

Marking Melbourne's Arterial Roads to Assist Cyclists

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Abstract. Over the past two decades a range of different line marking techniques has been introduced to Melbourne's arterial roads. These include wide kerbside lanes sometimes marked with bike symbols, exclusive bike lanes, parking and bike lanes, and advanced stop lines at signalised intersections. In parallel to their introduction, VicRoads has undertaken a wide range of studies to test the effects of the new treatments.

This paper describes the range of line marking measures and the situations in which they have been applied. It summarises a series of video based studies which have observed the response of over 10,000 car drivers- particularly changes to the tracking of cars. The studies emphasise the critical affect that line marking has on separating cyclists from motor vehicles and on the comfort and stress levels of cyclists.

INTRODUCTION

Over the past 20 years VicRoads has gradually introduced line marking that explicitly and implicitly recognises the needs of commuter cyclists on arterial roads. The main motivation has been the reduction of the riding stress of cyclists. The program recognises cyclists as legitimate road users.

Improving the safety levels of Melbourne's cyclists has also been a concern as there are around 250 bicycle accidents every year in the metropolitan area resulting in the hospitalisation of at least one victim. A summary of the road user movements of these accidents is shown in Table 1. The accidents that are most likely to be conducive to treatment by line marking are 'cyclist hit from behind or from the side' (8%) and 'cyclist hit by car door' (8%). The hitting of cyclists from behind is accounted for three out of the thirteen fatal accidents in the four years of analysis.

Road User Movement	Reported Accidents	%
Cyclists by cross traffic	305	30%
Cyclist hit after leaving footpath	135	13%
Cyclist hit after leaving driveway	103	10%
Cyclist hit from behind or from side	84	8%
Cyclist his by car door	81	8%
Cyclist hit by out of control car	56	5%
Other	263	26%
	1,027	100%

Table 1 – Road User Movement Resulting in Serious Injuries to Cyclists: Melbourne Metropolitan area 2001 to 2004 inclusive

The studies shown in Table 2 were undertaken in association with the introduction of different types of road marking. Most studies included the video recording of cars and cyclists at the sites. In the three studies where the tracking of position of cars overtaking cyclists were investigated (the kerbside lane studies) there were too few cyclists to obtain sufficient sample sizes. In these studies cyclists were employed to ride along the roads and a video camera recorded the tracking positions of the cars that overtook them. The authors conducted each of these studies.

Year	Type of road marking	Number of cars observed	Sites	Summary
1980	Parking and bike lane	About 200	1	Before/after study in Ludstone Street
1989	Kerbside lanes	About 2000	5 kerbside lanes	Lane widths varied from 2.95m to 4.47m
1998	Advanced stop lines	245	4 sites with bike storage boxes	Before/after study at 4 sites
1998	Kerbside lanes	2592	2 kerbside lanes	Before/after study at one site
1999	Advisory bike symbol on right side within exclusive left lane	About 1000	2 sites	After study of cyclist behaviour
1999	Narrow parking and bike lanes (3.0m to 3.5m)	-	10	144 cyclists tracking observed and 67 cyclists interviewed
2004	Kerbside lanes	9906	5 kerbside lanes	Before/after study at three of these sites

Table 2 – Summary of Observation-Based Studies of Road Markings for Cyclists

EXCLUSIVE BICYCLE LANES

Motorised traffic is not permitted to travel in exclusive bike lanes except for short distances to cross the lane. A typical application is shown in Figure 1. It is commonly accepted that cyclists consider that this form of on road making is preferable to the others outlined later in this paper. Anecdotal evidence suggests that compliance rates by car drivers are high.

Their application is limited because a 1.2m to 2.7m lane width is required to the left of the adjacent traffic lane. Their application is also limited because many of Melbourne's arterial roads have parking bans during peak periods and on-street parking at other times. Although

on-street off peak parking is permitted over some older ‘part time’ exclusive bike lanes, current practice is to avoid their use in these situations. However they are frequently marked on new arterial roads that do not have on street parking. Typically bicycle lanes are marked on the main carriageways of new roads which have adjacent service roads and new roads on the urban fringe.



Figure 1 – Typical Exclusive Bicycle Lane

An important application is to mark exclusive bike lanes to the right of exclusive left turn traffic lanes as shown in Figure 2. Although there is strong support by cyclists, there are still fewer than one hundred applications of exclusive bike lanes in this type of situation in Melbourne.



Figure 2 – Exclusive Bicycle Lane to the Right of an Exclusive Left-Turn Lane

PARKING AND BICYCLE LANES

The first parking and bike lanes were introduced to the metropolitan area in the early 1980s. A longitudinal line is marked to the right of the parked cars sufficient to accommodate a cyclist between the parked cars and overtaking traffic that travels to the right of the line. There are several ways to line-mark parking and bicycle lanes. The main point of difference is whether another line is also marked at the edge of the parked vehicles. The parking and bike lane is only of benefit to cyclists if there are parked cars in the lane to deter car drivers using the lane as a through lane. Where there are few parked cars, traffic managers have commonly introduced landscape planting to prevent through drivers from using the lane.

The width of the lane is a compromise. Unfortunately the space required for a cyclist to ride past an opening car door is too wide to avoid car drivers intruding into the lane and travelling along it at other times. The video based studies of lane widths greater than 4.2 m showed that many drivers track with their left front tyre to the left of the outside lane line.

Before and after surveys on the lateral tracking of cars were conducted at time of their first introduction to Victoria in the early 1980s. These surveys showed that the line marking significantly reduced the proportion of car drivers passing close to parked cars. Later surveys of 'narrow' parking and bike lanes (3m to 3.5m) showed the following.

- 95% of parked cars were within 2.0m of the kerb face- as measured to the outside rear tyre.
- Cyclists almost always tracked *within* the parking and bicycle lane even when passing parked cars- typically just to the left of the outer lane line.



Figure 3 – Parking and Bicycle Lane Incorporating a Line Adjacent to Parked Cars

Parking and bike lanes have been widely introduced to arterial roads where there is on street parking. They have also been widely used on busy local streets- typically 13m wide and carrying less than 8,000 veh/day at speeds around 60 km/h.

WIDE KERBSIDE LANES

Wide kerbside lanes are simply lanes wide enough to accommodate a cyclist and an overtaking car in the same lane. They are valued by cyclists because of the added overtaking

clearance compared with drivers squeezing past in a narrow lane. Wide kerbside lanes also reduce the stress on car drivers because they do not need to merge into the next lane to overtake cyclists.

About 160 km of Melbourne's arterial roads have been re-linemarked so that the kerbside lane is wider. The other lanes have generally been narrowed to create the space. In several cases the road pavement has been widened to achieve the additional width.

Many of the wide kerbside lanes are also marked with a bicycle symbol near the kerb. The purposes of the symbol are to raise the consciousness car drivers to the presence of cyclists and to alert bike riders to the presence of a better quality lane to assist their route selection. Pre-implementation interviews with car drivers and bus drivers showed that they were well enough understood to justify their introduction. Many wide kerbside lanes are not marked with a bicycle symbol or a short parallel line on the outside of the symbol.



Figure 4 – Wide Kerbside Lane Marking With Bicycle Symbol And Short Longitudinal Line

Three separate video based studies have been carried out to observe the lateral tracking of car drivers. These are summarised in Table 2.

The following conclusions were drawn from these studies.

- The width of the kerbside lane had a very significant effect on the clearance that drivers gave to cyclists they overtook. Figure 6 shows that increasing the lane width from 3.5m to 4.5m led to an increase of about 500mm in the clearance car drivers gave to cyclists when overtaking when the overtaking car driver was hemmed in by a car in the adjacent lane. The increase in clearance was even more marked for the case of a single vehicle overtaking a cyclist with no vehicle in the adjacent lane.
- There were large site to site variations in the car-to-bike clearance and wide variations between different car drivers.

- Overtaking drivers squeezed cyclists if another car was in the adjacent lane. Typically they drove 100mm to 250mm closer than if no car was in the adjacent lane.
- Some drivers allowed very small overtaking clearances to cyclists when the lane width was narrow- say 3.7m or narrower. In one case the inside front wheel of the car overtaking a cyclist was just one metre from the kerb face!
- On the basis of limited evidence drivers did not appear to significantly increase their clearance to cyclists when driving in higher speed zones.
- The marking of a bicycle logo in the kerbside lane did not change the tracking of car drivers. This was true both when a cyclist was present and when no cyclist was present.
- The employed cyclists reported less riding stress when a bicycle symbol was marked on the road.
- The employed cyclists reported much less riding stress when the kerbside lane was wide.



Car in left lane, no car in adjacent lane, no cyclist



Car in left lane, no car in adjacent lane, cyclist



Car in left lane, car in adjacent lane, no cyclist



Car in left lane, car in adjacent lane, cyclist

Figure 5 – Different Vehicle and Cyclist Combinations In A Wide Kerbside Lane at a Survey Site

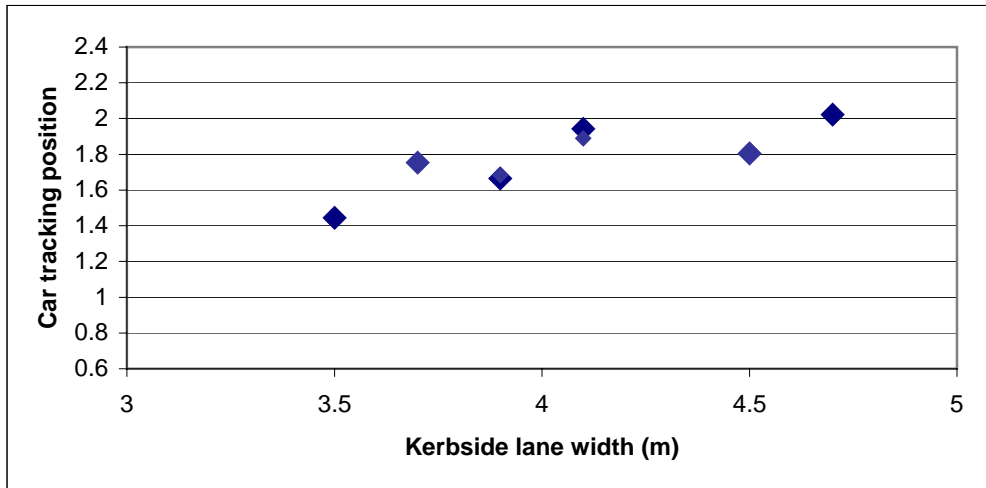


Figure 6 – Average Tracking Of Nearside Wheel of Cars in the Kerbside Lane: Overtaking Cyclist on Nearside and Car in Next Lane. See Fourth Photo in Figure 5

ADVANCED STOP LINES FOR CYCLISTS

During the red signal phase, many cyclists prefer to store in front of the motorised traffic. This allows cyclists to be seen by other road users, and to avoid vehicle exhausts. It can also reduce conflicts with left-turning vehicles and reduce the cyclist’s travel time marginally. A typical application is shown in Figure 7.

About 300 approaches to traffic signals in the metropolitan area have been marked in this way. They are mainly in the inner suburbs where cycling levels are higher. The details of the road marking of advanced stop lines vary between sites. The presence of exclusive left turn lanes operating on different traffic signal phases from the through movement results in many sites having the advance stop line for cyclists in front of the second lane from the kerb.

The results from a before and after study of advanced stop lines in St Kilda Road revealed the following behaviour.

- Typically cyclists wait forward of the stop line in the kerbside lane including on the pedestrian crosswalk itself- both before and after the advanced stop lines were marked.
- On average, the marking of advanced stop lines for cyclists increased the proportion of cyclists who chose to wait forward of the stop line (for vehicles) from 83% to 93%.
- About 67% of the first arriving cars in the kerbside lane after the signal turned red would queue just behind the advanced stop line for cyclists if no bikes were already present. If a cyclist was already occupying the bike box they would respect it.
- Typically 9% of cyclists arriving when the signal was red rode straight through. This did not change after the advanced stop lines were introduced.



Figure 7 – Advanced Stop Line for Cyclists

CONCLUSIONS

Through a variety of line-marking techniques VicRoads has improved cycling conditions for cyclists on Melbourne's arterial roads. This has been demonstrated by formal surveys of road user behaviour. Motorists have accepted the markings. There are subtle differences in the legal status and in the traffic engineering details of each technique that influence their applicability to particular traffic situations.

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