City cycling at the crossroads
Can Australia learn from Northern Europe?

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Abstract:
Australian policy makers and planners have for several years sought to encourage more cycling in cities. For more cycling to be sustained, ordinary people across a range of ages and abilities need to feel safe when cycling. Organisation for Economic Cooperation and Development (OECD) fatality comparisons however indicate that Australia has failed to provide safe conditions for cycling and that the trend has been for Australian cycling to become less safe compared to other modes. In several European cities, a systematic approach over decades and involving all levels of Government has led to safer cycling and more cycling. The barriers in Australia appear to include a lack of political will and reluctance amongst road managers and regulators to fully pursue a 'safe systems' approach. Working for a safe system would require significant changes to road space allocation and management, including more separation for cyclists; changed priorities for road investment; empowering local governments; and at the national level, changes to the design rules for heavy vehicles. This paper explores barriers to and enablers for safe cycling by comparing Inner Melbourne to two leading Northern European cycling cities: Amsterdam and Copenhagen. The case of intersections, where most serious cyclists injuries occur and the interactions between truck drivers and people on bikes (road users at opposite extremes of vulnerability) are used to explore some safe system possibilities.

Introduction

Are we at a turning point for cycling in cities? Will the passing of the crest of 'peak car' (i.e. the decline in per capita car use since 2004) (Loader, 2013) and health concerns over a sedentary lifestyle (Lee, Shiroma et al., 2012) provide an opportunity for a renewed focus on cycling? Replacing short trips by car with bicycle trips in cities would alleviate congestion, reduce pollution and provide health and environmental benefits to the community at large (van Ommeren, Lelieveld et al., 2012). The potential economic benefits would also be significant (Cavill, 2012; Grous, 2011). In Melbourne and in other Australian cities the main impediment to more cycling is fear of injury from motor traffic (Jacobsen & Rutter, 2012).

For the last 30 years, the main policy responses to improve cycling safety in Australia have been compulsory helmets and the provision of unprotected bike lanes to inconsistent standards that usually disappear at intersections. An Austroads 2011 study however found that bike lanes had no overall effect on cycle safety as the modest effect of the high standard lanes was neutralized by the lesser standard lanes (Turner, Singh et al., 2011). Compulsory helmets reduce head injuries but they do not improve primary safety; that is, they do not reduce the risk of a crash occurring. Cyclists wearing a helmet can still receive critical injuries if hit by a motor vehicle travelling at speeds above 40 km/h or if run over by a large truck or bus travelling at any speed.

Providing for cars in Australian cities has been the key transport policy and funding priority for decades, yet all levels of government say they are promoting cycling. In Australia the National Cycling Strategy 2011–16, endorsed by states, territories and the Australian Government, aimed to double the participation rate in cycling by 2016 (Austroads, 2010). The Government of New South Wales aims to increase the share of Greater Sydney local trips (up to 10 kms) made by bicycles to 5% by 2016 (NSW Government, 2010); and the Government of Victoria aims to position Victoria as the most bike friendly state (Government of Victoria, 2012). National and state targets have, however, not been backed by realistic funding. Funding of improvements for cycling in Australia has tended to fall to municipalities. For example, the Capital City Councils of Sydney, Adelaide, Perth, Brisbane and Melbourne have each invested more than $24 per resident per year over the three years to 2012 (Bicycle Network Victoria, 2012). By way of comparison Amsterdam and Copenhagen, which each have extensive infrastructure and established programs, continue to invest more than the equivalent of A$32 per year per person in cycling (Schiott & Madsen, 2013)

Background

For many years cycling in Australian cities has not been seen as sufficiently safe to be a mainstream activity. Garrard et al (2010) suggest that there was a blind spot in Australia on cyclist safety, particularly in (metropolitan) Melbourne where an increase in cycling saw an apparent doubling of deaths and serious injuries over the eight years to 2008 (Garrard, Greaves et al., 2010). Feelings of vulnerability among bike owners have a powerful influence on travel choices (Goodwin, 2008). In Victoria research for VicRoads found that for 75% of bike owners safety was everything in determining trip making (Hall and Partners, 2010). While the City of Melbourne estimate that the crash rate (all types of reported crashes) per trip declined from 2001 to 2011 (Future Melbourne (Transport) Committee, 2013) the Victorian Transport Accident Commission claims data shows a 43% increase in claims from cyclists in the inner Melbourne area for the four years to 2011 and an increasing cost in claims relating to cyclists, with $43 million in claims made in 2012/13 (Nieuwesteeg, 2013).

Intersections are important as Victoria's crash statistics (VicRoads CrashStats) show that 60% of reported cyclist casualties occur at intersections; a disproportionality high percentage given that cyclists spend most time between intersections (VicRoads, 2012). The top three crash types reported by Bicycle Network Victoria members also happen at intersections and most are caused by motor vehicles failing to give way (Clark, 2013). In spite of years of evidence of a major problem for cyclists at intersections, improvements are only recently being considered (Fitts, 2013; Gray, 2013). For European cycling cities it has however been normal practice over decades for safe space and/or time to be provided for cyclists at intersections. Part of the explanation for the neglect of intersections in Australian bicycle planning in the four decades from 1970's could be the influence of the American John Forester's "vehicular cycling" philosophy that cyclists should operate like and be treated as operators of vehicles (Forester, 1994; Furth, 2012; Schmitt, 2013). The vehicular cycling approach was also consistent with the historic Australian pre-car practice of on-road cycling. Forester was particularly antagonistic to the provision of marked lanes (space) for cyclists at and through intersections, as in The Netherlands, as he held that this gave cyclists a false sense of security. In America the vehicular cycling approach has been rejected by the 27 Copenhagen influenced National Association of City Transportation Officials (NACTO) that include Portland and New York (NACTO, 2012; Schmitt, 2013). As noted by van den Dool, research since 2006 has demonstrating the effectiveness of separation, but separation Australian style tends to leaves cyclists vulnerable at intersections and crossings (van den Dool, 2013).

The case of interaction between trucks and cyclists is an important risk management consideration as 'The conflict between a truck and a cyclist or pedestrian may not be the most common situation encountered, but it is the most dangerous' (Niewoehner & Berg, 2004). In Victoria a disproportionate number of bike rider fatalities (28%) involved a heavy vehicle (VicRoads, 2012b). Truck drivers have difficulty seeing cyclist and many cyclists don't understand truck movements such as trucks moving right before turning left. An outcome for a cyclist of system interaction failure with a truck can be an initial knock down impact followed by being run over and crushed under the heavy truck's wheel(s) (Morgan, Dale et al., 2010). Cyclists are particularly at risk as they cannot, like pedestrians, move sideways or backwards to avoid an expected encroachment on their space by a truck or trailer side that swings-in when the large (long) vehicle turns left. Cyclists are also at risk at intersections when the through cyclist has right of way over turning trucks, but may not be seen, or may have their approach speed underestimated and/or their capacity to stop overestimated by a truck driver. A comprehensive safe systems approach that aims to minimize risk to cyclists from trucks is also likely to benefit pedestrians, motorcyclists and people in small (low) motor vehicles.

The current cycling situation has real risks but the perception of the safety of cycling in Australian cities is also likely to deteriorate if cyclists have to share road space with more trucks. More trucks are predicted on city roads - a consequence of cities' growing economic dependence on road based logistics (McTiernan & Levasseur, 2013; Stanley, Hensher et al., 2011). A city with more trucks and bikes is a challenging prospect. In the morning peak on major roads into the City of Melbourne, vehicle counts are already recording as many commercial vehicles as cyclists (City of Melbourne, 2012). In Melbourne the road freight task is predicted to more than double by 2046 (Goverment of Victoria, 2013). Inner area cycling conditions are also influenced by significant truck traffic from the Port of Melbourne and redevelopment construction activity which can cause significant safety problems for cyclists (Helman,

Delmonte et al., 2013). A wide range of safe system measures, including education, changes to the road environment and to truck designs are available to improve truck safety in cities (McTiernan et al., 2013).

If more people are to choose to cycle, both objective road safety (low risk of death or serious injury) and the subjective experience of feeling secure (not fearful) are important (Australian Department of Infrastructure and Transport, 2012). In Denmark for example, it has long been recognised that to encourage cycling more is needed than a low rate of accidents. For a trip to made by bike, potential cyclists need to believe that they will be secure (Anderson, Beredal et al., 2012).

Method

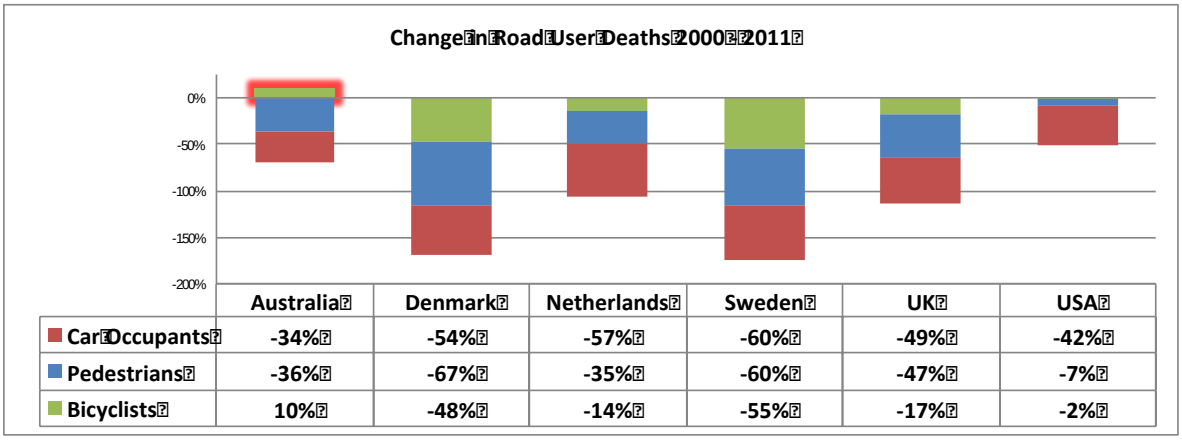
In this paper we explore lessons from Europe in improving safety to encourage city cycling. The data we present here has been compiled and analysed for quantitative and qualitative comparisons. A comparison is made between trends and safety outcomes for cyclists in Australia with other OECD countries. The analysis then considers where most serious injury crashes occur and explores the 'worst case' interaction between trucks and bikes. A comparative case study analysis is then used to explore some of the different contexts for cycling safety for the Inner Melbourne, Amsterdam and Copenhagen. A case study approach has been adopted to uncover possible contextual differences that may not be immediately evident in other kinds of analysis (Bryman, 2012; Yin, 2008). Some of the possible barriers to the adaption of European best practice to Melbourne are identified, including institutional factors at the municipal, state and national levels. We then develop and apply a framework to evaluate the relationship between System Elements and Actors, with examples given of possible safety improvements, drawing on published material and the lead author's visits to, and observations of cycling provisions in Amsterdam, Copenhagen and other European cities.

Findings and Discussion

Australia, an OECD cycling Black Spot

In Australia, decades of neglect of cycling are reflected in comparatively low levels of cycling and poor road safety outcomes. Australia (with Canada) are the only Organisation for Economic Co-operation and Development (OECD) countries where cyclists deaths increased in the period 2000 to 2011 (International Traffic Safety Data and Analysis Group (IRTAD), 2013) Fig. 3). In Australia cyclist deaths increased by 10% while in Denmark they decreased by 48% and in the Netherlands they decreased by 14%, as shown in Figure 1. Also in Australia, as deaths for pedestrians and car occupants decreased by 36% and 34% respectively, the trend was for cycling to become less safe compared to (improved safety for) car use or walking.

Figure 1 Change in Road user Deaths 2000 - 2011



	Australia	Denmark	Netherlands	Sweden	UK	USA
Car Occupants	-34%	-54%	-57%	-60%	-49%	-42%
Pedestrians	-36%	-67%	-35%	-60%	-47%	-7%
Bicyclists	10%	-48%	-14%	-55%	-17%	-2%

Extracted from (International Traffic Safety Data and Analysis Group (IRTAD), 2013)

An additional point of comparison is that for Denmark, which is comparable in terms of population to Victoria (each have a population of about 5.5 million) there were 21 cyclists killed in 2012 (down from 52 killed in 2002) while in Victoria in 2012 there were 9 cyclists killed. The telling difference is that cyclists in

Victoria undertake a small fraction (about 1/10) of the trips made by cyclists in Denmark (Buehler & Pucher, 2012b) but experience about 5 times the fatality rate for Denmark.

Comparative case study

A comparative case study approach can be used to both explore reasons for different outcomes and to consider the many factors that could effect the viability of the transfer of ideas between cities, such as social, legal and engineered contexts. Our local geographic focus is the area defined by the five municipalities of the Inner Melbourne Action Plan (IMAP), Melbourne, Port Phillip, Stonington, Yarra and Maribyrnong (Inner Melbourne Action Plan, 2013). The European cities of Copenhagen (Cph.) and Amsterdam (Ams.) have been chosen as the cities for comparison as they are leaders in making progress to provide for cycling (Pucher & Buehler, 2013) and are comparable with Inner Melbourne municipalities on several parameters, except for having about 10 times the percentage of trips by bike (see Table 2). In selecting comparative case studies for large city cycling, Buehler and Pucher (2012) suggest parameters such as: size, population density, per capita GDP, presence of a University, rainfall and extremes of temperature as important factors. The IMAP area is smaller than Copenhagen but larger than Amsterdam. The population is smaller than Copenhagen or Amsterdam but is part of a larger inner Melbourne population. Population densities in IMAP are similar to Amsterdam but about half that of Copenhagen. Estimated per capita GDP is similar, based on regional GDP, being within the range of A$60,000 to 70,000. The IMAP area is in the cycling catchments for Melbourne, RMIT and Victoria Universities, and has a mixture of land uses that provide many convenient destinations accessible by bike. Rainfall is a key factor for cycling but is similar for the three cities. Maximum temperatures influence cycling levels and Melbourne for example has on average of over 30 hot (>32 ^{o}C) days per year compared to none for Amsterdam and Copenhagen (Buehler & Pucher, 2012a). The significance of hot days is that while cyclists can dress for cold weather there are limits to (un) dressing to compensate for heat. Melbourne, Amsterdam and Copenhagen are all relatively flat and as Handy et al (2010) note, absence of hills is important for cycling (Handy, Xing et al., 2010).

Table 2 Inner city comparison, Melbourne, Amsterdam and Copenhagen

Area	Pop. (000's)	Inner Area (km^2)	Density Res. / km^2	Cycling (% trips)	Regional Governance	Road Safety Performance [2]All Rd. deaths (per 100,000)	[5]Basis of legal liability for injury
Melb. (IMAP)	446	135	3300	[1]3.9 (2007)	State of Victoria (Pop. 5.5 mil.) in Australia	5.1	Equal
Ams. (City)	820	219	3745	[3] 29 to [4]50. (2008)	Province of North Holland (Pop. 7 mil) in E. U.	3.9	MV driver if cyclists < 14 yrs. MV assumed to cause risk > 14yrs
Cph. (City)	559	77	7260	[3]29. (2008)	State of Denmark in (Pop. 5.4 mil) in E.U.	4.7	MV driver assumed liable unless otherwise proven.

[1]The Victorian Department of Transport 2007 Victorian Integrated Survey of Travel (VISTA) estimated people cycled for 3.9% of total travel in the inner suburbs (Department of Transport Victoria, 2009).
[2](WHO, 2013)
[3] (Rask & Skov-Peterson, 2013)
[4] (Voerknecht, H 2010, estimate for Inner Amsterdam)
[5] (Cycle Law, 2012)

The road systems in the older inner parts of all three cities now experience severe congestion during peak hours, with Melbourne ranking worse than Amsterdam in the IBM Computer Pain Survey 2011 (Major

Cities Unit, 2012) p. 208). Using a bike can be the fastest means of travel for short trips under congested road conditions in all three cities. Like many older inner cities, all three have a pre-car layout and pattern of development with a mix of land uses served by public transport and an urban form and that is relatively accessible and not inherently car dependent (unlike many newer outer suburbs). There are some differences in infrastructure including that Melbourne remains a very active 'Port' city, has no canals and in Copenhagen the last tram ran in 1972. Overall however there appear to be enough contextual similarities for the possible reasons for differences in cycling to be instructive.

The differences in approach to legal liability (right hand column in Table 2 above), where a higher duty of care is placed on motorists in The Netherlands and Denmark is one indication of cultural difference. Other socio-cultural dimensions, as described by Hofstede, and as used in the EU transferability projects have a strong influence on transferability of road safety ideas (Hofstede, 2001; Persia, Corazza et al., 2010). Hofstede's criteria suggest that the cultural acceptance by a host country of road safety and sustainable mobility measures can be considered in terms of similarities in:

(i) democratic power sharing across income and social strata,
(ii) the sense of collectivism (concern for the general good rather than individualism),
(iii) caring rather than competitive norms,
(iv) a willingness to take some risks for the public good (compared to uncertainty avoidance), and
(v) generousness with regards to supporting change that may result in some loss of privilege by the more powerful.

Given Australian's inclination to: admire power, individualism, competitiveness, avoidance of uncertainty and reluctance to change, cultural considerations would lead us to a somewhat pessimistic prospect for development of a caring environment for cyclists. Also, In Australian cities 'cyclists' tend to be framed as a minority 'out group' (Rissel, Bonfiglioli et al., 2010), while in Amsterdam and Copenhagen most people cycle some of the time and riding a bike is a mainstream activity. Recent (2013) experience in Inner Melbourne has however shown significant changes can be successfully achieved with skill, persistence and intense engagement with stakeholders (Oke & Robinson, 2013). Recent (2013) examples of European style changes successfully implemented (often as 'trials') include: protected bike lanes in Latrobe St (serving RMIT University); and re-allocation of a traffic lane to cyclists over Princes Bridge, one of the main entry points to the city (ibid).

Safe System approach

A crucial difference between Australian cities such as Melbourne and European cities such as Amsterdam and Copenhagen appears to be the social support for and institutional commitment to provide a safe road system. The policy path for safer cycling and more cycling has been followed by several Northern European Governments since the 1970's (Directorate General for Passenger Transport, 1999; Rasmussen, 2012). Since the mid 1990's road safety improvements in Australia and Europe have been influenced by the ideas of Vision Zero (Sweden and Denmark) and Sustainable Safety (The Netherlands) which are based on Safe Systems principles (Mooren, Grzebieta et al., 2011). In tackling the 'road toll' in Australia however the safe system philosophy has not been fully adopted and tends to have been traded off against, if not subjugated to, motor vehicle mobility and freight economy (Australian Transport Council, 2003) . As noted by Wooley 'changes to the road network consistent with Safe system principles are required if significant progress is to be made in road safety over the next decades' (Wooley, 2012) p. 52. The value of using a safe systems framework to explore cycling issues has been demonstrated in several studies including the 'naturalistic' (observation of cyclists) study in Melbourne (Johnson, 2011). The safe systems approach has also been applied to the problem of cyclist – truck interactions in Europe and Japan (European Cyclist Federation, 2011) but not in Australia.

The four principles of a Safe System, adapted from Corben et al 2010, are:

1. Recognising the limits of human performance (e.g. to perceive and avoid potential conflict and take action).
2. Acknowledging the limits of the human body to tolerate violent forces; for unprotected road users this means limiting potential vehicle impact speeds to 30 km/h.

3. Shared responsibility for safe road use – individual users complying with safe design standards and operational rules (educated for their own and others safety).
4. Creating a forgiving road-transport system – where human errors do not result in serious injury.

From (Corben, Logan et al., 2010)

The safe system principles apply to all three system elements: 'Only when the characteristics of man, the road and the vehicle are adjusted to each other, can the transport and traffic system work as planned' (VTT Technical Research Centre of Finland, 2001). System 'adjustments' to improve safety made in Europe and elsewhere include changes to trucks to improve driver field of view, intersection designs and operation that separate cyclists from trucks, and regulations (such as lower speed limits) to give participants more space and time to avoid conflicts. Cyclists usual see trucks, expect that truck drivers see them and will obey the road rules, but truck drivers may do neither (Wegman, Zhang et al., 2012).

The commitment to pursue road safety and sustainable travel management programs in Northern Europe consistent with a true 'safe systems' approach has meant a significant investment in a wide range of programs including: road user education; local streets made safe (survivable) for cyclists and other road users by a 30 km/h speed limit (compared to the default urban speed limit in Australian cities of 50 km/h); controlled operation of large trucks in cities and truck cabins designed to ensure drivers can see cyclists (e.g. by lower driver positions, large field of view and extensive use of mirrors); and on busy roads, protected space and/or time for cyclists between and at intersections. For decades in Northern Europe cycling supportive programs to restrict car use, support public transport and provide a higher density urban form have been part of a comprehensive package for sustainable travel which now shows progress that includes lower road deaths and healthier city populations.

The safe systems approach is proactive and fits with the strategic and normative planning approaches familiar to urban planners. It also fits with urban planning's broader understanding of transport and land use interactions. A systems approach can point to where structural policy changes are needed, in contrast to the reactive approach to road safety typified by traditional 'black spot' programs that target areas where people have died in sufficient numbers to warrant corrective action. For example, the 2013 Victorian Government's Road Safety Action Plan says it is based on the 'Safe Systems approach' but the Plan does not mention strategic action to support a shift to travel by low harm (and beneficial) modes such as walking, cycling and public transport (Government of Victoria, 2013).

Barriers and enablers: Framework and discussion

There is hope for change but the potential adaption and transferability of European measures requires expert judgment regarding differences in circumstances and conditions (Wegman et al., 2012). Meticulous planning and thoughtful adaption have achieved recent successes in Melbourne. The approach in Sydney appears promising (and appropriately different to that in Melbourne), focusing on development of a cycling network (NSW Government, 2010). As noted by Stead et al successful policy transfers include: developing locally appropriate solutions and implementation mechanisms; working with strong local champions (change agents); and seizing opportunities in times of crisis and/or when there is a community appetite for change (Stead, de Jong et al., 2010). In Australia, health concerns, the burden of disease from inactivity, may be an important factor in support for cycling (Giles-Corti & Whitzman, 2012).

The barriers to increasing cycling in Australia have included the absence of a whole-of-government approach to integrate: health, transport, environment, education and planning policies (Bauman, Rissel et al., 2008). Overcoming some of these barriers gives experience in enabling, as has been the case with recent successes in Melbourne. Institutional ('actors') responsibilities, related to safe system elements, that can be enablers or barriers, are illustrated in the table below:

Table 2 Actors and System Elements

Actors:	System elements:			
	Roads	**Vehicles**	**HV Operators**	**Cyclists**
Influencers (e.g. Media)	Road management and space allocation	Community demands	Corporate Social Responsibility	Responsibility
Businesses	Support for road space re-allocation	Purchases of vehicles	Purchases of logistics	Staff & customer info.
Municipalities	Local roads	Operational requirements	Purchases	Local user groups (BUGS)
State	Arterial roads Speed limits and other major traffic regulation	Operational requirements	Enforcement Purchases	Education Enforcement
National	Design Stds	ADR's and performance	Regulations	Taxation provisions

Using the framework in Table 2, outlined below are some examples of measures, related to system elements, which may improve safety for cyclists in inner Melbourne:

Road-engineering measures that have been neglected in Australia include a wide range of major intersection treatments, such as kerb-protected cyclist left-turn lanes, to encourage all cyclists to move in an 'outer box' as used for all vehicular traffic right turns at several Melbourne intersections with trams. A European difference is designated pavement for cyclists and signal sequencing designed to minimise conflict. Other measures include 'trixi' mirrors on signal posts, to enable large vehicle drivers to see in otherwise blind spots (also being trialed in London); and requiring roundabouts to have large radius islands and a single exit lane to slow motor vehicles. A variety of proven treatments are given in the *Dutch Design Manual for Bicycle Traffic* (2007) and the Copenhagen influenced *NACTO Urban Bikeway Design Guide* (Center for Traffic Transport and Infrastructure (CROW), 2007; NACTO, 2012).

Truck design standards are set Nationally through the Australian Design Rules, currently making it difficult for higher safety 'E U standard' equipped trucks to be obtained but the new National Heavy Vehicle Regulator is open to discussing such issues. A coordinated approach across levels of Government could improve cyclist's safety and reduce environmental problems related to trucks. In Amsterdam and Copenhagen truck access restrictions have been based on environmental criteria such that only the highest EU standard equipped trucks are permitted to enter the city centre (Dablanc, 2007). As noted by Dablanc however, most municipalities view truck traffic as something they would like to ban and few consider or have the expertise to engage in heavy vehicle regulation or management.

Australian businesses and governments who purchase vehicles and logistics can also have a role and may not appreciate the potential they have to improve safety for cyclists by buying or requiring the use of safer urban trucks. For over a decade European (and Japanese) truck regulators and manufactures have shown outstanding leadership in designing and supplying safer trucks, but the Australian market has not always demanded such features. In Japan for example, in the eight years after the 1976 introduction of Euro Class IV mirrors the number of fatal accidents caused by left-turning vehicles dropped dramatically (Jacobs Consultancy, 2004). Australia has no equivalent to EU Directive 2003/97 for improved mirrors, or EU Directive 2007/38 for the retrofitting of indirect vision installation and for Class IV mirrors to be required for new trucks to improve driver spatial awareness.

Vehicle based Intelligent Transport Systems (ITS) has the potential to transform land transport and to make a substantial positive effect on road safety (Bayly, Fildes et al., 2007). The EU Intersafe-2 project estimates that ITS could improve truck safety at intersections by up to 80 per cent, by bringing together a

number of known measures to eliminate blind spots and communicate information (Volvo Trucks, 2011). For example, Radio Frequency Identification devices (RFID's) are being tested in Europe that provide for autonomous communication between truck drivers and cyclists (e.g. chips incorporated into hire bikes or bike helmets with receivers in trucks).

For heavy vehicle operators and cyclists a number of approaches to improve road user behaviour are also available, including: education and publicity to improve understanding between road users and explaining appropriate behaviour directed to both cyclists and truck drivers. For example, ongoing training for truck drivers in The Netherlands includes cyclist awareness. Enforcement philosophy is also important, aimed at changing behaviour, rather than punishing or raising revenue. An example is the 'wear a helmet because we love you' campaign in Denmark, which threatens the deterrent of hugs from policemen if cyclists are seen without helmets (which are not compulsory for adults).

In many Northern European cities at major intersections, cyclists are given designated space and/or favourable signal operational timing. At Australian city intersections cyclists' are vulnerable as they are on the roadway, often without marked space and only recently has any special consideration been given, such as a few seconds head start for cyclists. For cyclists travelling at low speed, the risk of a fall is ever-present, particularly for novice and senior cyclists and the later are likely to suffer serious consequences from any fall. Until recently intersections were generally optimised for the mobility and safety needs of car users. Also, at most intersections neither the special needs of trucks for a large turning radius and broad swept path (because of extensive off-tracking), nor the needs of cyclists to be seen and acknowledged, have been given priority. Some Australian road markings and truck designs create high risk situations for cyclists by placing them in truck driver 'blind spots', beside or immediately in front of trucks at intersection (RoadPeace, 2012; Schoon, Doumen et al., 2008). Perhaps in an alternative future, there could be 'vehicle to vehicle' (V2V) communication and autonomous avoidance to overcome human-to-human communication and reaction limitations. In the short and medium term however there is much to learn from decades of experience in Northern Europe in striving to provide safer intersections for cyclists.

Conclusion and next steps

On the basis of OECD benchmarking, Australia urgently needs to do better in providing for cycling. The measures used in Europe over recent decades to support cycling have contributed to reduced road trauma and demonstrate that investing in cycling: improves safety; increases cycling; and provides widespread community benefits. The amount of cycling in many European cities now makes a major contribution to the local economy and livability.

The priorities for transport investment in most Australian cities have been to provide more road infrastructure capacity in the hope of saving motorists' time. While public transport has been supported and concerns recently voiced about ill heath due to lack of exercise, providing for ordinary people who could cycle for regular short trips has not been a priority.

In Australia the financial burden for investment to support cycling has fallen on local government with very little financial support from State or Federal Governments, even though a cycling population would require less road investment than for car users and lower expenditure on the looming epidemic in non-communicable diseases. International comparisons point to the need for cycling in Australian cities to receive substantial initial investment and then sustained annual funding of least $30 per person over decades. Resources need to be directed to all system components: infrastructure, vehicles and road users, and to be targeted to improving safety and mobility for cyclists in all elements of the road system to reduce both real and perceived dangers, including at intersections.

On the basis of the analysis above, there appear to be enough contextual and cultural similarities between inner Australian cities like Melbourne and the exemplar Northern European cycling cities for more 'safe system' measures to be considered and trialed. Such learning and transfer of best practice is being done in the USA through NACTO with positive outcomes demonstrated in several cities. The local barriers are not technical knowledge. Rather, barriers include resistance from some local stakeholders, professions and agencies to full 'safe systems' principles. There is also a reluctance by the National and state governments to adequately fund programs for a safer system for cycling.

The next phase of our research will explore some of the barriers and enablers by interviews with local (Melbourne) bike owners and truck drivers and with key informants in Melbourne, Amsterdam and Copenhagen.

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