling infrastructure.

### *National*

There have been two national strategies on bicycling, the first *Australian Cycling: The National Strategy 1999–2004* and the current *The Australian National Cycling Strategy 2005–2010* (Ausroads, 2005). Both strategies were produced by Ausroads, which is an association of Australian and New Zealand road transport and traffic authorities. This current strategy seeks to increase participation and improve safety through its priorities that include infrastructure and facilities provision, including cycling in integrated transport and land use planning, and improving coordination of activities relevant to cycling at all levels of Australian government.

Substantial financial resources are being allocated to bicycling in Australia by governments but several factors make estimation of this spending difficult, such as the large number of local governments involved and variation in year-to-year spending. Notwithstanding these difficulties, the Strategy estimates that AUD\$100 million is being spent annually on ‘infrastructure and facilities, coordination and planning, road safety for cyclists and cycling promotion and education.’ Progress on implementing the strategy is reported by the Australian Bicycle Council (2007) *Report to 30 June 2007*.

### *State strategies and plans*

Each state and territory has its own approach to the planning and management of bicycling infrastructure (see Table 10). Some jurisdictions are without a specific state-wide approach (Northern Territory, Victoria, and Tasmania) although Victoria states that cycling is picked up in a range of overarching state and metropolitan transport strategies.<sup>21</sup> Here, the ACT and Canberra are exceptional by virtue of being Australia’s version of a city-state and the strategy for the territory is the plan for Canberra.

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<sup>21</sup> *Melbourne 2030 - Planning for Sustainable Growth* (Victoria, DSE, 2003); *Linking Melbourne: Metropolitan Transport Plan* (Victoria, 2004) (followed by *Meeting Our Transport Challenges*, s. 8 (2006); and *Linking People and Spaces - A Strategy for Melbourne’s Open Space Network* (2002). Even in sum, these policy initiatives fall considerably short of comprising anything like a state-wide cycling strategy.

In March 2009, the *Victorian Cycling Strategy* (Victoria, 2009) was released along with the state’s latest recently-released *Victorian Transport Plan*; promising an additional \$115 million for cycling - for cycling lanes, shared paths, and a cycle hire programme for Melbourne’s CBD.

**Table 10 State strategies and plans**

<b>Australian Capital Territory</b> Dept. of Territory and Municipal Services	<ul style="list-style-type: none"> <li>• <i>Canberra Bicycle 2000 Strategy</i> (on-line)</li> <li>• <i>ACT Sustainable Transport Plan (2004)</i></li> <li>• <i>Ten Year Master Plan for Trunk Cycling and Walking Path Infrastructure 2004–14</i></li> </ul>
<b>New South Wales</b> Roads & Traffic Authority	<ul style="list-style-type: none"> <li>• <i>Actions for Bikes: BikePlan 2010</i> (1999)</li> </ul>
<b>Queensland</b> Queensland Transport	<ul style="list-style-type: none"> <li>• <i>Queensland Cycle Strategy</i> (2003)</li> <li>• <i>Queensland Cycle Strategy – Implementation Report</i> (2005)</li> <li>• <i>Queensland Transport South-East Queensland Principal Cycle Network Plan</i></li> </ul>
<b>South Australia</b> Dept. of Transport, Energy and Infrastructure	<ul style="list-style-type: none"> <li>• <i>Safety in Numbers: A Cycling Strategy for South Australia 2006 – 2010</i> (n.d.)</li> </ul>
<b>Western Australia</b> Dept. of Planning and Infrastructure	<ul style="list-style-type: none"> <li>• <i>Bike Ahead: Bicycle Strategy for the 21<sup>st</sup> Century</i> (1996)</li> </ul>

However, the presence or absence of a state plan is not indicative of the scale of commitment of states and territories to bicycle infrastructure investment. Investments by these state and territory governments vary considerably, although these amounts are usually small fractions of road investments.

#### *Capital city strategies and plans*

Given the primacy of Australia's state and territory capitals as a proportion of the national population and as comprising the nation's largest cities, cycling infrastructure in these places is of particular interest.<sup>22</sup> Yet, the governance of Australia's capitals is generally the task of state governments from 'above' and a large number of constituent local governments from 'below'. Such circumstances present a constant challenge to addressing public policy issues that concern the entire metropolis. For three of the capitals there is unified governance at the metropolitan level; obviously the national capital (Canberra) is one such case, as is the relatively small Darwin (whose population is around 11,000), with Brisbane having the single Brisbane City Council. There are comprehensive metropolitan bicycle strategies for Brisbane, Canberra (see Table 10). Perth also has a cycling strategy for the metropolis, produced by the state Department for Planning and Infrastructure (see Table 11).

Several of the local governments responsible for the CDB areas of the capital cities have cycling strategies, some of them being quite comprehensive (see Table 11). These LGAs are, however, only a small part of the overall city and are reliant on the infrastructure provided by adjoining and distant LGAs to provide the links between the LGAs of origin and the destination of the city centre. Darwin has a network of cycling paths, but is without a city strategy; the Hobart City Council has a broad-brush bike plan for the city (available online).

<sup>22</sup> There are approx. 13.7m of Australia's 21.3m inhabitants in the eight capital cities (approx. 64 per cent).

**Table 11 Capital city bicycle strategies and plans**

<b>City</b>	<b>Authority</b>	<b>Plan/ Strategy</b>
<b>'Whole-of-city'</b>		
Brisbane	Brisbane City Council	<i>Brisbane Active Transport Strategy – Walking and Cycling Plan 2005–2010</i>
Canberra	ACT Government	<i>Canberra Bicycle 2000 Strategy (on-line)</i> <i>ACT Sustainable Transport Plan (2004)</i>
Perth	WA Dept. Planning and Infrastructure	Perth Cycling Network
<b>CBD-only</b>		
Adelaide	City of Adelaide	<i>Adelaide City Strategic Bicycle Plan (1995); reviewed and updated in 1999 Movement Strategy, Bicycle report; now in Integrated Movement Strategy – Adelaide on the Move</i>
Melbourne	City of Melbourne	<i>Bicycle Plan 2007–2011 (2007)</i>
Sydney	City of Sydney	<i>Cycling Strategy and Action Plan 2007–2017 (2007)</i>

*Local government*

Although local governments play a large role in the provision of cycling – and walking – infrastructure, there is no consolidated database on their activities or available infrastructure.

A survey of Australian local governments by the Australian Local Government Association and Australian Bicycle Council (ALGA and ABC, 2007) indicates the investment in infrastructure and other services for bicycling during 2005–2006 for 155 respondents, see Table 12 below. Over AUD\$37m was spent on bicycle-related programmes, the bulk of which related to infrastructure. On average, each local government (urban and rural) had an average of 30km of off-road facilities and 21km of on-road facilities. In a response to the content of their bicycle strategies and plans, 99 per cent of responding local governments stated that infrastructure was addressed.

**Table 12 Average expenditure on bicycle-related programmes, 2005–2006 (rounded to nearest thousand AUD\$)**

Category	Average metropolitan (\$'000)	Average regional/rural (\$'000)	Total average (\$'000)
New construction of paths and on road cycling lanes	261	73	126
Maintenance of paths and on-road cycling lanes	71	22	36
Purchase and installation of cycling parking facilities	13	1	4
Purchase and installation of other 'end of trip' cycling facilities	64	0	18
Maintenance of 'end of trip' cycling facilities	0	0	0
Bikeway signage	5	1	2
Development of bike plan	6	3	4
Bicycle education programme	1	0	1
Bicycle information	3	0	1
Cycling/bikeways promotion	3	0	1
Cycling events	5	2	3
Average expenditure for all categories	361	114	191
Total average expenditure of all authorities that responded (including undifferentiated expenditure totals)	366	116	194
	Metropolitan (\$'000)	Regional / Rural (\$'000)	Total Exp. (\$'000)
Total spent from all authorities that responded	21,953	15,596	37,549

Note: Table 12 shows the average expenditure by each participating local government by category. According to the source document, when calculating the averages within the categories, authorities that only provided total expenditure have been excluded, but they have been included when calculating total average expenditure. Authorities that skipped the question are assumed to have not contributed resources to any bicycle related programmes and these nil amounts have been included in the category averages and the total average expenditure. A total of 39 respondents skipped this question with 6 from metropolitan authorities and 33 from regional/rural areas. Table 12 also shows the average total expenditure during the 2005/06 financial years. The calculation of this average has included all 194 survey participants. The averages shown in Table 12 provide an overview of expenditure for the year 2005–2006, the disparity in expenditure, even between responding metropolitan authorities, was substantial, e.g., one local government spent AUD\$7 million on 'new construction of paths and on road cycling lanes' while others spent less than \$10,000.

Source: Australian Local Government Association and Australian Bicycle Council (AGLA and ABC) (2007). *Cycling Survey of Australian Governments*.

## 2 Current debate

### 2.1 *Worth of cycling-specific infrastructure*

Infrastructure is one of the key elements to facilitating urban cycling, but it alone won't foster greatly increased cycling; other important aspects include increasing safety, urban design and planning, design and operation of the road system, education, regulations and laws, publicity and awareness (as described above). Determining the role and influence of cycling infrastructure in encouraging cycling is difficult because this influence occurs in conjunction with these and other factors concerning behavioural, social, legal, economic, environmental, and engineering and technical dimensions of the issue.

Infrastructure provision is a priority of the national cycling strategy (Ausroads, 2005), which covers cycling networks, end-of-trip facilities, and directional signage. Other strategic priorities also relate directly to infrastructure provision, notably those on integrated planning (Priority 2) and road safety (Priority 4). In broad terms, there are three aspects to infrastructure provision, proposals for new infrastructure, existing infrastructure, and the maintenance of existing infrastructure.

Our knowledge of existing cycling infrastructure is not terribly good overall, so that while for some cities there is quite good information, for others, there is essentially no publicly available data. No national database on cycling infrastructure or facilities exists. Available information on existing cycling networks usually does not describe their attributes and qualities. There is no way of knowing the condition of existing bicycle infrastructure across Australia at present, but there is acknowledgement in several of the existing plans and strategies that much infrastructure is of poor design, in poor condition, and has been inadequately maintained. This paucity of relevant data makes evaluating current facilities at the broad scale difficult and can inhibit planning for new facilities in many places.

Despite these limitations in our understanding, the facilities for cycling are, arguably, the one 'necessary but not sufficient' component of cycling as transport. Regardless of the type and form of cycling infrastructure involved, the capacity of the system to serve cycling requirements depends on cycling infrastructure. As Pucher and Dijkstra state in their review of cycling in Germany and the Netherlands (2003: 1513):

Unlike the sparse and fragmented cycling facilities in the United States, the bike paths, lanes, and streets in The Netherlands and Germany form a truly coordinated network covering both rural and urban areas. Importantly, Dutch and German bikeway systems serve practical destinations for everyday travel, not just recreational attractions, as with most bike paths in the United States.

Such is the state of development in the best-practice cities that a review of cycling in the Netherlands, Denmark, and Germany observed (Pucher and Buehler, 2008: 512):

The bicycling networks in all these cities include numerous off-street short-cut connections for cyclists between streets and traversing city blocks to enable them to take the most direct possible route from origin to destination. The result of such a wide range of facilities is a complete, integrated system of bicycling routes that permit cyclists to cover almost any trip either on completely separate paths and lanes or on lightly travelled, traffic-calmed residential streets.

Further, we have a reasonably good understanding of what's required of infrastructure to serve the transport needs of cyclists. For example, a review by Jones (2001) of a series of seminars held in the UK on the problems faced by practitioners in promoting their national strategy highlighted the role of five criteria that made specific cycle routes popular:

- *Coherence*: Paths needed to be part of networks and be of a consistent design standard
- *Directness*: Routes should follow that preferred by cyclists and be without detours
- *Attractiveness*: Aesthetically pleasing, well-lit, and well-signed
- *Safety*: Infrastructure should minimise risks, and
- *Comfort*: Smooth surfaces, flat gradients, well-maintained, and without 'obstacles'.

Although this list resembles many others of similar purpose, it is of interest that these criteria can be met by cycling-specific infrastructure or by public roads shared by cyclists without any cycling-specific attributes, other than they form part of recognized and designated cycling route.

Investments are made in cycling infrastructure with the expressed purpose of encouraging cycling. It follows that there are links between travel behaviour – and choice – and infrastructure provision; in promoting active transport, the role for infrastructure is based on: recruitment to cycling – i.e., adding new cyclists, and thereby achieving modal shifting from motorized transport; conversion of recreational cyclists to utilitarian cyclists; and encouraging greater bicycle use – i.e., a greater frequency of cycling trips. Evidence of the influence of cycling infrastructure mostly addresses crash rates and the perceptions of safety (discussed below in Section 2.2).

It is worth identifying here that the task of ‘more cycling, more often’ for Australians is not that of addressing a homogenous segment of society, but involves recognizing that the ‘market’ for cycling is differentiated (such as shown in Table 13 below). Lumsden (1997) considered this problem in terms of what sorts of messages would work best for these different social groups; it is clear that for those cycling already at some level, cycling infrastructure has a role to play.<sup>23</sup> Among policy makers and advocates, it is generally believed that the higher priority task is to address the needs of those already cycling at some level as this group will take less convincing than those without any cycling experience. As discussed elsewhere, infrastructure is particularly important in attracting casual and irregular cyclists.

**Table 13 Segmentation of the cycling market**

Segment	Positional Statement
Non-cyclists (Determined motorists)	Benefits from reducing the number of vehicles on the road; educating for shared use
Casual irregular leisure cyclist (Casual converts)	Awareness of new facilities, safety, promoting trial, fashion-conscious imagery
Casual regular leisure cyclist (Opinion leaders)	Conversion to more trips for all purposes encouraging to be opinion leaders to stimulate word of mouth marketing
Regular all-purpose cyclist (Cycle warriors)	Confirmation of decision, support to encourage cyclist way of life

Source: Lumsden, L. (1997) *Recreational cycling: Is this the way to stimulate interest in everyday urban cycling?* In Tolley, R. (ed.) *The Greening of Urban Transport: Planning for Walking and Cycling in Western Cities*, Second Edition, John Wiley and Sons: Chichester: 113–27: Table 9.3.

Within the Australian bicycling community and in other nations, opinions are sharply divided over the worth of bicycling infrastructure – perhaps to an extent that might surprise advocates of such expenditure. This debate concerns whether the above goals of cycling infrastructure – i.e., coherence, directness, attractiveness, safety, and comfort – are best achieved through approaches that seek further integration of cycling into the existing traffic system or whether the priority should be a separate, segregated system (as described in Section 1.2 above). Safety issues are discussed in greater detail in the following section. In brief, the opposing cases are as follows.

Advocates (generally) hold that bicycling-specific infrastructure is:<sup>24</sup>

- Essential for attracting far larger numbers of citizens to use bicycles as a transport mode and that without these investments, bicycling will remain at its very low current levels
- An obvious way to make bicycling markedly safer
- Concerns over safety are a consistent and major barrier to cyclists and those not cycling; there is evidence that women prefer safer cycling routes
- Necessary to be included into urban design, urban planning, and transport planning

<sup>23</sup> Tolley and Hallsworth (1997) and Diekstra and Kroon (1997), e.g., offer some interesting insights into the behavioural and psychological barriers to cycling and reducing car use.

<sup>24</sup> Such as Pucher and Dijkstra (1999, 2000).



- Part of enabling and encouraging inter-modal trips and forming part of an integrated transport system
- Highly cost-effective for encouraging an environmentally benign mode of urban transport, and
- A feature that adds to the quality of urban life and other desirable urban attributes, such as being part of car-free areas of cities.

Opponents of bicycling infrastructure, who include both proponents and opponents of increased cycling, believe:<sup>25</sup>

- Promoting cycling infrastructure solutions – bicycle paths and on-road bicycle lanes – is misguided and possibly harmful because as most cyclists use conventional roads, and their rights and status as road-users is eroded
- On-road bicycle lanes reduces cycling safety but also may engender a false sense of security by cyclists – especially those less experienced
- On-road bicycle lanes allow motor vehicles to drive faster by lowering the motorists' perceived risks of collisions with cyclists
- Most on-road bicycle lanes are of poor design and are typically too narrow and facilitate cyclist's needs
- Many cycling infrastructure routes are poorly planned, uncoordinated, and fragmented, with design, construction and maintenance defects
- Shared paths are only safe for low volume low-speed recreational use and are dangerous to pedestrians and cyclists when serving as popular cycling routes
- 'Copenhagen Lanes' confine cyclists limiting the options to avoid collisions, despite being designated for bicycles pedestrian use occurs, their high expense limits extensive applications, intersection points with roads remain dangerous, and they are unsuited to higher speed commuting cyclists
- Segregated facilities for cycling usually attract 'interference' from pedestrians, pets, 'small-wheeled vehicles (e.g., skateboards)
- Scientific support is lacking for the claimed benefits of cycling infrastructure
- Infrastructure is largely a waste of money; expenditure on driver education and law enforcement is a better investment to improve cycling safety, and
- Investment in cycling facilities is out of proportion to the transport service provided; these funds would give a better mobility return on investment if used for walking, public transport, or motor cycle infrastructure.

There is a degree of cross-purposes in this debate and the common interest of all cyclists in improving bicycling has become diffused in differences over strategies and priorities, and there seems to be some confusion over the normative and positive aspects of the issue.<sup>26, 27</sup>

Many of the key points of difference are difficult to resolve on an evidentiary basis. That infrastructure encourages cycling is taken for granted in our promotion of cycling infrastructure and improved cycling infrastructure leading to an increase in the number of cycling trips has been demonstrated (see, e.g., Martens, 2004, 2007). Yet other studies have contested these claims (McClintock and Cleary, 1996, Krizek and Roland, 2005). And while there is consensus in the perceptions of some cyclists and non-cyclists that infrastructure improves safety, infrastructure improvements do not necessarily result in the recruitment of new cyclists (see, e.g., Dickinson et al, 2003).

Complaints over the qualities of existing cycling infrastructure have a legitimate basis, but it seems unreasonable in this instance to decry the principles of cycling-specific infrastructure on the grounds of inadequate execution. In the case of on-road bicycle lanes, most are relatively narrow and were not designed for cycling use from scratch, but added to existing public roads and lie between car parking bays and the lane for cars. Claims that cyclists in these on-road lanes are in a 'car door opening zone'

<sup>25</sup> Such as Forester (2001) and Wardlaw (2000).

<sup>26</sup> 'Normative': In short, 'What ought to be' and 'positive': in short, 'How things are'.

<sup>27</sup> Additionally, there appears to be some confusion in the debate over the dimensions that are often used in assessing road safety and risk, specifically behaviour, infrastructure, institutions, and vehicles, as discussed below.

and that these lanes act to facilitate motorists being able to overtake cyclists with ease are generally correct in the case of Australian cities.

Bicycle paths present a somewhat mixed picture in Australia. Along a continuum, in places such as Canberra and Perth, there are lengthy and dedicated bicycle paths with few intersections which are quite separate from the road network. These paths are of high quality and designed for higher-volume and higher-speed cycling associated with use as commuting routes. It is unlikely that cyclists have many complaints of such facilities. At the other end of this continuum are the poorer quality paths, often shared with pedestrians, that are narrow and possibly with numerous intersections and junctions with the road network. These facilities present a level of service that does not meet the demands of higher volumes of cyclists, with limitations in their design, construction and maintenance. In fact, many were not originally intended to become cycle paths. Shared paths are essentially for low-speed recreational cycling use and their use by higher-speed cyclists is dangerous: pedestrians can be unaware of the risks posed by approaching cyclists, very few have night lighting, surface conditions can be of poor quality, and maintenance is often neglected. It would seem that it is the poorer bicycle paths that attract much criticism. But it may be that, for many cyclists, the debate is less about the efficacy of the concept of cycling paths as it is with the quality of the infrastructure they have available.

'Copenhagen Lanes' may well be a compromise between on-road bicycle lanes and dedicated bicycle lanes, but in some ways this compromise combines both desirable and less desirable features of the competing options. Certainly, while these lanes are free of motor vehicles, those places where the Copenhagen Lanes have junctions with laneways and driveways and at intersections with roads are locations of increased risks of collisions between motor vehicles and cyclists. One obvious limitation of those lanes behind parked vehicles is that cyclists are less visible to motorists when arriving at road junctions and other openings in the lanes. There is debate of whether these lanes are suitable for higher speed cycling associated with commuting cycling, but it is clear that the lanes are not suitable for high-speed cycling as might occur on open roads. Because they are located in busier urban locations, these lanes are often used illegally for parking delivery vehicles, by waiting taxis, and by pedestrians.

Regardless of the type of cycling-specific infrastructure involved, it is a safe generalization that there are very few instances of Australian cities possessing a cycling network worthy of the name. For the most part, the location of these services appears unplanned, uncoordinated, and very uneven: the location of many paths has little to do with meeting the transport needs of cyclists. Debate over the value of infrastructure is primarily about whether it is present or not and of the types of infrastructure being provided. From a transport service perspective, the larger question is whether there is a network in place to meet the demands made of the service as a transport system. Having a cycle network concerns more than infrastructure provision and should include such aspects as route design, signage and information services, and so on.

Despite the apparent legitimacy of many concerns over the efficacy of cycling infrastructure, its advocates also have a good case for its expansion. It is the higher-use cyclists that seem more inclined to be critical of infrastructure solutions, whereas these solutions seem to have greater appeal to those cycling with far less frequency or duration. Research by Daley et al (2007) seems to bear out this speculation, as they describe how non-riders tend to emphasize the barriers related to personal factors and the physical environment, as opposed to more regular riders who might recognize more political and structural factors. Indeed, the provision of additional cycling infrastructure to encourage more cycling is the orthodox position, promoted by cycling organizations and governments alike. For example, Bauman et al in *Cycling: Getting Australia Moving* make the following (2008: 21): 'Recommendation 6. Bicycle Infrastructure. This report recommends the provision of high quality, integrated bicycle routes (on and off road) to meet the challenges of increasing Australia's participation in active travel and recreation.' Those claims that cycling-specific infrastructure is essential to attracting new cyclists – especially the more casual and recreational cyclists – have a basis in evidence.

Godefrooij observes that experienced cyclists tend to reject segregated facilities and links this to the characteristics of the transport system and its planners: (1997: 232):

As long as planners do not give enough weight to the interests of cyclists, keen riders will have a preference for the integrated approach. The greater their skills to survive, the

greater the preference. In fact this has more to do with the insufficient quality of the actual design (which often does not comply with quality requirements on aspects like comfort and directness) than with the principle of segregation.

In a clear statement on the value of cycling infrastructure, based on the experience of the Netherlands, Godefrooij states (1997: 232): ‘If the design of segregated facilities has sufficient quality, many objections against segregation will disappear.’

Based on the Dutch design manual, Godefrooij (1997) seeks ways that integration and segregation can be made complementary, based on the characteristics of the local traffic system. In essence, the levels of vehicle traffic and the speed of the traffic determines whether cyclists should be integrated or separated from other vehicles. Where motor vehicle speeds cannot be reduced then segregation is recommended and where infrastructure is shared between cyclists and motor vehicles, there must be lower motor vehicle speeds.

Intersections between roadways and cycling facilities – bicycle lanes and paths – are locations of higher collision risks. There are a number of international design manuals and guidelines on this subject (such as the US AASHTO, Netherlands’ CROW),<sup>28</sup> as well as Ausroads’ bicycle design guidelines. Cumming (2000) produced a framework for bicycles at intersections for Australia, showing that there are a number of design solutions available that will reduce the risk of collisions.

There are risks that the infrastructure debate is couched in all-or-nothing terms. Such an approach can create the false impression that the cycling network is primarily about cycling-specific infrastructure, which can lead to neglect of the role of the public road network and other aspects of the cycling network. Focusing exclusively on specific facilities or indeed, on specific routes, can lead to neglecting the development of an integrated network that is designed to facilitate overall cycling services. Akin to much of Australian urban transport planning, there has been neglect of the role and value of integrated transport services in the cycling infrastructure. Providing networked cycle routes to public transport stops and stations and having facilities for bicycle parking and secure storage is important for improving the usage of both modes. To date, planning and development of this form of coordination is very poor in Australia. Urban cycling networks at present are typically vaguely associated with some origin–CBD destination model; very little work has gone into integration. By way of illustrative example, there is little evidence of bicycle parking at Australia’s suburban railway stations, bus stops, bus terminals, and ferry and light rail stops and stations, in contrast to overseas best-practice cities.

If cycling is to become part of a routine way to get to and from work, then it is possible that we would need to rethink many of our current assumptions about cycling infrastructure, as described above. Additionally, the approach to cycling-specific infrastructure based on one lane, two-way bicycle paths and one-lane bicycle lanes on public roads is inadequate and does not have sufficient carrying capacity for high volume use. Those cities with high cycling rates have cycling infrastructure with high levels of capacity. Australian cycling-specific infrastructure continues to be designed and built on the assumption that light recreational use is its primary purpose. Such design approaches appear to be built on demand responsiveness, which are the antithesis of using planning to promote demand and for planning cycling infrastructure in conjunction with land use and urban planning.

## 2.2 *Safety benefits of cycling-specific infrastructure*

A major rationale for investing in cycling infrastructure is that it contributes to improving cycling safety. There is little question over the proposition that those who do not cycle or cycle rarely, perceive that providing of infrastructure significantly reduces the risk of cycling to them. Indeed, there would seem to be much commonsense about this provision; if cars are the major danger to cyclists, then the greater the degree of separation of cyclists and cars, the less the risk of collisions between the two. However, the issue is somewhat more complicated and the risks involved cannot be understood or explained in simple terms.

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<sup>28</sup> AASHTO: American Association of State Highway and Transportation Officials, see, e.g., their report *Guide for the Development of Bicycle Facilities*; CROW: Information and Technology Platform for Transport, Infrastructure and Public Space, see, e.g., their report *Design Manual for Bicycle Traffic*; see also Litman, et al (2006).

Since we are concerned with cycling as urban transport, the issue of risk and infrastructure can be approached as a road safety issue. Road safety often considers the contributions of four factors:

- Human – such as driving behaviour, experience and skills, use of safety equipment, and demographic factors
- Vehicular – in-vehicle crash protection, impacts on other parties in crashes
- Road – road design, high-risk crash sites, and
- Institutional – education programmes, planning, law enforcement, legislation, standards, and research and data collection.

Of particular importance is that cycling safety is not exclusively about cyclists, but also about motor vehicle drivers, as it is this group of road users that is the major source of risk to cyclists. This problem is made worse because it is widely recognized that road systems are designed and operated with the interests of motor vehicles taking the highest priority.

Key safety issues for cyclists were identified by the European Transport Safety Council (ETSC) (1999) (as shown above in Section 1.5), and these include the vulnerability of cyclists, especially in collisions with motor vehicles travelling at higher speeds, the ‘invisibility’ of cyclists to motorists, and the range of cycling abilities amongst the cycling population. Three types of risk were identified by the ETSC (1999), those from traffic, from falling, and from crime. They identified risk management approaches or each of these risks. Traffic risks are minimized through separation of cyclists to reduce conflicts, creating safer conditions when cyclists and traffic are integrated, and seeking to minimize the consequences of collisions. Falling risks are to be reduced through high-quality design of cycling facilities and appropriate maintenance of cycling surfaces. Crime risks, which generally have a low profile in the Australian understanding of safety, can be reduced through providing well-lit, visible, and well-maintained cycling routes and by having secure bicycle storage. Measures to improve cycling safety often comprise:

- *Prevention*: engineering and planning
- *Prevention*: marketing, education, and enforcement, and
- *Adaptation*: equipment and hazard management.

For example, from these ETSC responses, the ETSC (1999) identified several action strategies, including separating different road users, creating safer conditions where separation isn’t possible (such as speed control measures and other engineering responses), addressing motorists’ attitudes, consulting and informing cyclists, and minimizing collision consequences through helmet-wearing and improving the front sections of motor vehicles.

All these elements play some role in the official responses to improving cycling safety in Australia and around the world. However, because the risks of major trauma from road cycling crashes is primarily determined by the exposure to motor vehicles, the role of engineering and planning are particularly important. Marketing, education, and the like are all important elements in improving cycling safety, but in the absence of engineering and planning responses, these elements are unlikely to make a major difference to the levels of cycling risks.

Infrastructure changes can alter the riskiness of cycling through such effects as separating bicycles from motorized vehicles, alerting motorists to the potential presence of cyclists, advising motorists and cyclists of hazards, and removing specific road risks from cyclists. Increasing cycling safety that occurs as the level of cycling increases is well established in research, but the exact causes of this relationship are debated. Several factors are involved; when there are more cyclists, the behaviour of all road users changes because cyclists are more dominant as a road using group and that motor vehicle drivers are more likely to have cycling experience themselves. In places with very high cycling rates there is a corresponding fall in motor vehicle use, thereby lowering the risks of collisions. Together with these factors is that high levels of cycling and public investment and public policy development for cycling tend to be associated, with supportive police promoting cycling growth.

Our understanding of the influence of infrastructure to cycling risk is quite poor. Perhaps surprisingly, there is some questioning by experts on whether cycling safety is improved by infrastructure and ambiguity over existing evidence. There does not appear to be a great volume of research on the topic and, additionally, there are limits as to the wider applicability of a number of local studies. For

example, Wardlaw (2002) cites studies that found cycling safety was either lower or about the same for segregated cyclists compared with those sharing roads with motor vehicles, although these studies only address certain conditions.<sup>29</sup> On the other hand, Moritz (1997) developed an empirically based 'relative danger index' (RDI)<sup>30</sup> for North America and found: major streets without bicycle facilities (RDI: 1.26); minor streets (1.04), streets with bike lanes or bike routes (0.05), bike paths (0.67), and footpaths (5.3). Some 7.3 million km of cycle commuting was reported and Moritz calculated the annual accident rate of 37.1 events per million km.

Views among cyclists as to the safety of infrastructure options, as measured by survey, has also produced mixed results. One US study used survey responses from cycle commuters to develop a relative danger index (RDI) of accident frequency for bicycle facilities.<sup>31</sup> A survey by the US Bureau of Transportation Statistics (2004) found that cyclists in areas without bicycle paths and bicycle lanes were twice as likely to feel endangered than those cyclists riding in areas with such facilities. Further, while infrequent cyclists showed no preference for bicycle paths or lanes, frequent cyclists 'have a strong preference for more bike lanes over more bike paths'. Whether or not such facilities were available had no influence on the frequency of cycling; rather, the influence of such facilities increased the 'sense of personal safety'. These findings must be viewed, however, in light of the US having not only very low cycling rates, but a very low national level of utilitarian cycling.

Increasing numbers of cyclists greatly increases cycling safety – and reducing cycling numbers has the opposite effect – even though there are no clear explanations for this result. Bonham, et al (2006) question whether there is a problem of self-selection in this association, whereby the cyclists in question are of higher skill and/or experience levels in the situations of high levels; by implication, introducing significant numbers of inexperienced cyclists onto the roads may not bring about the expected increases in cycling safety. In any event, the place of infrastructure in this association is unclear.

We find, therefore, that the safety aspects of the debate over 'segregation versus integration' concerning cycling infrastructure cannot be resolved using available evidence at this time. Our concern here is with the actual changes to the safety of cyclists that could be measured, rather than with risk perception by either cyclists or motorists. If the default position is cyclists and other vehicles sharing public roads, i.e., modal integration, then the basic safety question of cycling-specific infrastructure is whether it reduces the prevailing level of risk to cyclists. Off-road cycle paths eliminate the risk of collisions with motor vehicles when cyclists are on the paths and must therefore be safer than public roads, as vehicle collisions are the major source of the most serious trauma to cyclists involved in road accidents. When cycle paths intersect with public roads, cyclists and motor vehicles must share the road space, and at these locations the risks will be increased. When these paths are shared with pedestrians, the level of safety seems quite likely to be reduced, especially when there numbers of cyclists is high, due to higher likelihood of collisions between cyclists and pedestrians. Such deductions depend, however, on the bicycle paths offering an appropriate level of service for the cycling demand.

Bicycle lanes on public roads appear to offer a questionable safety benefit to cyclists and further investigation is required of the critics' safety objections to this infrastructure. Essentially, the issue is whether the separation of motor vehicles and bicycles lowers the net risks to cyclists, or whether the potential risks outweigh any gains. In summary, these potential risks include the aforementioned opportunities for passing motor vehicles to drive faster, that cyclists may be indirectly 'encouraged' to ignore road rules, cyclists are confined to a narrow lane and the dangers of the 'opening car-door zone' problem, motorists passing cycle lanes at normal speeds are dangerously close to cyclists and closer than might be the case when cyclists and cars share the same road, and such facilities may engender a false sense of security in cyclists – especially those less experienced. This is a complicated problem and cannot be resolved using available evidence at this time.

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<sup>29</sup> Such as Wachtel and Lewiston (1994) and Garder et al (1994).

<sup>30</sup> A higher RDI value indicates greater danger.

<sup>31</sup> However, the sample size of those involved in crashes was quite small, being some 10 per cent of the 2374 survey respondents.

### 2.3 *Role of policy and infrastructure provision*

Assessments of the role of public policy – primarily through investment in cycling infrastructure – find it to be essential for successfully promoting greatly increased cycling (e.g., Pucher, 1997; Pucher and Buehler, 2008; Pucher and Dijkstra, 2000; and Rietveld and Daniel, 2004).

Rietveld and Daniel (2004) examined the influence of local government policies on bicycling for short trips – up to 7.5km – in the Netherlands, a nation of particular interest to cycling researchers. In general they found that these policies are influential when they improve the competitiveness of cycling relative to the motorcar by reducing the costs of cycling – in a broad sense – and increasing the costs of making the same trip by car. Additionally, policies that improve the safety of cyclists – which relates to infrastructure – and add to their satisfaction promote cycling. These authors identify four implications from their research on the influences on cycling:

- Physical effort – which is influenced by slope and number of stops
- Travel time – influenced by route directness and number of stops
- Accident risks – even though crash rates may be low, it is the perception of risk that influences behaviour, and
- Cultural tradition.

#### **Key policies and innovative measure in Dutch, Danish and German cities to promote cycling**

- Extensive systems of separate cycling facilities
- Intersection modifications and priority traffic signals
- Traffic calming
- Bike parking
- Coordination with public transport
- Traffic education and training
- Traffic laws

Source: Pucher, J. and Buehler, R. (2008). Making cycling irresistible: Lessons from the Netherlands, Denmark, and Germany, *Transport Reviews*, Vol. 28 (4): 495–528: Table 1.

As the authors state, the Netherlands has more than 16 per cent of the road network devoted to bicycle paths and it was the first nation to have a national bicycle policy. In response to the oil crisis of 1975 the National Bicycle Tracks Grant Act provided funding for constructing urban and rural bicycle facilities and introduced a uniform design for facilities.

There are a few cities in the world where cycling is the dominant transport mode, or at least, occurs at very high levels. Typically, policy advocates, researchers, and those involved in policy design and formulation are drawn to such exemplars. Some critics, however, are sceptical of the value of such best-practice approaches and question the validity and applicability of these examples.

As a developed and industrialized nation, the most useful and direct lessons are to be drawn from similar nations. Many large Asian cities have featured cycling as an urban transport mode, but interestingly as industrial development has increased, these cities have invested more heavily in road transport for private vehicles to the detriment of cycling levels.

Dekoster and Schollaert's (1999) report for the EU, *Cycling: The Way Ahead for Towns and Cities*, identifies the range of cycling rates across Europe and a number of best-practice cities. Cycling within Europe varies considerably, with low rates in nations such as Spain, Luxembourg, and Portugal (less than 100km per capita annually), a large group of nations cycling between 150–300km per capita annually, and two nations – Denmark and the Netherlands – with exceptionally high rates of 958km and 1019km per capita annually (see Table 14).

A study of interest compared the cycling rates of Canada and the USA (Pucher and Buehler, 2006). A notable feature of those nations with the highest cycling rates – the Netherlands, Denmark, Sweden, and Germany – is that they have the lowest cycling fatality rates (Pucher and Buehler, 2007). As the authors note (2007: 12):

The relative safety of cycling in the Netherlands, Denmark, and Germany helps explain the higher levels of cycling there, especially among women, children, and the elderly. Those groups are probably the most vulnerable and the most sensitive to traffic dangers (Garrard et al, 2008).

**Table 14 Cycling rates in the European Union**

Country	Cycles per 1000 inhabitants	Regular cyclists (at least once or twice a week) (%)	Occasional cyclists (1–3 times month) (%)	Total cyclists cycling at least 1–3 times per month	Distance per inhabitant per year (km)
Belgium	495	28.9	7	2,947,000	327
Denmark	980	50.1	8	2,489,000	958
Germany	900	32.2	10.9	29,585,000	300
Greece	200	7.5	1.8	779,000	91
Spain	231	4.4	3.9	2,613,000	24
France	367	8.1	6.3	6,584,000	87
Ireland	250	17.2	4	553,000	228
Italy	440	13.9	6.8	9,900,000	168
Luxembourg	430	4.1	9.7	44,000	40
Netherlands	1010	65.8	7.2	9,031,000	1019
Austria	381	-	-	-	154
Portugal	253	2.6	2.8	430,000	35
Finland	596	-	-	-	282
Sweden	463	-	-	-	300
United Kingdom	294	13.6	0.8	6,727,000	81

Source: Dekoster, J. and Schollaert, U. (1999) *Cycling: The Way Ahead for Towns and Cities*, Office for Official Publications of the European Community: Luxembourg.

Pucher and Buehler examined lessons for increasing cycling drawn from the experiences of the Netherlands, Denmark and Germany, stated (2008: 497):

With only a few exceptions, however, even the most bike-oriented cities in the UK, Australia, Canada and the USA generally have bike shares of travel that are lower than the least bike-oriented cities in the Netherlands, Denmark and Germany. No British, Canadian, Australian or American city even approaches the bike share of trips in most Dutch and Danish cities.

Goodman and Degman suggest for Melbourne (and as would apply to many other Australian towns and cities) (2008: 8):

At first glance, it might be considered unrealistic for Australian cities to aspire to European cycling rates. The difference between Melbourne and the cities of northern Europe are stark. Melbourne is a large, sprawling, dispersed and automobile dependent; European cities are typically small, dense and easily walked or cycled. However, not all of Melbourne is sprawling and dispersed, the older inner suburbs of Melbourne have conditions that are favourable to walking and cycling (DOI 2006:7), and compare well with cities such as Copenhagen which can boast cycling modes shares of over 30 per cent. All of Melbourne, but particularly the more densely settled inner areas, have potential for a substantially higher cycling mode share.

Further, Pucher and Buehler (2008) discount the influence of distance by stating that although it might be expected that Europeans cycle more than Americans because their trip distances are smaller ‘... both Americans and Britons cycle for only 2 per cent of their trips shorter than 2.5km, compared to 37 per cent in the Netherlands, 27 per cent in Denmark and 14 per cent in Germany’ (Pucher and Buehler, 2008: 498).

One clear indication that cycling rates could be higher in the future in Australian cities is that there were significantly higher in the past.

#### 2.4 'Shared space': an alternative to infrastructure?

Road safety has been founded on the 'triple-e' approach of engineering, enforcement, and education. When combined with the dominant position given to motorized transport in cities and towns in urban and transport planning, many of the basic contours of our urban transport system emerge. Conventional urban transport planning uses differentiated and exclusive access between modes usually under the general rationalizations of improved safety and efficiency, such as freeways for motor vehicles, roads for wheeled transport, buses on priority lanes, bicycles on bicycle paths and bicycle lanes, and pedestrians on footpaths. Urban streets, reflecting the dominant position given to motorized transport, have come to be the domain of cars and trucks, with active transport made to fit with the demands of motorized transport.

A strong design and operational component of these systems is regulated control of transport users through active technologies, rules and regulations, monitoring and surveillance, policing and enforcement. Recently, there has been a renewed interest in considering urban transport and urban design in its older, more integrated forms, and with an emphasis on control through passive design. This is perhaps best exemplified in the 'shared space' concept, as advocated by the late Hans Monderman in the Netherlands and across Europe more broadly.<sup>32</sup>

Typically, shared streets are created through the removal of existing 'traffic furniture', such as lane markers, signage, traffic lights, and barriers, and removing the distinctions between footpaths and roads. That such an idea originated in the Netherlands is not surprising as it extends the 'home zone' (*woonerf* in Dutch) concept, pioneered in the 1970s, that applied traffic calming measures to rescue residential streets for community use from traffic.<sup>33</sup> Instead of traffic calming through various forms of road hardware – speed humps, deflections, chicanes, and the like, shared streets emphasize urban design and psychological principles and an absence of devices and regulatory information to influence drivers. In shared streets, control and enforcement of behaviour don't assume their usual forms, but road safety is achieved through individual motorists and road users making their own decisions in a setting devoid of formal instructions and with such uncertainty and unpredictability. Not surprisingly, deprived of official protection, motor vehicles slow down greatly in streets that have a higher level of perceived risk for drivers and a higher 'cognitive load'.

Monderman found that such streets became safer and more efficient, despite an apparent increase in the risk of collisions. A key to Monerman's concept is that conditions require drivers to drive more slowly and road users to concentrate on crash avoidance. As the EU explain (Frysiân Province, 2005: 13):

The movements are unfocused, unpredictable, and relatively slow. In social spaces people's behaviour is largely determined by the physical environment and by the behaviour of others, and eye contact plays an important role.

Hamilton-Baillie explains that Monderman's approach is based in an understanding of psychology and cognition (2005: 57): '... single-purpose motorways and high-speed highways demand different cognitive skills to the complex human context of public space. The former requires standardized, simple, repetitive signs and signals. But if you treat the driver in the public realm like an idiot, you will foster idiotic driving.' First used by Monderman in 120 projects across Friesland in the early 1980s, the approach has been examined by the Congress for New Urbanism and by the EU in seven cities across Europe.<sup>34</sup>

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<sup>32</sup> In the Australian context, David Engwicht has promoted similar concepts; see, *Reclaiming our Cities and Towns: Better Living through Less Traffic* (1993), *Street Reclaiming: Creating Livable Streets and Vibrant Communities* (1999), and *Mental Speed Bumps: The Smarter Way to Tame Traffic* (2005).

<sup>33</sup> Professor Niek De Boer, a professor of urban planning at the Delft University of Technology and the University of Emmen developed the *woonerf* concept, subsequently taken up by the municipality of Delft in 1969, and later attracting national legislative support in the Netherlands; other nations have followed this lead.

<sup>34</sup> Details available at the EU-sponsored 'shared space' website at: <http://www.shared-space.org/>



There has been some broader consideration of the concept by the EU. In *Shared Space: Room for Everyone* (Frysiân Province, 2005: 10), which reviews the European experience: ‘Shared space strives towards a design and layout of public spaces where traffic, human exchange and other spatial functions are in balance. Shared Space requires a clear distinction between public space and highways.’ Something of this distinction is shown in the differences between the behaviour of drivers on highways and in public, with social behaviour being that conducted in shared spaces (see Table 15). Whereas public behaviour in public space is not guided by any programme, the behaviour on highways is characterized by the goal of quick and direct movement, and guided by road and traffic engineering signals. Spaces must be unambiguous as to their purpose so that there is a clear signal on the expected behaviour (Frysiân Province, 2005: 14):

In public spaces and where social traffic behaviour is required, enhancing the social character by accentuating spatial or natural elements is the most obvious choice. In traffic spaces the required traffic behaviour is encouraged by employing traffic-engineering tools.

**Table 15 Overview of the differences between social behaviour, social traffic behaviour, and traffic behaviour**

	<b>Social behaviour</b>	<b>Social traffic behaviour</b>	<b>Technical cum legal traffic behaviour</b>
<b>Characteristics of behaviour</b>	Pluriform and pluralistic	Pluralistic	Uniform
<b>Movement mode</b>	Unfocussed	Largely focused	Extremely focused
<b>Appropriate speed</b>	<30kph	<50kph	>50kph
<b>Predictability of behaviour</b>	Largely unpredictable	Limited predictability	Largely predictable
<b>Eye contact</b>	Frequent	Limited	Minimal
<b>Determinants of behaviour</b>	Social environment (people) and physical environment	Social environment (people) and physical environment + basic traffic rules	Control system – traffic engineering and legal system (vehicles and traffic engineering environment, road markings and road signs)
<b>Behaviour expected of other road users</b>	Social behaviour	Social behaviour with legal and technical constraints	Technical and regulated traffic behaviour
<b>Signals from spatial layout that are relevant to behaviour</b>	Context of built and natural environment	Built environment, design of public space, road design, contextual references	Signals, traffic signs and lights, traffic lights, speed-humps, instructions from authorities

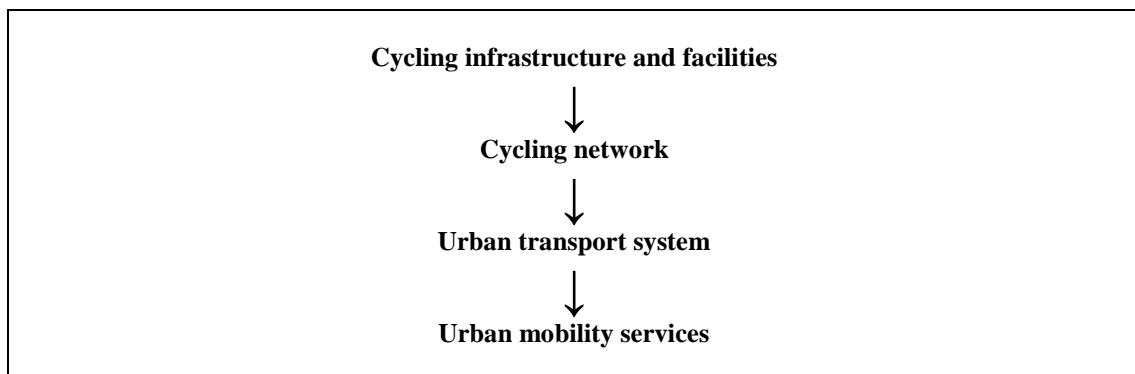
Source: Frysiân Province (2005) *Shared Space: Room for Everyone: A New Vision for Public Spaces*. Frysiân Province: Leeuwarden, The Netherlands.

## 2.5 *Cycling within an integrated urban transport system*

There would appear to be considerable variation in the extent to which the location of bicycling infrastructure has been determined by research and investigation; some facilities are the result of conventional transportation planning techniques, while others are the serendipitous result of the conversion of existing paths and thoroughfares. Locating bicycle infrastructure is a difficult problem for planners as conventional techniques developed for motor vehicles and pedestrians are often of limited suitability for bicycles. Data on bicycle traffic is generally very sparse in Australia. Further, existing bicycle use indicates little of potential – i.e., the problem of determining suppressed or latent demand.

Transport planning approaches, such as the ‘origin-destination’ type, can be used in decisions for infrastructure location. In practice, these are often applied in an abbreviated form that seeks to provide services to high-demand destinations from a small number of locations where smaller volume routes congregate. Bicycle-specific infrastructure networks have developed incrementally and often haphazardly, shaped by the location of existing paths, local interests and opportunistic local government funding, and as a result of local urban developments that included provision for cycling. As a result, the ‘network’ in most cities does not exhibit the convenience, directness, interconnectivity, extent, and density of coverage that the term might be denote.

Achieving a significant modal share for cycling in Australian cities is unlikely to be achieved by the piecemeal approach adopted to date by making marginal additions to the existing fragmented networks of cycling infrastructure. Rather, cycling must become part of an integrated approach to urban mobility, as depicted in Figure 4 below.



**Figure 4 Cycling infrastructure and the hierarchy of urban mobility**

Australian consideration of the possibilities of integrating cycling into urban transport systems lags behind known best practice; largely, cycling infrastructure has been considered in isolation from the overall urban transport system. This is hardly surprising since until fairly recently, cycling-specific infrastructure was almost exclusively for recreational purposes and that overall urban transport integration is generally poorly developed in Australia (see, e.g. Glover, 2007).

Integration of cycling with public transport offers a number of benefits. Combining public transport with cycling increases the efficacy of both modes, extending the mobility ‘reach’ of the traveller. Cycling also extends the catchment area for public transport by giving greater access to rail, light rail, and bus stations and stops. As a result of the speed advantage of the cyclist over the pedestrian, the catchment area with 10 minutes travelling time from a public transport stop is sixteen times greater (as shown by Dekoster and Schollaert (1999), see Table 16 below). An obvious benefit of such combined trips is to promote public transport, an essential step in promoting an environmentally sustainable transport system. Based on European experience, those places with high levels of cycling also have a high proportion of trips to/from train stations (Bauman et al, 2008). Bauman et al (2008: 17) identify three key areas for promoting greater integration of cycling and public transport:

- Safe bicycle routes to public transport
- Secure bicycle parking, and
- Taking bicycles on public transport.

**Table 16 ‘Reach’ of active transport: speed, distance, and catchment area: walking and cycling**

Mode	Average speed (km/h)	Distance covered in 10 minutes (km)	Catchment area (sqkm)
Walk	5	0.8	2
Bicycle	20	3.2	32

Source: Dekoster, J. and Schollaert, U. (1999) *Cycling: The Way Ahead for Towns and Cities*, Office for Official Publications of the European Community: Luxembourg.

Martens’ (2004, 2007) reviews of cycling as a ‘feeder’ mode provides a number of insights from the most successful applications. One relevant lesson for Australian cities (Martens, 2007: 336):

First, the lack of attention for the bicycle as a feeder mode for public transport trips even in a country like the Netherlands suggests that measures to promote bike-and-ride are hardly likely to be implemented without an explicit bike-and-ride policy.

Successful transport integration requires coordinated activity from relevant institutions. In Martens’ review of Dutch experience with bike-and-ride, he identifies the problem in the Netherlands that is surely close to a universal need for public policy reform, namely that effective action requires institutional ‘ownership’ of the problem (2007: 336):

Especially in the case of slower public transport modes, none of the involved authorities – public transport operators, municipalities, road authorities, or the national government – considered access and egress trips to public transport stops their responsibility.

Martens’ observation is particularly pertinent in Australia, where even bicycle transport planning has given little regard to the bike-and-ride concept. Bicycle planning has been as narrowly cast as the ‘other’ transport mode and the opportunities for linked modal transport have not been systematically or thoroughly pursued. Certainly those institutions dealing with the planning and operations of the other components of the transport sector have given little consideration to integration with cycling.

Scale is an important influence on the types of planning decisions to be considered in integrated transport, with different policy actors being involved at different levels. Whether considered at the local or city-wide scale or in the context of the transport system within a city, determines the types of issues and problems being addressed; an example of these differences and of some of the planning issues for cycling infrastructure involved is shown in Table 17.

**Table 17 Cycling infrastructure and urban and transport planning**

Scale	Sphere of interest	Planning considerations (examples)
Local [Individual point-to-point cycling trip]	Facilities	<ul style="list-style-type: none"> <li>• Separate vs. segregated</li> <li>• Bicycle access to local locations</li> <li>• End-of-trip facilities</li> <li>• Bicycle parking/storage</li> <li>• Facilities design</li> <li>• Signage</li> </ul>
Transport [Multiple trips, multiple trip purposes, route choices]	Routes	<ul style="list-style-type: none"> <li>• Transport ‘catchments’</li> <li>• Contribution to network</li> <li>• Level of demand and capacity Requirements</li> <li>• Primary role of route</li> <li>• Network coverage/coherence/density</li> <li>• Information services</li> </ul>
	Interaction with road network	<ul style="list-style-type: none"> <li>• Intersections of bicycle lanes/paths and public roads</li> </ul>
Urban [Opportunities for multi-modal trips]	Transport networks	<ul style="list-style-type: none"> <li>• Integration with urban transport system</li> </ul>

## 2.6 *Other measures to support increased cycling*

In the debate over cycling infrastructure greatest attention is focussed on the provision of cycling-specific infrastructure, but there are many practices involving the existing road system that can greatly improve cycling conditions regardless of the whether or not there is high-quality and extensive cycling infrastructure. This Working Paper is concerned with the question of cycling infrastructure, but it is worth identifying at least those issues that have received some attention as being measures that can improve conditions for cycling and as such could reinforce the effect of cycling infrastructure.

### *Low urban motor vehicle speed limits*

Although in this Working Paper we are concerned with cycling infrastructure, and in particular its capacity as a way to encourage greater participation rates and its influence on safety, we can also draw some lessons from cities with high cycling rates and little cycling-specific infrastructure. Many Asian cities, for example, have high levels of cycling with little cycling-specific infrastructure. Indeed, in many large Asian cities, cycling infrastructure appears to have been introduced to facilitate growing numbers of motor vehicles in places where active transport modes were the dominant mode, so that bicycle lanes and bicycle paths were introduced in order to clear the streets for motorized traffic.

Cycling – and motorized two-wheelers – provides essential mobility for economic services for individuals, families, small businesses, and the self-employed in these often busy and crowded cities. Many of these cities are without formal cycling-specific infrastructure, so that cyclists and all other modes necessarily share the road space, frequently including pedestrians. Clearly, there are considerable risks to all – and especially to vulnerable road users – as shown by the traffic accident rates in developing nations,<sup>35</sup> but this is often offset by the low speeds due to congestion, narrow roads, and the not inconsiderable skills of those involved. Vehicle speeds are low on the highly congested streets and while the risk of collision is high, the level of trauma of collisions in these circumstances is relatively low because the speed of motor vehicles is low. Without accompanying changes to road conditions, congestion relief that aims to increase the speeds of motor vehicles increases the risks and the severity of road trauma when collisions occur. A contributing factor is that mixtures of different modes in low-speed traffic begin to separate into lower- and higher-speed groups as overall traffic speed increases. Safety is not governed not so much by the provision of special infrastructure for controlling the movement and direction of vehicles and pedestrians, in these congested urban streets, but by the low speed of all traffic.

On these often seemingly chaotic roads, there is a lesson that the role of cycling infrastructure in Australia and developed countries is the expression of an intention not only to offer cyclists a zone of ‘safe’ and exclusive use but also to preserve the norms of road use for motorized vehicles. What is happening in the crowded streets of Asia’s developing cities is a form of democratization of the road space. Vehicle speed is of importance here; however we understand the risks of cycling on roads, there can be no argument that the risks to cyclists increase as motor vehicle speeds increase. If all vehicle speeds were restricted to those of cyclists, then cycling would be considerably safer.

Although reducing urban speed limits is often controversial and subject to competing claims, the case that lower speeds improve road safety for all road users is unequivocal and not contested by any of Australia’s state or federal road and traffic authorities. As the WHO state (WHO, 2004: 76): ‘The speed of motor vehicles is at the core of the road injury problem. Speed influences both crash risk and crash consequences.’ Several reasons are usually cited for this relationship: crash energy and impacts speeds are greater when vehicle speed is higher; driver reaction times and vehicle braking distances increase with vehicle speed; loss of control over the vehicle increases with vehicle speed; and drivers’ estimation of the speeds of approaching high-speed vehicles are more likely to erroneous.

Higher vehicle speeds result in proportionally higher fatality rates in collisions with pedestrians; there is a point of inflexion around the 30kph in injury levels and severity, at vehicle speeds higher than this, pedestrian injuries increase rapidly (WHO, 2004: Chapter 3).<sup>36</sup> This relationship also applies to

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<sup>35</sup> See, e.g., WHO (2004).

<sup>36</sup> Broadly, the probability of serious road injury is proportional to the cube of vehicle speed; for every increase in mean traffic speed of 1 per cent, the increase in crashes producing injuries is 3 per cent, and conversely by the same proportion are injuries diminished by reducing speeds by 1 per cent; see the WHO report *World Report on Road Traffic Injury Prevention* (WHO, 2004) for a review of this evidence. Broadly speaking, the consensus position from the research literature is that the risk

cyclists, although there is less available research on this issue. One factor in lower crash rates between slower vehicles and cars on streets with lower speed limits is the lower speed differentials. Put simply, roads with lower speed limits have fewer crashes and have crashes of lower severity than those with higher speed limits; slower vehicle speeds make roads 'safer', but not 'safe'.

Hutchinson et al (2007: 8) in examining cycle crashes in South Australia stated of the issue of speed and crashes:

But there has been a revolution in attitude over the past 10 years, with increasingly strong belief that a worthwhile reduction in risk will accompany even small reductions in speed. This change of attitude came about because of the case-control studies of Kloeden et al (1997; 2001; 2002).

Studies, such as by Richer et al (2006) and Hutchinson et al (2007), have highlighted the increase in injury severity to cyclists when colliding with vehicles travelling at higher speeds, leading the latter to conclude of efforts to improve cycling safety (Hutchinson et al, 2007: 8):

But empirical evidence (notably the case-control studies already cited) and theory (reaction distances, stopping distances, speeds at impact) both point to choice of a slightly lower speed as being the easiest method at present of achieving improved safety. We include the word 'safety' to emphasise that improved safety can be achieved with an utterly negligible increase in travelling time.

It is axiomatic that lower speed limits will make roads more attractive to cyclists. There are other benefits of slow street speeds, such as the promotion of walking by children, reduced GHG and vehicle emissions, and the creation of more 'convivial' streets.

What then, is a 'low urban speed limit'? In Australia, state and territorial legislatures set urban speed limit policies, with delegated traffic and road authorities applying these policies; in built-up areas, 50kph has now become the default urban speed limit – revised downward from 60kph between 1997 and 2003 (Woolley, 2005). Lower speed limits apply in specific locations, such as near schools and hospitals, with a range of local and state differences. Around the world there have been numerous debates and initiatives in addressing urban speed limits, with considerable interest in a 30kph limit for residential areas. As advocates for such a limit point out, the 30kph limit can be related directly to the research on pedestrian trauma from collisions with motor vehicles (see, e.g. Pilkington, 2000).

Research has demonstrated that, worldwide, lowered speed limits reduce the incidence and severity of casualty crashes (see, e.g., the review by Richter et al, 2006). Within Australia, the introduction of 50kph speed limits in former 60kph areas lowered road trauma (see, e.g., the review by Woolley, 2005) and there is now a body of experience in Europe and elsewhere with low urban speed limits. Sammer (1997) reviews the experiences of Graz, Australia with 30kph speed limits, one of the 'early adopters' of these limits. In 1992, Graz introduced the 30kph speed limit on residential streets – and in front of schools and hospitals, covering about 80 per cent of the city – and set a 50kph limit for priority roads. Although there are now many towns and cities with 30kph speed limits, notably in Northern Europe and the UK, there is no database of these regulations.

Several studies evaluating the effect of these lowered speed limits and traffic calming on road trauma have identified reductions in the level and extent of pedestrian injury and fatalities (e.g., Bunn et al, 2003). Following the revision of urban speed limits in Australia to 50kph there have been reviews of the results with general findings of reduced levels and severity of road crashes (Archer et al, 2008; Woolley, 2005). Other benefits result from lower speed limits include reduced fuel consumption, higher vehicle energy efficiency, lower noise levels, and lower vehicle operating costs (Archer et al, 2008). Vehicle emissions, including GHG emissions, are likely to be lower with lower speeds, but there are a number of complicating factors, such as the extent and type of acceleration and the extent of cruising speeds, that make generalizations difficult (Archer et al, 2008).

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of death for pedestrians in collisions with motor vehicles is 10 per cent at around a vehicle speed of 30kph and 100 per cent occurs between 50–60kph.

There has been some interest from local governments and non-government organizations in Australia in setting lower default speed limits in built-up areas. For example, four inner-city local governments (Melbourne, Port Phillip, Stonington, and Yarra) and health groups formed the Safe Speed Forum in 2008 seeking a blanket 40kph speed limit (Cooper, 2008). However, the next day, the Victorian state Minister for Roads rejected the concept (Lucas, 2008).

Road design changes can reduce vehicle speeds without need to formally change the formal speed limits, such as through the addition of roundabouts at street intersections, speed humps, road narrowing, and measures that reduce the driver's line of sight. Sometimes these measures are known as 'Local Area Traffic Management' (LATMs) approaches. It is believed that LATMs are necessary to accompany lower speed limits – such as 40kph limits near schools and hospitals – in order to ensure their effectiveness.

In some regards such approaches are preferable to low speed limits as these are often, one might say routinely, exceeded by motorists when the conditions 'encourage' speeding. Speed limits can be enforced to ensure their effectiveness, but the costs and practicalities of speed limit enforcement are such that speeding in Australia is widespread and the rate of detection and prosecution is minor.

#### *Urban planning and urban design*

Planning and design is of particular importance in shaping active transport and can complement or undermine the influence of cycling infrastructure in encouraging greater cycling. Further, we note that urban planning in this context involves the integration of land use and transport planning. Neighbourhood and local planning exerts a strong influence on the conditions for local cycling, such as for shopping, local services, and access to schools. Broader urban planning influences the distribution of major new centres of employment, commercial activity, and housing and therefore determines a high proportion of trip origins and destinations, particularly for commuting and regular journeys. Urban planning also determines the proximity and access between different transport modes, such as the location of public transport stations and access routes. Urban planning shapes the location of open space and access to recreational areas. These factors influence a wide array of cycling choices and opportunities for cycling, especially utilitarian cycling.

Australia has generally performed poorly in integrating urban planning and transport planning; much of the urban growth in Australian cities occurs on the periphery and these new developments rarely have access to public transport. Further, the overall pattern of urban growth has been based on land use planning that has promoted and fostered urban car dependency. Residential and commercial land uses under urban planning have been usually widely separated with strict uniformity of land use within specific land use zones. While some experts object to the term and contest that it applies to Australian cities, most urban planning commentators consider that Australian cities are blighted by the phenomenon of urban sprawl.

Urban design and local area transport planning has performed quite poorly in Australia in promoting local areas that are suitable and encouraging of active transport. For the most part, Australian cities have given an absolute priority to the private motorcar at the local scale – as well as at the city-wide scale. Research has shown that suburbs with better public transport facilities and/or access to recreational areas have higher rates of active transport and higher rates of physical activity by their inhabitants (see, e.g., Pucher and Buehler, 2006).

There are many innovative and progressive examples of urban planning and urban design that have improved the conditions for cycling, and these successes should not be overlooked. However, it remains the case that such places are exceptions and that for the most part, Australian governments, particularly at the state and local level, are vigorously promoting car dependency through their use of urban planning and urban design decisions.

#### *Role of laws and regulations: behaviour control, enforcement, and liability*

An often-neglected issue in the debate over cycling in general and cycling infrastructure in particular is the role of regulation, as it pertains to roads and traffic and to cyclists and cycling facilities. To state the obvious, when we consider cycling infrastructure we make a number of assumptions about its use, usually on the basis of local experience, and we tend to overlook the institutions and regulations that seek to govern our conduct and use of these facilities. A considerable body of law and regulation

governs and controls the urban road system, the use of road vehicles, and to the use of cycling infrastructure and defines the roles of key institutions.

Pucher and Dijkstra's (2003) review of best practice in Germany and the Netherlands includes traffic regulations and enforcement and notes:

- Traffic regulations offer strong protection to pedestrians and cyclists
- In collisions between children/the elderly and motor vehicles, the motorist is usually found to be at fault – the police and courts consider that motorists should anticipate unsafe and illegal walking and cycling
- Strict rule enforcement for all road users, including pedestrians
- Penalties for traffic violations tend to be high, and
- Violations against pedestrians and cyclists are considered as serious traffic offences.

Here, the authors support a regulatory system that is stricter and one that offers stronger legal protection to vulnerable road users.

Among cycling advocates in Australia there is interest in increasing the legal protection available to cyclists as road users. Although this is complex matter, there are some basic principles being espoused to redress the imbalance between vulnerable road users and motor vehicles through the rule of law and use of regulations.

#### *Recognition of the rights of active transport modes to public road use*

Underlying many of the decisions over urban design, transport policy, and transport and land use planning in Australia is the presumption that public roads are primarily preserve of motor vehicles. Although cyclists might enjoy the legal status of bicycles as road-using vehicles, the perception that bicycles are inferior to motor vehicles underlies several of issues identified above, such as street design and layout, and setting speed limits, which clearly favour motor vehicles. Litman (2004) has examined this issue – in the North American context – and the assumptions that motor vehicles are more important to society than non-motorized modes. Points identified by Litman include the observation that motor vehicle transport receives considerable financial subsidies from all taxpayers, so that pedestrians and cyclists pay a far greater amount for the road system than motor vehicle users by virtue of the small costs they impose on the roadways. On a journey basis, cycling exhibits several economic, social, and environmental advantages over motor vehicle use (as outlined above), which is at odds with decisions that axiomatically give motor vehicles priority in design, resource allocation, and operational matters. Motor vehicle users also benefit from investments in cycling, as any displacement of motor vehicle use typically improves the conditions for driving through reduced peak-hour congestion and less competition for parking. Given that cycling is typically an inner-city phenomenon in Australian cities, both motorists and public transport users enjoy the benefits created by cycling in the areas where competition for road and seating space is at its highest.

### *2.7 Data and knowledge base on cycling*

Data and information availability on cycling in Australia, as indicated in this review, is not particularly well developed; there are many key policy issues for which we have very little empirical knowledge. Many of the Australian studies on cycling have had to apply international information.

Goodman and Degman, in commenting on this issue for cycling in Melbourne, make a case that could readily apply to other urban centres in Australia (2008: 13): 'Just as the lack of quantifiable goals limits the effectiveness of policy, the lack of empirical measurements limits the ability of planners to justify the policies chosen.' Three consequences result: 1) The numbers of cyclists was largely unknown until recently, leading to neglect of cycling in infrastructure provision; 2) An absence of cost-benefit studies to justify investment in cycling infrastructure; and 3) 'There is considerable controversy over whether on-road bicycle lanes – and on-road cycling without lanes – are more cost-effective and safer than off-road cycling lanes' (Goodman and Degman, 2008: 14).

### 3 Discussion and Conclusions

#### 3.1. *A model for the future of urban cycling*

Although cycling is usually considered as having a set of distinguishing characteristics requiring of special attention in transport and urban planning policy, it is difficult to avoid the conclusion that many of the key debates are cycling-specific versions of larger transport debates. To begin, if cycling is to serve an expanded urban transport role, then it must be part of the urban transport system and not left as a residual issue, as primarily recreational, or as an impediment to motorized transport. In principle, urban roads need to be planned, designed, and managed so as to meet the requirements for all users, and reconciliations achieved between bicycles, motor vehicles, and other transport modes. An important aspect of this reconciliation is the need to lower the risks to the vulnerable users, namely cyclists and pedestrians.

If the goal of cycling in sustainable transport strategies is to greatly increase its popularity for utilitarian purposes, then the following assumptions are proposed:

- Cycling must replace a significant portion of motorized urban journeys
- Mode-shifting from motor vehicles to cycling will largely depend on attracting new participants to cycling and encouraging existing cyclists to undertake more journeys by bicycle
- That inexperienced cyclists consider the risks of cycling as a major barrier to participation
- That inexperienced cyclists perceive dedicated cycle paths as being safer than sharing the road with motor vehicles under current road conditions
- That cycle paths currently only serve a small portion of cyclists' needs
- That only the existing road network can provide the network of routes required to facilitate the majority of intended journeys by bicycle
- That dedicated cycling infrastructure is relatively expensive to provide, and
- Cycling must be effectively integrated into the public transport system.

Against these assumptions, the current system of cycling infrastructure cannot deliver greatly increased cycling rates for several reasons. First, inexperienced cyclists will not tackle the road network as it currently operates, largely because of fear. Second, we do not have much of a bicycle path network in most major cities; further, many of the most popular routes are not dedicated bicycle paths, but shared paths with pedestrians, so that increasing cycling use poses increased risks. These bicycle paths, for the most part, have not been planned to provide a network. Third, the provision of a significant amount of new cycling infrastructure is very unlikely to occur either quickly or comprehensively; more likely, there will continue to be ad hoc and incremental additions.

It follows that the proposed model for cycling infrastructure represents a practical compromise for promoting cycling in Australian cities, based on research findings and relevant best-practices from around the world (see Table 18). There are three key elements to this model: urban networks of bicycle paths, safer urban streets for cyclists, and integration between cycling and public transport.

Essentially, this model recognizes that bicycle paths play an important role in providing a means for introducing entrants to utilitarian cycling and can provide a means to connect popular origins and destinations. However, bicycle paths can only provide for a minority of cycling journeys in Australian cities at this time and in the immediate future, although they can serve an important role for high-volume routes if they provide a level of service equal to their task. Bicycle paths are popular routes for journeys to work in the major cities, despite the limitations of some being shared paths and many not providing sufficient levels of service or safety. To be effective, bicycle paths must be of sufficient design, construction, and maintenance that they provide a necessary level of service. These paths need to serve popular routes. Based on best-practice lessons, we know that cities of similar forms and functions to Australian cities achieve high levels of cycling through such dedicated infrastructure. One advantage of such facilities is that they address the major barrier to new entrants to cycling, concerns over sharing roads with motor vehicles.



**Table 18 A model for cycling infrastructure and lower speed limits to promote greatly increased utilitarian cycling in Australian cities.**

Urban street speed limit	Infrastructure requirements	Trade-offs
Proposed: <ul style="list-style-type: none"> <li>• Low street speed limit*</li> <li>• Expanded cycling-specific infrastructure</li> <li>• Integration with public transport</li> </ul> (*Nominally 30kph)	Dedicated bicycle paths and lanes for high-volume routes; the rest of the suburban road system is shared between bicycles and motor vehicles	Higher risks for inexperienced cyclists on road system; Nearly all the existing road system offers a dense network for cyclists with greater safety than at present
Current Situation: <ul style="list-style-type: none"> <li>• High street speed limit</li> <li>• Limited bicycle paths</li> <li>• Limited shared paths</li> <li>• Limited on-road bicycle lanes</li> <li>• Little integration with public transport</li> </ul>	Road system is a barrier to new cyclists; Bicycle paths comprising a network between popular origins and destinations	Bicycle paths are attractive to inexperienced cyclists wanting to make a restricted set of journeys; Intersections with the road system may be high-risk sites

Yet, in order to provide access to cyclists across the urban landscape, there must be full use of the existing street network. Whether or not these streets are currently safe or unsafe is the same problem as determining whether cycling is safe or unsafe; there are no absolute answers, but research and experience does tell us about selected actions that influence cycling safety. Attracting and retaining greater numbers of cyclists in urban transport will necessitate Australia's streets being made safer for vulnerable users at all times and under all circumstances – and such changes must be obvious to all. Research into cycling safety shows it to be considerably safer when there are greater numbers of cyclists. Introducing large numbers of inexperienced cyclists into the existing urban road system, however, would seemingly expose those least well-experienced to hazardous conditions. We consider that the key to exploiting the potential of cycling depends on making the existing road network safer and to achieve this goal, the most obvious and proven approach is to reduce urban street speed limits to 30kph universally and without exception. Low vehicle speeds on public roads in residential areas will make cycling is safer than at present.

As a consequence of cycling being neglected in Australian urban and transport planning, there has been little consideration of its integration with public transport. In contrast, best-practice cities have comprehensive integration between cycling and public transport. Both cycling and public transport are key aspects to a sustainable transport system and both will benefit from closer coupling. There are several aspects to this integration, but the most obvious is providing bicycle parking and storage at public transport stations and interchanges and provisions for taking bicycles on public transport vehicles. Bicycle parking and storage can also be provided at key bus stops. Popular locations in the cities can also be provided with bicycle parking.

*A balance of segregation and integration is needed*

This model is a compromise between several different positions, based on a precautionary approach to the insights from available research. A balanced approach is advocated to achieve a balance between segregated facilities and those integrated with the road system. Dedicated bicycle paths are supported because they are effective when in the right location and of sufficient quality; they are essential for introducing new cyclists to cycling. Bicycle paths and dedicated cycling lanes are perceived as being safer than roads – notably by inexperienced cyclists – although, at this time, we consider that there is insufficient evidence to establish the validity of this perception. Notably, this belief is also promulgated by federal, state, and local government officials supporting cycling infrastructure funding and projects. (It seems likely that the bicycle paths are relatively safe, but the points at which paths and roads intersect are of concern, making the overall evaluation of these facilities difficult.) Research is clear that lower speeds mean fewer and less severe road crashes. Slower speeds on built-up roads are supported because this is proven to make cycling and walking safer and, in the longer term, will enable a more equitable and balanced sharing of roads between cyclists and motorized transport – and other

urban uses. Cyclists include categories of people who require particular protection, notably children and the elderly. Road safety must strive to give protection to all users and not be built around assumptions that all cyclists are, or should, be male, athletic, mature, and experienced and skilful. A safe cycling network should not need to depend on the highest expression of skills and judgement by cyclists so as to avoid crashes, rather, the system should be able to function under the understanding that cyclists are fallible to misjudgements, miscalculations, carelessness, and so on. Current concerns of non-cyclists that the roads are dangerous to cyclists are not unreasonable; therefore, slower and safer roads are essential for greater urban cycling in the future.

Addressing the issue of 'segregation versus integration' is, perhaps, a secondary matter to be resolved after a greater effort is directed at the issue of bringing a greater 'democratization' of urban mobility resources within Australian towns and cities. Our presumption that the primary mode for mass mobility is the private motorcar is one that results in diminished resources and opportunities for public and active transport. By introducing slower road speeds, the opportunities for cycling would be greatly expanded. If the majority of Australian cities were subject to the traffic calming of low speeds, integration of cycling into the road network would greatly enhance the opportunities and capacities for cycling. Following the advice of Godefrooij (1997) and the examples of Northern European cities with high cycling rates, those roads where motor vehicle traffic is of high volume and high speed present unacceptably high risks for cycle-motor vehicle collisions and bicycle paths are needed to segregate bicycles from motor vehicles.

Bicycle lanes on existing roads, perhaps the most contentious aspect of the cycling infrastructure debate, are considered in this Working Paper to be of far less importance than the other initiatives of expanding cycling paths and reducing road speeds. Here, the litmus test must be that of whether on-road cycling lanes reduce the risks to cyclists. On the evidence examined in this Working Paper, it appears that the jury is still out and still divided – we simply don't know whether the risks to cyclist are reduced, increased, or a mixture of the two depending on circumstances. One fact is clear, however, namely that the risks and consequences of collisions between cyclists and motor vehicles on roads with bicycle lanes would be smaller if the default urban speed limit was reduced to 30kph across Australia.

Adopting a precautionary approach to the issue leads to the guiding principle of only creating such lanes when there is sufficient width and other requirements to enable the cyclist to ride safely. Critics' concerns that narrow cycle lanes place cyclists between close speeding traffic and on a course that places them into the realm of opening doors of parked cars are surely justified on the grounds of common sense in most on-road bicycle lane locations in Australian cities. That most bicycle lanes seem designed for the benefit of cars is a claim with some credence: the case for greater use of on-road bicycle lanes with current high speed limits seems poorly founded. Our interpretation of the available evidence and international experience is that the safest cycling occurs when there are many cyclists using the roads and that traffic speeds are quite slow. If vehicle speeds are low, then on-road cycling lanes should be less necessary.

Treatment of intersections between roadways and cycle lanes/paths to reduce these locations of higher risk collisions is required. There are a number of solutions available, but these have not been implemented to a high degree. Greater attention therefore needs to be given to these locations.

That other contentious issue, the role of paths shared between pedestrians and cyclists, needs resolution. On shared paths pedestrians are the vulnerable users – particularly children and the elderly – with the likelihood of cyclist/pedestrian conflicts increasing with density of use. Simply put, the use of shared paths for high-volume and higher-speed cycling is a dangerous practice and such paths should not be part of a cycling network, but used for low volume, recreational cycling only. Our goal in promoting sustainable transport is that the safety of walkers and cyclists must be increased and this is not possible using shared paths as primary routes in a network of cycling paths. A high priority for infrastructure spending on cycling must go to creating separate facilities for pedestrians and cyclists on those few high-volume shared paths. If one consequence of such decisions is that cyclists are removed from the more scenic and rustic routes and these are left as the domain of pedestrians, then that must be seen as a fair compromise on the part of cyclists.

#### *On the role for greater investment in infrastructure*

Given that cycling would seem to have the greatest immediate potential for displacing short-distance vehicular trips that are so common in Australia, the case for a dense network of cycling routes and for

small-scale local facilities is strong – such as in shopping centres, commercial areas, medical and educational centres. Our conceptions of planning need to incorporate more thoroughly and consistently the issues associated with the concentration of activities and matching these to mobility planning. To some extent, we consider the trips associated with local destinations to have a largely discretionary character. Yet to make significant reduction in motorized urban transport, active transport needs to displace motorized transport for longer journeys and less discretionary trips. For the larger Australian cities, around one-half of the population is in the workforce and around 40 per cent travel to work, so that commuting remains highly influential in urban transport. Ultimately, such changes involve substantial changes in urban and transport planning and, no doubt, considerable changes in social preferences, community values, and such matters. Yet, cycling planning can make a contribution to reducing motorized commuting through integrating cycling with public transport.

#### *Promoting a urban network for cycling*

Too much of debate about cycling infrastructure has concentrated on cycling-specific investments to the exclusion of the needs of cyclists on public roads who currently have only the routine functioning of the road services designed for motorists for their needs. These two ways of cycling are part of the single urban cycling experience; it makes sense that we ought to think about bicycle transport in ways that broaden our understanding of what constitutes the needs of cyclists. In effect, there should not be two cycling systems, one formal, planned, and receiving investment and the other, informal, unplanned, and receiving no investment to serve the needs of cyclists. Rather, there should be single cycling networks in our cities comprising a range of facilities suited for specific purposes, users, and locations. Essential to developing such networks is having a planning and design process, working to established plans, and revising and adapting these plans as necessary; we have some excellent examples within this country that can serve as guide for others.

An integrated cycling network does not exist for its own sake, but as the means to enable cycling mobility. It is important, therefore, to consider the infrastructure as being nested in this realm: Cycling Infrastructure and Facilities–Cycling Network–Urban Transport System–Mobility Services.

### *3.2. A final word – on the need for change*

Cycling has attracted public attention far above that which is justified by its current contribution to urban transport. This situation can be read in different ways. Negatively, it implies that the nation may be wasting its time and effort in promoting cycling as a transport mode. Positively, it suggests that there are at least some of the foundations for increasing cycling rates to the levels where cycling makes a significant contribution to urban mobility, something that has been achieved by leading cities in other parts of the world.

However, by definition, the challenge of transforming Australia's urban transport system cannot depend on existing trends. If Australian cities are to move towards the goal of sustainable transport, almost regardless of what form the realization of this goal takes, high use of active transport modes will be essential. Urban mobility for short journeys using exogenous energy is most likely to become an artefact of an era when transport energy was cheap, abundant, and used without regard to its social and environmental consequences. And that era is drawing to a close.

In this context, our challenge is simply that of finding ways to make this aspect of the transformation of the transport system happen. Although there is debate over how to achieve this goal, we do at least have an understanding of at least some of the essential components, and in particular of some of the important issues in cycling infrastructure investments. Technical solutions are important, but these require the other components of change to be engaged, such as plans and policies, effective public institutions, education and awareness-raising for cyclists and drivers, law enforcement and a legal system that more thoroughly protects the interests of cyclists, access to public transport, and adequate funding and other resources. But unpinning these solutions is the need for cultural change. As a broader community we need to consider how we value our time, the condition of the environment, and our own physical and mental health. Greater cycling by more people, more often, is not an approach to urban mobility that erodes the opportunities for movement, but it can be one that enhances urban life and the human experience.

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## Appendices

### Appendix I

#### Short-distance car travel in Australian cities

There is considerable interest in the proportion of short distance car travel in Australian cities and a wide variety of trip distances are quoted (as shown in Table A.1). In many instances, it is not possible to locate the source materials for these estimates. As a generalization, one-third of urban car trips are less than 3km and almost one-half are less than 5km.

**Table A.1 Motorcar travel in selected Australian cities: short distance travel**

	Proportion of trips less than 3km (%)	Proportion of trips less than 5km (%)
Brisbane <sup>(1)</sup>	29	45
Melbourne <sup>(2)</sup>	37	53
Perth <sup>(3)</sup>	32	48
Sydney <sup>(4)</sup>	25	42

Sources:

1 Queensland Transport, *South East Queensland Travel Survey, 2004–04*.

2 Transport Research Centre *Victorian Activity and Travel Survey, 1994–1999*, Melbourne: RMIT University.

3 Socialdata Australia (2000) Potential Analysis 'Perth', Department of Transport, Western Australia.

4 Transport and Population Data Centre, *2002 Household Travel Survey*, Sydney.

**Appendix II**  
**Advocacy organizations: resources and information sources (Australia)**

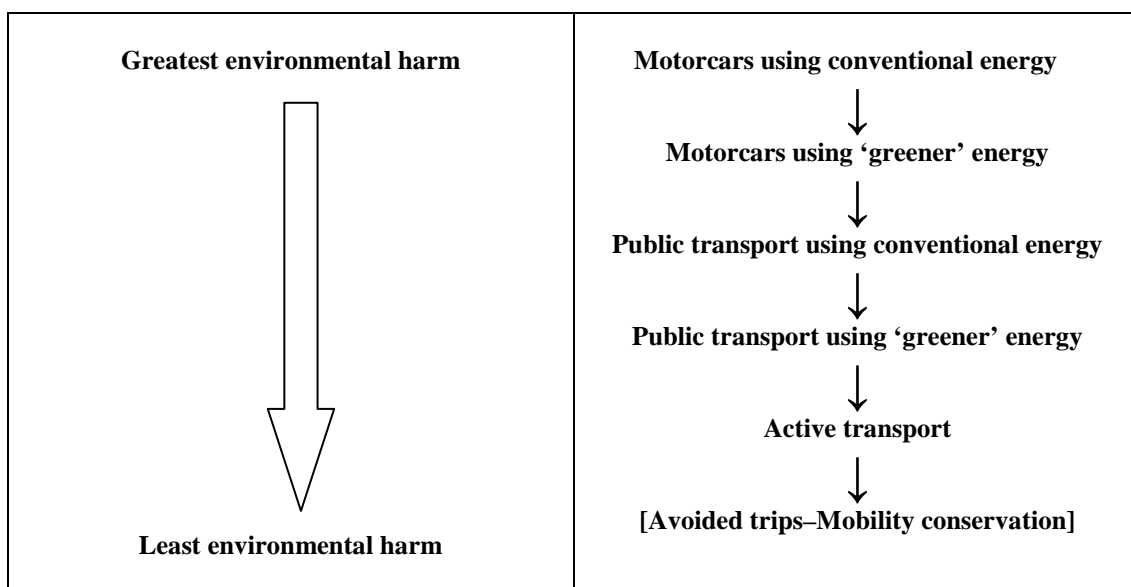
**Table A.2 Advocacy organizations: resources and information sources (Australia)**

<b>Scope</b>	<b>Organization</b>	<b>Internet address</b>
National	Australian Bicycle Council	<a href="http://www.austroads.com.au/abc/">http://www.austroads.com.au/abc/</a>
National	The Bicycle Federation of Australia	<a href="http://www.bfa.asn.au/">http://www.bfa.asn.au/</a>
National	Cycling Australia	<a href="http://www.cycling.org.au">http://www.cycling.org.au</a>
National	Cycling Promotion Fund	<a href="http://www.cyclingpromotion.com.au">http://www.cyclingpromotion.com.au</a>
National	Cycling Resource Centre	<a href="http://www.cyclingresourcecentre.org.au/">http://www.cyclingresourcecentre.org.au/</a>
National	The Bicycle Transportation Alliance	<a href="http://www.multiline.com.au/%7Ebta/">http://www.multiline.com.au/%7Ebta/</a>
ACT	ACT Cycling Federation	<a href="http://www.act.cycling.org.au/new/index.htm">http://www.act.cycling.org.au/new/index.htm</a>
ACT	Pedal Power ACT	<a href="http://www.pedalpower.org.au/">http://www.pedalpower.org.au/</a>
NSW	Bicycle NSW	<a href="http://www.bicyclensw.org.au/">http://www.bicyclensw.org.au/</a>
Northern Territory	Northern Territory Bicycle Association	<a href="http://www.nt.cycling.org.au/">http://www.nt.cycling.org.au/</a>
Queensland	Bicycle Queensland	<a href="http://www.bq.org.au/">http://www.bq.org.au/</a>
South Australia	Bicycle Institute of South Australia	<a href="http://www.bisa.asn.au/cgi-bin/wf.pl">http://www.bisa.asn.au/cgi-bin/wf.pl</a>
Tasmania	Bicycle Tasmania	<a href="http://www.biketas.org.au">http://www.biketas.org.au</a>
Victoria	Bicycle Victoria	<a href="http://www.bv.com.au/">http://www.bv.com.au/</a>
Western Australia	Bicycle Transportation Alliance	<a href="http://www.multiline.com.au/~bta/index.shtml">http://www.multiline.com.au/~bta/index.shtml</a>

### Appendix III

## Addressing the argument that increased cycling lowers the environmental performance of the public transport system

Recently emerging in some public debate is the argument that increasing cycling as inimical to the broader efforts to make Australian urban transport systems more sustainable. Orthodox opinion on the environmental costs of urban transport is summarized in Figure A.1 below. In the broadest terms and using greenhouse gas emissions as a guide to environmental sustainability, the less net fossil fuels consumed per unit travelled per person using a particular mode, the less polluting that mode.<sup>37</sup>



**Figure A.1 A simple schematic describing a hierarchy of environmental costs of single journeys by competing urban transport modes**

To argue that cycling has a negative impact on sustainable transport is, therefore, set against conventional thinking. This argument against cycling features three propositions:

- That the increase in cycling is not replacing car use, but is replacing walking and public transport modes
- That increased cycling lowers the patronage of public transport and thereby increases public transport's per capita environmental impacts, and
- That increases in cycling contribute to road congestion, thereby reducing its efficiency and increasing its costs and environmental impacts.

Essentially, the first two propositions can be addressed simultaneously. Cycling is concentrated in the inner city areas of Australian cities where the greatest density of public transport occurs. Where modal decisions are being made, it is likely that many of those who are cycling are more likely to regard the next most preferable mode as public transport – even though in Australian cities, the majority of adult cyclists hold motor vehicle licences. In particular, where the journey is to and from work, the substitution of bicycles for public transport journeys – especially to the city centre – is most likely. This seems likely because those who have available the full range of available modes are less likely to chose between a bicycle and a car on a regular basis because of an established preference for public transport for this journey – such as wanting to avoid commonly-cited complaints about car commuting, such as peak-hour road congestion, fuel and parking costs, and tollway costs. But for journey types that involve more flexibility and a higher 'discretionary' component, it may not be so clear that the bicycle is being substituted for public transport. An important consideration here is travel time and distance;

<sup>37</sup> There is a considerable literature on the comparative environmental costs of different transport modes; see, e.g., the comprehensive review for Australia by the CSIRO: Beer, T., Grant, T., Watson, H. and Olaru, D. (2004). *Life-Cycle Emissions Analysis of Fuels for Light Vehicles*. Melbourne: CSIRO.

for short trips – of a few kilometres – and for destinations and travel times not conveniently serviced by public transport, for many adult cyclists, the modal choice may well be between the bicycle and the car.

Urban transport modes should not always be considered in isolation, although Australian cities have generally very low levels of internodal journeys of any type – or indeed, of linked journeys using public transport. However, because existing cyclists have ready access to a greater area of public transport services – by virtue of the known highest concentration of commuting cyclists being in the inner-cities of large cities – cycling could play a role in increasing public transport use – e.g., cycling to and from railway or light rail stations/stops. In cities with very high cycling levels, as international best practice shows, modal connections with cycling are a feature of their transport systems. Therefore, rather than positioning cycling as antagonistic and competitive with public transport, there are models in existing practice, and in theory and planning, of ways that increasing cycling strengthens public transport.

Reducing public transport loads can arguably be said to lowering the environmental performance of these public and private modes because we often assess their performance on the pollutants released per passenger kilometre; thereby, fewer passengers reduces vehicle efficiency and increases the pollutants attributable to each passenger. If one of two people travelling in a car decides to bicycle, there is no significant net benefit if the car driver continues to make this trip alone; the only environmental gain in this scenario occurs when passenger and driver replace the car commute with public or active transport. In the case of off-peak public transport services, this argument is particularly acute, for the loadings for these services can be very low.

However, where this argument fails is that it considers each trip in the transport system as an isolated event. Often when promoting bicycle use this scaling effect is ignored; bicycle use lowers the environmental impacts of the transport system when it cumulatively reduces the number of motorized vehicles in use. And although it may be counter-intuitive, it is not the case that every bicycle trip lowers the environmental costs of the entire system; many bicycle journeys will produce no discernable influence because that trip could have been taken by public transport services that have operated regardless of whether the bicycle trip was taken. In short, there are threshold effects in displacing motorized transport trips within large cities and beneath that level, individual actions produce little change at the system level.

To return to the logic described in Figure A.1 above, the goal of a sustainable urban transport system is shift as much mobility downwards from private cars to active transport as possible and as soon as possible. Greater active transport in this scenario does not deprive public transport of patronage because it is part of a strategy that needs to accommodate a great amount of motorcar mobility in public and active transport. If active transport creates vacancies in public transport, then those spaces are opportunities for former motorists.

That bicycling can increase road congestion and thereby increase vehicular pollution is an argument employed against the case for increasing bicycling infrastructure.<sup>38</sup> This is something of a perverse argument from an environmental and ethical perspective, namely that non-polluting vehicles should be curtailed on the grounds that polluting vehicles can operate (i.e., pollute) with marginally increased efficiency. In theory, such an argument could be demonstrated but it seems likely that there would have to be far greater bicycle traffic on urban roads than presently occurs anywhere in Australia to produce a measurable congestion effect. Counts of the number of people crossing a road per hour typically find that private cars allow about 2,000/hr; buses: 9,000/hr; bicycles: 14,000/hr; pedestrians: 19,000/hr; and trains: 22,000/hr (see, e.g., Botma and Papendrecht, 1991 in Dekoster and Schollaert (1999)). In practice, this seems like an issue of theoretical concern at best. On freeways and major arterial roads where the traffic volumes are highest, bicycles are in very low numbers and make no discernable effect on traffic flows; when there is congestion, it comprises motor vehicles. On minor urban roads, congestion is also the result of car volumes and if cyclists were in sufficient numbers to slow motorized traffic then it seems likely that that road is approaching its capacity in any event. Most on-road cycling occurs in the inner-city during the journey to work and this is also the time and place

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<sup>38</sup> For students of classical economics, there is something of a ‘Coasian’ appeal in this construction of environmental costs and how they might be addressed, namely by distributing the costs incurred by the driver onto the cyclist.

of motorcar congestion, so if cyclists elected to drive to work, the net environmental costs would be higher. Airing this particular concern in public debate seems somewhat disingenuous; motorists have traditionally complained of traffic congestion because of the inconvenience it imposes on individuals and, of all the representations to governments for road-building, environmental protection has hardly been a prominent argument.

**Summary**

- A portion of cycling journeys could lower public transport emissions performance on a per capita basis and per vehicle basis, but system-wide and in the longer term, increased cycling generally lowers net transport sector emissions.
- Cycling is unlikely to have any meaningful impact on road congestion and lowering of motor vehicle emissions performance; increased cycling may contribute to reduced road congestion by reducing car use.