

Roundabouts in Australia

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ABSTRACT

This paper presents a collation of comments received from Australian traffic and transport professionals in response to a survey about the current status of roundabouts in Australia. The survey posed questions related to the extent to which roundabouts are being built, replacement of roundabouts with signals or signals with roundabouts, use of roundabouts with metering signals and fully-signalised roundabouts, the public's view on roundabouts, educating road users (drivers, cyclists, pedestrians) to use roundabouts correctly, current experience with roundabouts in terms of efficiency (delays, congestion), environmental aspects and safety, and the future of roundabouts in Australia.

INTRODUCTION

A survey of Australian traffic and transport professionals was conducted in relation to the current status of roundabouts in Australia. This was organized upon invitation by the organizers of the TRB National Roundabout Conference, Kansas City, MO, USA.

The following questions were posed:

- Are we currently building many roundabouts?
- When a new intersection is built (or an unsignalised intersection is upgraded), what sort of priority is given to roundabouts vs signals?
- Are we replacing signals with roundabouts, or are we replacing roundabouts with signals?
- Statistics about roundabouts in your jurisdiction (how many roundabouts in total, residential vs major traffic roundabouts, etc)?
- What is our current experience with roundabouts in terms of efficiency (delays, congestion), environmental aspects and safety?
- Are roundabout metering signals in use in your jurisdiction (and how many)?
- Are there any fully-signalised roundabouts (all approaches as well as circulating roads controlled by signals) in your jurisdiction?
- What is the public's view on roundabouts (car and truck drivers, pedestrians, cyclists, etc)? Does everybody love them or do we have opposition?
- What effort is being made for educating road users (drivers, cyclists, pedestrians) in using roundabouts correctly?
- Do you use models other than SIDRA INTERSECTION for roundabout analysis?
- What do you think about the future of roundabouts in Australia?

The Australian professionals who contributed are listed under ACKNOWLEDGEMENTS.

The responses given to each question (sometimes grouped) are given below. Each table cell represents a response by one person. The statements are presented with minimum amount of editing. [Author's added words are shown in blue colour](#). Emphases in the text (***bold italic***) belong to the author.

Publications recommended by respondents are given under REFERENCES (1-5).

Readers should note that the road rule in Australia is driving on the left-hand side of the road.

Are we currently building many roundabouts?

When a new intersection is built (or an unsignalised intersection is upgraded), what sort of priority is given to roundabouts vs signals?

Are we replacing signals with roundabouts, or are we replacing roundabouts with signals?

The technical document "Roundabouts and Traffic Signals - Guidelines for the Selection of Intersection Control", Vic Roads Traffic Management Note No. 22 based on my work (1) focuses on a range of issues that need to be considered when choosing a treatment for a particular site. The document is written from a point of view to assist practitioners in identifying the issues in the selection process.

Although capacity and safety are both important and usually considered in decision making, they are not always quantified (particularly in off-peak times when roundabouts can have significantly lower delays and better safety performance). However, there are also a number of other factors that need to be considered.

The choice of roundabout or signals depends on the crash history assessment and other factors such as geometric constraints and public transport route.

We tend to replace roundabouts with signals rather than the other way round, for example: Somerton Rd - Pascoe Vale Rd intersection, Roxburgh Park, and Plenty Rd - McDonalds Rd - Gorge Rd intersection, South Morang.

In Hornsby local government area, the worst locations have (already) been treated so the number built is fewer. On local roads, roundabouts are favoured except where pedestrian volumes or specific needs (i.e. disabled persons, school children, etc.) have to be considered.

Tendency is to replace roundabouts with signals when the roundabout exceeds its design life.

Tasmanian government has been promoting roundabouts as a road safety and traffic management device.

Mostly roundabouts are being replaced with signals for capacity constraint or *unbalanced flow situations*.

Roundabouts are popular as gateways to residential and industrial estates off the main road; for access to regional shopping centres and for traffic calming within residential estates.

In my analysis, significant pedestrian traffic and/or *potential for a dominant movement* in a roundabout would sway me to recommend signals.

We have undertaken signal design for roundabout replacement but we have not been involved in the reverse scenario.

We are building roundabouts on local roads. We are not replacing signals with roundabouts, nor roundabouts with signals.

Penrith City Council is still building roundabouts as an upgraded priority control to sign-controlled intersections. As the Council relies heavily on RTA NSW funding, it is estimated that potentially one roundabout per year is being built in the local government area.

When a new intersection is built, the function and classification of the road is considered and modelling analysed to determine suitability of the upgrade.

We replace roundabouts with signals as capacity is reached.

[From a paper written in 1995](#): Despite sites having been identified and even designs prepared in some of the municipalities without these traffic devices, there is still some resistance to the roundabout being installed ([in Tasmania](#)). However, most authorities these days actively pursue funding for roundabouts to improve safety at existing locations and also require their provision as part of new subdivision developments.

In the City of Casey, roundabouts are currently being installed on local roads as local traffic management treatments and not specifically for operational reasons at an intersection.

Both roundabouts and signals are considered as solutions to issues with the most effective treatment installed. I cannot think of examples of replacing roundabouts with signals or signals with roundabouts in Casey.

Authorities often install roundabouts in urban areas where there is insufficient sight distance. There are a few in our area and in Wollongong where this is a problem (conflicts with vehicles and pedestrians). In these cases, where the impacts of installing stop signs [instead of roundabout give-way \(yield\) signs](#) on capacity are not likely to cause major problems, I have often wondered why our legislation does not permit the use of [stop signs at roundabouts](#), particularly to address this issue.

Where two-lane roundabouts are present, often motorists in the left lane turning left, sneak into the left lane on the roundabout, even though there is through traffic in the inside lane. The current rules allow this to occur, and my opinion is the rules should be changed so that all traffic approaching should give way to all traffic on the roundabout. Why this is particularly a problem is that this traffic (turning left) gives no consideration to through traffic or right-turning traffic wishing or needing to merge to the left lane for whatever reason ([usually](#) to access a development), and this causes conflicts with traffic trying to sneak out on to the roundabout from the side road.

Many practitioners, particularly those with limited experience, and also members of the public, think that roundabouts are the solution to just about any [local intersection problem](#).

Single lane roundabouts are quite popular with local councils and residents as traffic calming and safety measure. Newcastle and Central Coast (the stretch between Sydney and Newcastle) seems to have much more roundabouts than Sydney. For example, the recently opened Newcastle Bypass motorway has a "figure 8" roundabout interchange at Hillsborough Rd, and there are other interchanges with roundabouts along this new motorway. However, the large roundabout at John Hunter Hospital, New Lambton Heights has been converted into signal.

Under NSW's Sydney "pinch points" program, congestion points along Sydney's major road corridors are targets for improvement. Possible works include "Replacing heavily-used roundabouts with traffic lights". See www.nsw.gov.au/docs/Pinch_Point.pdf.

Without alternative facility, pedestrians complain that multi-lane roundabout (two or more lanes at entry or exit) are hard to cross. Note that for safety reason, RTA NSW is modifying all multi-lane zebra crossings (two lanes each way) on state roads, by signalling the crossing or narrowing the zebra crossing to one lane each way.

In the Australian Capital Territory (ACT), we are continuing to build roundabouts in newly developed areas. [When a new intersection is built \(or an unsignalised intersection is upgraded\)](#), usually both roundabout and signal options would be considered. Roundabouts would probably be favoured in residential areas or at locations with little pedestrian activity.

I can think of three sets of signals that have been replaced with roundabouts during the past 20 years. Over the same period two roundabouts have been replaced by signals with another two to be replaced within the next 12 months.

The Queensland Department of Main Roads is still building roundabouts, as are Local Authorities in Queensland. However, other intersection forms (unsignalised and signalised) are built more often than roundabouts. This has always been the case.

The choice of a roundabout over a signalised intersection is discussed in Section 13.4.3.5 (pages 13-33 to 13-34) of Chapter 13 of the Queensland Road Planning and Design Manual. This manual can be found online at www.mainroads.qld.gov.au. The choice depends on factors such as capacity considerations, traffic movements through the roundabout, number of heavy vehicles, pedestrians, cyclists, operating speeds, form of control at adjacent intersections, future considerations, cost and the number and angle between legs.

Roundabouts do not often replace traffic signals. However, traffic signals do replace roundabouts for reasons such as improved capacity and better allowance for road users such as pedestrians and cyclists.

Instances of roundabouts being replaced by other intersection forms do occur reasonably regularly. This generally happens when the capacity of a roundabout is exceeded, especially if the roundabout is two-lane. Such roundabouts are usually replaced with traffic signals (mostly) or interchanges. It is not common for roundabouts in Queensland to be increased to three circulating lanes to improve capacity (although it occasionally happens).

Roundabouts are not usually replaced by other forms of intersection on the basis of safety. In general, a well-designed roundabout is the safest type of intersection control. Numerous international studies have shown that in general, fewer vehicle accidents occur at roundabouts than at intersections containing traffic signals, stop or give-way (**yield**) signs. Unfortunately, this same safety performance does not apply to pedestrians and cyclists. The primary reason for the improved safety record for motor vehicles is that the relative speeds of vehicles are considerably lower at a well designed roundabout than for other types of at-grade intersections.

The majority of new roundabouts are built in new subdivisions by developers in low speed, low to moderate traffic volume environments on the Collector Street network, and in many cases at the entry to a new estate from the Road Network. Council has built some roundabouts on the local network as part of Local Area Traffic Management schemes and at intersections on the major road and street network to address safety issues.

An assessment of roundabout operation and signal operation is undertaken at major intersections on the arterial and sub-arterial network. Choice of intersection type is based on performance, implementation cost, social impacts, impact on pedestrian and cyclist movement, space available and location (urban, rural, CBD, or suburban).

In most cases signals have replaced roundabouts. We do not have any examples where a roundabout has replaced traffic signals.

This is an interesting topic to discuss, and one which would generate a lot of disagreement. I am involved with many developments across Sydney and roundabouts are not being installed at anywhere near the rate of Signals or Give Way (**Yield / Stop**) controls, simply because the land is not available. I have only ever seen roundabouts converted to signals and never the other way around.

I can offer a comparison between rural Britain (I grew up there) and the Sydney metro area (I now live here). Clearly these areas have different characteristics which may provide clues as to where roundabouts are suitable. Basically, Bristol and the greater southwest area, being mainly rural, provide more road space, per vehicle, than the Sydney road network. While a six lane road through a commercial strip in Sydney will cover the same area as a four lane road in Bristol, the Sydney road will carry far more traffic and provide less spare land within the road reserve. Sydney has allowed the road area to expand within the road reserve providing more capacity, which is now full, so that traffic signals are the only viable option.

This squeezing of more vehicles into a smaller space means that there is *less spare road reserve land for roundabouts in Sydney and predictably this means fewer roundabouts*. Sydney's arterial road network has responded to the fact that traffic signals provide far more efficiency per metre than roundabouts, whereas Bristol's has utilised the available space.

There are not many roundabouts on the NSW motorway junctions. This is a real pain because of the U-turn issue ([see below](#)) but also because you never know whether all of the ramps / directions are provided; more often they are not.

For roundabouts:

- They provide flexibility in the road network and the ability to perform *U-turns*. Not only useful when directional mistakes are made but they would accommodate the many banned right turns in Sydney where trying to reverse direction is almost impossible without relying on the local roads.
- They accommodate right turns more efficiently than signals.
- They provide favourable capacity when large enough and where the incoming volumes are *balanced*.
- They break-up the road surface area at large intersections and provide greater separation between opposing flows (many of Sydney's larger traffic signal intersections lack any form of directional guidance in the expanse of surfacing).
- They provide a *traffic calming* affect when introduced to the local road network.
- While you tend to get longer queuing with roundabouts (distance) it tends to be a *moving queue* rather than the stop / start pattern resulting from signals. Of course, you don't get the temptation to jump the red light at a roundabout, *but if you are not on a dominant approach the gap acceptance can become very tight*.

Against roundabouts:

- They do not provide the level of control that coordinated signals can when operated by a SCATS or SCOOT system.
- They do not provide for pedestrians [although](#) the left turn / pedestrian conflict ([at signals](#)) is far from ideal.
- They take up more land space per vehicle movement.
- They can be confusing to unprepared drivers.

Mackay Regional Council does favour roundabouts as the preferred treatment for crossroad intersections in local streets. Initially there was a relatively high rate of construction for roundabouts in residential areas. This was due to the need to treat local traffic areas that were constructed in the days of the 'block and grid' type residential development. These types of developments were dominated with cross road intersections that provided poor intersection control, and were characterised with high accident rates.

Developments are more sensitive to the needs of all road users nowadays and the need for roundabouts in residential areas is significantly less. As a result the construction of roundabouts in residential areas is becoming less common, and in many cases are being surpassed with less expensive treatments such as Modified T-Intersections.

Apart from the need to treat the 'block and grid' type residential areas that focused more on accident reduction than intersection performance, roundabouts are increasingly being used to [improve](#) intersection performance, and to simplify complicated intersections that are otherwise too expensive to treat with signalisation.

All too often Council considers signals over roundabouts for the control of major intersections. I have analysed signalised intersections that are failing and have tried roundabouts as a solution and have found the life of the intersection greatly extended past the capacity of signals. (However,) Council views *roundabouts as an evolutionary step before signals*. It is hard to convince the lay person (who often controls the budget) that a reversal of the intersection "evolution" from signals to a roundabout is the answer. Accordingly, a saturated (signalised) intersection is often treated through the construction of extra lanes, slip lanes and in some cases constructing alternate routes, rather than considering the option of a roundabout.

Statistics about roundabouts in your jurisdiction (how many roundabouts in total, residential vs major traffic roundabouts, etc)?

In the Australian Capital Territory (population 334,000 in 2006), we have around 220 roundabouts: 25 are on major roads, 63 on collector/distributor roads and the rest on minor/residential streets.

We have approximately 55 roundabouts and only approximately 14 sets traffic signals, which is a lot of roundabouts in an area servicing 90,000 people.

Brisbane City Council (population over 900,000) had about 200+ roundabouts in 1994. My understanding is that BCC now prefers signals for major road intersections (arterials and sub arterials). There has been a *movement away from two-lane circulating roundabouts* for safety reasons. Drivers still find them confusing.

The Queensland Department of Main Roads has one and two-lane roundabouts at the intersection of high speed rural roads, at the intersection of busy urban arterial roads and sub-arterial roads, at the intersection of lower speed sub-arterial roads and Local Authority collector roads and on the minor road at interchanges. The number of each is unknown.

The following estimates are available for roundabouts and traffic signals in the former Maroochy Shire Council area on the Sunshine Coast (population close to 300,000):

	State Controlled (Maroochy Area)	Maroochy Shire Council Jurisdiction
Roundabouts	25	62
Traffic Signals - Intersection	43	27
Traffic Signals - Pedestrian Crossing	12	7

We have 15 roundabouts on State Roads in Western Australia.

In 1995, there were some 220 roundabouts in Tasmania (population 485,000 in 2005). About 25 of these are on State roads and the other nearly 200 on local road intersections. There are roundabouts presently in 21 of the 29 municipalities in the State.

What is our current experience with roundabouts in terms of efficiency (delays, congestion), environmental aspects and safety?

As long as the roundabouts are operating within capacity they are very efficient.

We do have a number of very large roundabouts, e.g. Kings Ave/Parkes Way, that come out quite badly in terms of total crashes, but they tend to be crashes that do not involve injury.

It is my opinion that roundabouts are much more efficient than signals. However, the perceived efficiency of a roundabout by motorists is distorted by the level of difficulty using roundabouts compared to signals. Motorists are content to wait on average 90 – 120 s for a green signal telling them when it is safe to enter the intersection. This is easy and requires a relatively low level of concentration. The level of concentration and alertness required to assess a roundabout and determine a safe gap in circulating traffic to enter the roundabout is difficult to maintain. Accordingly, motorists soon lose patience with roundabouts even though the actual delay using the roundabout is less than that would be required for signals.

Roundabouts are more suited to local roads or rural arterial roads.

A paper is available on road safety benefits from a roundabout installed at a shopping strip with pedestrians on all legs (2). Generally, consistent excellent road safety benefits, but depends on the installation and circumstances.

Controlling speeds through roundabouts by their design is paramount in maximising the safety performance for all road users. The most important geometric consideration in controlling vehicle speeds through roundabouts in the application of appropriate *entry curvature*. The USA, UK and the Queensland Department Main Roads all specify requirements for entry path curvature. The current national criteria for controlling speeds through roundabouts, however, is achieved by using the old measure of *deflection*, which is measured as a maximum radius of 100 m through the circulating carriageway, given a number of parameters (3-5). The second draft of Part 4 of the AUSTROADS Guide to Road Design series "Intersections and Crossings" is to incorporate a model for entry curvature in lieu of deflection. This model has been developed from a study by Arndt (3,4), the results of which are incorporated into the Queensland Road Planning and Design Manual, and will be presented as a paper at the 23rd ARRB Conference (5). The AUSTROADS Guide to Road Design and Guide to Traffic Management series are intended to replace all of the current Guide to Traffic Engineering Practice and Guide to Road Design series by the early 2009.

If careful consideration is given to the location, traffic conditions and the geometric design, roundabouts can provide an efficient and safe solution.

[The overall poor understanding of the use of roundabouts result in inefficiencies.](#) Better use may also offset cases of *movement dominance* where road authorities revert to controlling approaches.

Roundabouts are safer than traffic signals. They provide low severity of crashes. In some cases roundabouts are better than traffic signals especially in T-intersections for reduction of delay time.

Are roundabout metering signals in use in your jurisdiction (and how many)?

Are there any fully-signalised roundabouts (all approaches as well as circulating roads controlled by signals) in your jurisdiction?

The Queensland Department of Main Roads would only have a few roundabouts around the state that comprise metering signals (the UK *indirect control* form of signalisation of roundabouts).

The Queensland Department of Main Roads has one fully-signalised roundabout (Gateway Arterial Rd and Airport Drive) which has signals fitted to each entry and circulating carriageway adjacent to each entry (the UK *direct control* form of signalisation of roundabouts).

There used to be a partially signalised roundabout in Sydney but that has been converted to a signal cross intersection, which may give a clue as to the future of roundabouts in Sydney. Bristol has a handful of fully controlled roundabouts in the city and on the motorway junctions, purely because they provide enough queuing capacity on the circulation. They are everywhere in UK, including the Heathrow airport entry.

There is one roundabout with metering signals in the ACT at this stage with another possible next year. There are no fully-signalised roundabouts in the ACT.

There are no roundabouts with metering signals or fully-signalised roundabouts in Western Australia.

There are no roundabouts with metering signals or fully-signalised roundabouts in Penrith City Council area.

Recently, a traffic signal metering system was installed on the minor approach of the Midway Point roundabout at the intersection of Tasman Highway and Penna Road.

The major roundabout at Brooker Avenue - Liverpool Street has been in operation for many years.

No roundabout metering exists on the Sunshine Coast.

There are no signalised roundabouts on the Sunshine Coast, however the Queensland Department of Main Roads are currently converting a large two-lane roundabout at the Sunshine Motorway - Maroochydore Road interchange to a signalised "Squareabout" which will have four sets of traffic signals ([see below](#)).



Author's Notes:

1. A paper by the author describes a major project undertaken for VicRoads, the state transport authority in Victoria, for field investigation of the performance of roundabouts with metering signals in Melbourne, Australia (6). The list of all roundabouts with metering signals considered for surveys in this project is given in *Table 1*, and their locations are shown on a map in *Figure 1*. Three roundabouts (not surveyed) included in this list are shown in *Figures 2 to 4*.

Victoria appears to be the State with most roundabouts with metering signals in Australia.

Table 1 indicates that there are not many single-lane roundabouts with metering signals.

A senior engineer stated that it would be preferable to change a single-lane roundabout which is experiencing congestion problems to a two-lane roundabout for additional capacity rather than introducing metering signals (since this would provide a longer design life).

2. The recent cost of installing metering signals on one leg of a roundabout in Victoria was stated as AUD \$80,000 to 90,000. This cost includes all civil and electrical works and control equipment. This compares with around AUD \$170,000 for freeway ramp metering at one location (higher due to more extensive signage including electronic signs).
3. In relation to the introduction of metering signals at the Midway Point roundabout mentioned above, a news release titled "Midway Point Traffic Flow Improved" was issued in Sep 2007 by the State Minister of Construction (Tasmania). It included the following statements:

Cutting-edge technology is to be installed at Midway Point to improve traffic flow in the weekday morning peak-hour.

Consultants have identified a number of projects in the study area, including a clearway in Cole St, Sorell; a metered signal on Penna Rd, Midway Pt; and traffic management works in Sorell.

A metered signal to be installed on Penna Road at Midway Point will operate only during the morning peak period. For the rest of the day, the normal roundabout arrangements will operate.

The signal will create gaps at the existing roundabout for Tasman Highway traffic by making Penna Road traffic stop at a red signal in the vicinity of the Fenton Street junction. These gaps will reduce the queue lengths on the Tasman Highway.

The Sorell Council will letterbox all residents at Midway Point before the commissioning of the metered signal to inform them of the traffic management changes.

What is the public's view on roundabouts (car and truck drivers, pedestrians, cyclists, etc)? Does everybody love them or do we have opposition?

Drivers of passenger cars generally like roundabouts (especially single lane) except maybe for elderly drivers and drivers in areas where there are no roundabouts. There appears to be different opinions as to whether truck drivers like roundabouts.

In general, pedestrians probably dislike roundabouts, particularly higher speed multi-lane roundabouts that make it difficult to cross the entrances and exits. Cyclists hate roundabouts, particularly higher speed multi-lane roundabouts. And not without reason, because cyclists are way over represented in accidents at roundabouts compared to other road users.

Careful design minimises complaints.

<p>I do not think Sydneysiders like roundabouts, simply because there are not many. To know whether Brits like them you should go to Swindon (look at the Google earth imagery, but do not mention the Magic Roundabout, everyone else will anyway).</p>
<p>Roundabouts are generally less pedestrian friendly than signals and are a concern for parents with young children. I have had direct feedback on this from the public. However, given the right situation and traffic volumes, most arterial road roundabouts seem to be working satisfactorily (anecdotal evidence only).</p>
<p>My experience with community consultation for Local Area Traffic Management (LATM) programs has given me the impression that <i>roundabouts are the least understood type of intersection</i>. Give Way (Yield) rules are the most confusing issue with the public as fact is often mixed with urban myth.</p> <p>I have a lot to do with various traffic committees from road safety to the determination of speed limits. While roundabouts reduce the accident rates of motor vehicles, there is increasing evidence that they may increase the accident rates for cyclists and pedestrians. Roundabouts are notoriously difficult to design for cyclists and pedestrians. For example, the approaches to roundabouts often create squeeze points creating conflict points between motor vehicles and cyclists, and pedestrians often cross within the circulating lane of roundabouts due to the offset nature of the pedestrian path.</p>
<p>I think most people hate them, but this is just a perception.</p>
<p>Generally positive, I think. Pedestrians and cyclists can have problems at busy roundabouts. Motorists seem reasonably happy as long as they are operating within capacity.</p> <p>We do have quite a few roundabouts in the Tuggeranong area that widen from one lane on the approach to two lanes at the give-way line but then quite quickly transition back to one lane after the exit. This arrangement is not universally liked.</p>
<p>For those who understand the way to use the roundabouts, they are favoured but it will take time to have total community's understanding and acceptance. They are still relatively new to Australia as a traffic control option. In many ways, it will be the generational factor not educational programs that will improve acceptance / use; hence full acceptance will evolve over time.</p>
<p>Pedestrians and truck drivers do not like roundabouts</p>
<p>No significant opposition to roundabouts in Casey - possible issues with cyclists and pedestrians</p>
<p>I have found that generally the public feedback has been very good in our area. The benefit of the roundabout is that, in effect, you can have four filter turns operating at an intersection and do not necessarily have to stop if sight distance is adequate, but slow down and pass through the device. There have been comments by residents that roundabouts are exceptionally good. When we receive requests for upgraded intersection controls, roundabouts are almost always at the top of the list for local roads.</p>
<p>There are varying opinions on Roundabouts and Traffic Signals. However, in the regional area of the Sunshine Coast, the public generally prefer roundabouts as first choice based on the pros mentioned below.</p> <p>The pros for roundabouts are:</p> <ul style="list-style-type: none"> ▪ Perception that they better for minimising delays because there is no waiting at red lights. ▪ Reduce delays during off-peak operation.

- Reduced traffic speeds along the main road.
- More aesthetically pleasing because they can be landscaped.
- In small villages, rural communities and suburban areas in cities and towns located outside the metropolitan area, roundabouts are the preferred intersection treatment. These communities prefer to maintain a relaxed atmosphere without the congestion that occurs in metropolitan cities. Traffic lights are perceived to be associated with congested networks and therefore traffic signals are not welcome in these communities.

The cons for roundabouts are:

- Two-lane roundabouts are not pedestrian or cyclist compatible.
- Priority cannot be given to pedestrian movements at roundabouts which is a particular concern in City, Town and Village Centre areas.
- They interrupt traffic flow along the major road.
- They provide the minor road with equal priority to the major road which is good for the minor road but not for the major road. Minor road movements which have priority over major road movements can cause significant disruption to major road flows.
- They do not handle two major opposing flows very well.
- They reduce legibility of the major road network. This is a particular problem in areas where there are high percentages of visitors who are unfamiliar with the road and street network.
- Greater space is needed to build roundabouts, which often is not available in the CBD and suburban areas of older cities and towns when retrofitting.

What effort is being made for educating road users (drivers, cyclists, pedestrians) in using roundabouts correctly?

Driver education can only really respond to the dominant road features. Sydney does not have many roundabouts in comparison to UK therefore the education level is low. Some of Sydney's highest accident locations are roundabout intersections. The RTA NSW roundabout guide is hardly rocket science, stating that you should give way to vehicles already on the roundabout, *what about the car speeding towards the roundabout on the approach to your right?* Nobody in the world knows how to indicate (signal) properly and you cannot indicate that you are doing a U-turn. It would be interesting to compare roundabout accident data between Australia and UK or other countries.

There does not appear to be much education being given at the moment to the general motoring public in Queensland on how to use roundabouts. For some roundabouts (especially multi-lane roundabouts with more than four legs), it is virtually impossible to produce information on the appropriate selection of lane choice on all configurations of these roundabouts.

This issue is discussed with respect to line marking these roundabouts, as given in Section 14.3.5 'Line Marking of Multi-lane Roundabouts' (pages 14-13 to 14-18) of the Queensland Road Planning and Design Manual. For this reason, the Queensland Road Planning and Design Manual recommends against designing these types of roundabouts. The UK Design Manual for Roads and Bridges has the same recommendation.

The correct use of roundabouts has been included in previous ACT road safety campaigns and advertisements: www.tams.act.gov.au/move/roads/road_safety/road_rules_reminders

It is also covered in the ACT road rules handbook, the mandatory Road Ready pre-learner course, training and assessment procedures for novice drivers, and the ACT Older Drivers' Handbook.

<p>RTA NSW has some useful information on roundabouts on their website: www.rta.nsw.gov.au/rulesregulations/roundabouts.html?tlid=4</p>
<p>Responsibility for educating motorists on road rules primarily lies with Queensland Transport. Some effort has also been made in the past by the RACQ (local automobile club) in Queensland regarding the use of and marking of multi-lane roundabouts.</p> <p>Some effort has been made at the former Noosa Shire Council to educate motorists in this regard. The Travelsmart Noosa Program includes Roundabout Traffic Rules to educate motorists on the use of roundabouts which are the embraced concept for managing traffic movement at busy intersections in Noosa. These rules can be viewed at the following website: www.travelsmartnoosa.com.au/futurePlanning/RoundaboutTrafficRules.shtml</p> <p>More effort is still needed in this area, particularly in regard to the use of multi-lane roundabouts.</p>
<p>There appeared to be some education campaigns in the past. Continuing this would assist motorists.</p>
<p>From a paper written in 1995: The two major failings on the part of motorists using roundabouts across the State (Tasmania) are considered to be <i>failure to use indicators</i> and <i>waiting for excessively long gaps</i>. While it may not be clear to motorists at times which indicator to use when turning at complex roundabouts, poor use of the indicator at simple roundabouts is a symptom of generally poor driver behaviour.</p> <p>At other than very small roundabouts the capacity for the roundabout to accept entering traffic is much higher than for a standard give way sign control. However, all too often motorists tend to wait at the holding line for vehicles on their right or vehicles diagonally opposite that might be turning right. The poor gap acceptance behaviour may not be an issue at low trafficked locations, but can have an effect on the efficiency of the roundabout performance at busier locations or during peak hours. It can also lead to frustration for delayed motorists.</p>
<p>Author's Note:</p> <p>Refer to a paper by the author (7) on the relationship between driver behaviour and intersection capacity.</p>

Do you use models other than SIDRA INTERSECTION (8) for roundabout analysis?

<p>No, just SIDRA INTERSECTION (three respondents).</p>
<p>SIDRA INTERSECTION analysis is our primary tool for assessing operation of intersections.</p>
<p>No other software currently. I used INTANAL previously.</p>
<p>We have used INTANAL and still have access to the software, but favour the use of SIDRA INTERSECTION.</p>
<p>Queensland Main Roads uses SIDRA INTERSECTION for the capacity and delay calculations at roundabouts.</p> <p>Queensland Main Roads also uses Chapter 14 of the Road Planning and Design Manual and ARNDT (A Roundabout Numerical Design Tool) for the safety analysis / design of roundabouts.</p>

There is no substitute for real time observation and onsite calculation of an intersection's performance. Engineering judgement and experience is still the most reliable tool for intersection analysis. SIDRA INTERSECTION is a very valuable modelling tool to test assumptions made through engineering judgement and onsite observations.

We have been using PARAMICS microsimulation in some cases to determine the likely impacts on rerouting of traffic flow.

In terms of modelling, I used to use ARCADY in UK to model roundabouts. ARCADY or RODEL asks for far more geometry input than SIDRA (flair taper, etc.), maybe you have found that this makes too small a difference in the results to be worth including.

Most often assessment of CBD networks having a series of closely spaced intersections is undertaken using simulation or microsimulation models.

Author's Note:

The roundabout capacity analysis method used in the SIDRA INTERSECTION software was originally based on the method described in ARRB Special Report SR 45 (9) which was introduced into SIDRA INTERSECTION with some variations and extensions. The SR 45 method was also incorporated into the AUSTROADS (1993) Roundabout Guide (10) with some minor modifications. Subsequently, significant enhancements were introduced in various versions of SIDRA INTERSECTION (11). The analysis sections of the AUSTROADS Roundabout Guide were revised by the author for incorporation into a revised version of the guide (12). The revision ensures better compatibility between the Guide and the SIDRA INTERSECTION software.

What do you think about the future of roundabouts in Australia?

The future of roundabouts in Australia is expected to be similar to the current usage. One issue that regularly gets raised is how to allow for *cyclists at roundabouts*. Current treatments include no allowance, peripheral cycle paths with crossings on the entrances and exits, bike lanes around the outside of the circulating carriageway and on the entrances and exits with or without splitter islands and mid-block crossings only. There is no agreement among the various stakeholders as to the best solution. Even the cyclist lobbies disagree with each other.

There will always be a place for roundabouts in suitable locations. The main arguments against them would be limited capacity. In the ACT, there is a reluctance to design roundabouts with more than two approach lanes. [This considers](#) the fact that they do not provide for pedestrians and cyclists particularly well.

Roundabouts will always be considered as a valid intersection treatment and will be implemented where the right circumstances exist.

Very good. We are likely to see many more installations, particularly in urban areas.

I believe that the general public has become used to the roundabout as an intersection control especially in residential areas. I would see the roundabout having a place in Australia for the years to come as long as they are justified and properly designed and education of motorists continues.

CONCLUDING REMARKS

Various comments by respondents given in this paper could be summarised as follows.

Australia is continuing to build roundabouts but new installations are mostly in *newly developed residential and commercial areas*.

A respondent from Queensland stated that "other intersection forms (unsignalised and signalised) are built more often than roundabouts. This has always been the case.". Respondents from New South Wales indicated that there were not as many roundabouts in Sydney where signalised intersections played an important role.

When a new intersection is built (or an unsignalised intersection is upgraded), usually both *roundabout and signal options* are considered. The factors mentioned in relation to the choice between these two intersection types included capacity and safety, implementation cost, space available, location (urban, suburban, rural, CBD), impact on pedestrian and cyclist movements, operating speeds, traffic movements through the roundabout, number of heavy vehicles, the number and angle between legs, form of control at adjacent intersections, signal coordination, future considerations, and social impacts.

Many respondents referred to the issue of *unbalanced flows* at roundabouts. Refer to papers by the author on unbalanced flows and metering signals (6,13-18).

Overall trend is to *replace roundabouts with signals* rather than the other way round. The reasons for this trend were stated as roundabout capacity limitations, unbalanced flow situations and better allowance for road users such as pedestrians and cyclists. Replacing a roundabout with signals due to capacity reasons applies particularly to two-lane roundabouts since it is not common for roundabouts to be expanded to three-lane ones to improve capacity (although it occasionally happens). Conversion of a large two-lane motorway interchange roundabout to a signalised "Squareabout" with four sets of traffic signals was mentioned.

Roundabouts replacing signals in the past has been mentioned by one respondent. Another respondent commented that some see roundabouts as an evolutionary step before signals, and accordingly, a saturated signalised intersection is often treated through the construction of extra lanes, slip lanes and so on, rather than considering the option of a roundabout.

Difficulties for *pedestrians and cyclists* were acknowledged by most respondents. One respondent stated "Roundabouts are notoriously difficult to design for cyclists and pedestrians.". Another stated that "... pedestrians complain that multi-lane roundabout (two or more lanes at entry or exit) are hard to cross.". Difficulties by trucks, disabled people and school children were also mentioned.

There was an agreement that single lane roundabouts are popular. Three-lane roundabouts were not favoured. One respondent mentioned "movement away from two-lane roundabouts".

In relation to the efficiency of roundabouts, one respondent stated that "roundabouts are much more efficient than signals" but "motorists soon lose patience with roundabouts even though the actual delay using the roundabout is less than that would be required for signals". Another respondent stated "Roundabouts are more suited to local roads or rural arterial roads.". There was a general agreement about safety of roundabouts.

One respondent stated: "In general, a well-designed roundabout is the safest type of intersection control. Numerous international studies have shown that in general, fewer vehicle accidents occur at roundabouts than at intersections containing traffic signals, stop or give-way (yield) signs. Unfortunately, this same safety performance does not apply to pedestrians and cyclists. "

It appears that there is a significant level of *road user education* in the use of roundabouts. There was a general agreement on the need for better (a higher level of) education. The issues mentioned were *failure to use indicators* and *waiting for excessively long gaps*, giving way (yielding) to vehicles on the right or vehicles diagonally opposite that might be turning right (driving on the left-hand side of the road).

The respondents did not indicate many roundabouts with metering signals or fully-signalised roundabouts in their jurisdictions. However, roundabout metering signals are drawing much attention in Australia currently (as an alternative to replacing roundabout with a signalised intersection) due to growing demand flows at roundabouts (6). Victoria appears to have the largest number of roundabouts with metering signals (see *Table 1* and *Figure 1*). The recent cost of installing metering signals on one leg of a roundabout in Victoria was stated as AUD \$80,000 to 90,000.

Statistics about the *number of roundabouts in Australia* were not readily available. The number of roundabouts given by several respondents indicated a range of 1500 to 4500 persons per roundabout (average 2700 persons per roundabout). If this were representative of Australia (!), we could estimate roughly **8,000** roundabouts in Australia (population about 21 million). This is well short of 15,000 roundabouts mentioned on the US Insurance Institute for Highway Safety website (www.iihs.org/research/qanda/roundabouts.html). If the USA had roundabouts at the same rate as Australia (corresponding to 8,000 roundabouts), there would be well over 100,000 roundabouts in the USA (population about 300 million)!

Some interesting details were also mentioned:

- We should consider using *stop signs* at roundabouts rather than give-way (yield) signs, when there is insufficient sight distance.
- The current Australian criterion for controlling speeds through roundabouts is *deflection* measured as a maximum radius of 100 m through the circulating carriageway (10). This will be changed to *entry curvature* (3-5).
- For safety reasons, RTA NSW is modifying all multi-lane zebra crossings (two lanes each way) on State roads, by signalising the crossing or narrowing the zebra crossing to one lane each way.

Most respondents agreed that roundabouts will continue to play an important role in Australia in the future. One respondent stated "the general public has become used to the roundabout as an intersection control especially in residential areas. I would see the roundabout having a place in Australia for the years to come as long as they are justified and properly designed and education of motorists continues."

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Table 1 - List of roundabouts with metering signals in Victoria, Australia

Site No.	Site Name	Legs	Lanes	Notes	Type
VicRoads Metropolitan South East Region					
725	Fitzsimons Lane / Porter St, Templestowe	4	3	Queue loop on Porter St (East). POS activated on Fitzsimons Lane (North).	POS
974	South Gippsland Hwy / Pound Rd, Hampton Park	4	2	Queue loops on South Gippsland Hwy (North). Metering signals on South Gippsland Hwy (South)	RMS
2342	Nepean Hwy / McDonald St, Mordialloc	3	2	Queue loops on Beach Rd (South) POS activated on McDonald St	POS
3172	Dandenong-Hastings Rd (Western Port Hwy) / Thompsons Rd, Lyndhurst	4	2	Both approaches of Thompson Rd are metered. Eastern App in the AM and Western App. in the PM	RMS
620	Dandenong-Frankston Rd / Thompson Rd, Bangholme	4	2	Both approaches of Thompson Rd are metered. Eastern App in the AM and Western App. in the PM	RMS
3623	Princess St / Willsmere Rd, Kew	6	2	Metered signals activated by buses only.	RMS
3709	Beach Rd / Nepean Hwy, Mordialloc	3	2	Queue loop in Nepean Hwy. Activated by POS in Beach Rd.	POS
4638	Boundary Rd / Lower Dandenong Rd, Mordialloc	4	3	Queue loops in Lower Dandenong Rd (East). POS activated in Boundary Rd (North)	POS
3715	Boundary Rd / Governor Rd, Braeside	4	3	Queue loop on Boundary Rd (South). Metered signals on Governor Rd (East)	RMS
VicRoads Metropolitan North West Region					
2816	Greensborough Bypass / Diamond Creek Rd, Greensborough	4	2/3	Civic and Diamond Ck South metered	RMS
2169	Mickleham Rd / Broadmeadows Rd Deviation, Tullamarine	3	2	Mickleham Road South metered	RMS
2701	Melton Hwy / Sunshine Ave, Taylors Lakes	4	2/3	Melton West and Sunshine South metered	POS
2866	Melrose Dr / Matthews Ave / Mascoma Rd, Strathmore	5	2	Melrose North and South metered	POS
1007	Tullamarine Fwy EB / Bulla Rd, Essendon North	4	2	Bulla Road South metered.	RMS
2743	Calder Fwy / McNamara Rd, Airport West	4	1	Calder Fwy exit ramp metered	RMS
3519	Mt Alexandra Rd / Bulla Rd / Keilor Rd, Essendon North	4	2	Within roundabout for right turn to Lincoln metered	RMS
4659	St Georges Rd / Merri Pde, Fitzroy North	4	2	St Georges Rd North metered	POS
2399	Todd Rd / West Gate WB Entry, Port Melbourne	3	2	Todd Rd South metered	RMS
VicRoads South West Region					
5101	Separation St / Dunn St / Douro St, Geelong North	3	1	Separation St & Douro St metered	RLC
5010	Princes Hwy West / Anglesea Rd, Waurn Ponds	3	2	Anglesea Rd metered	RMS

POS: Pedestrian Operated Signal, **RMS:** Roundabout Metering Signal, **RLC:** Railway Level Crossing Signal



Figure 1 - Location of roundabouts with metering signals in Victoria (see Table 1)



Figure 2 - Intersection of Fitzsimons Lane and Porter Street, Templestowe (Site No. 725)

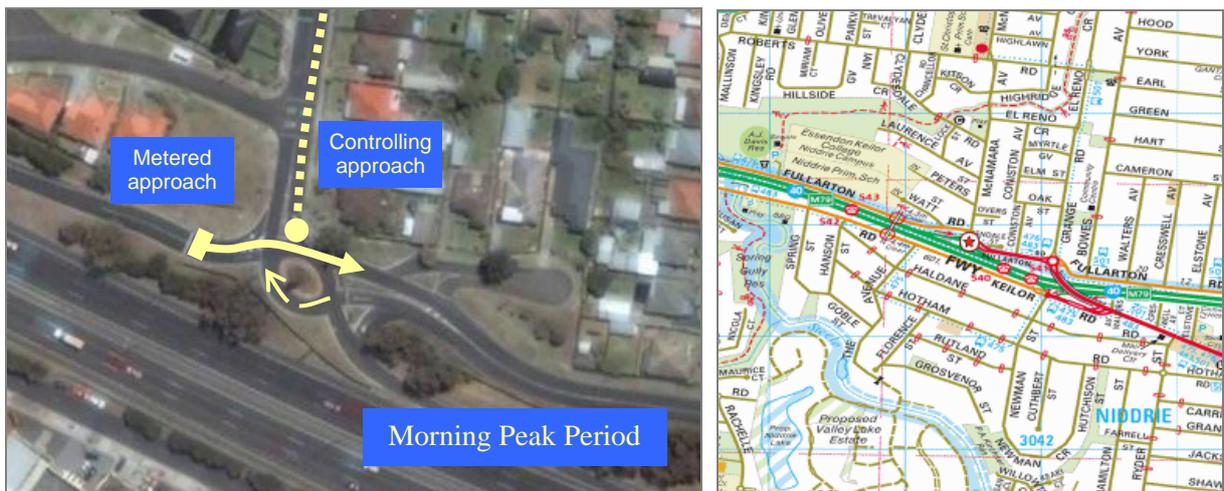


Figure 3 - Intersection of Calder Freeway and McNamara Road, Airport West (Site No. 2743)

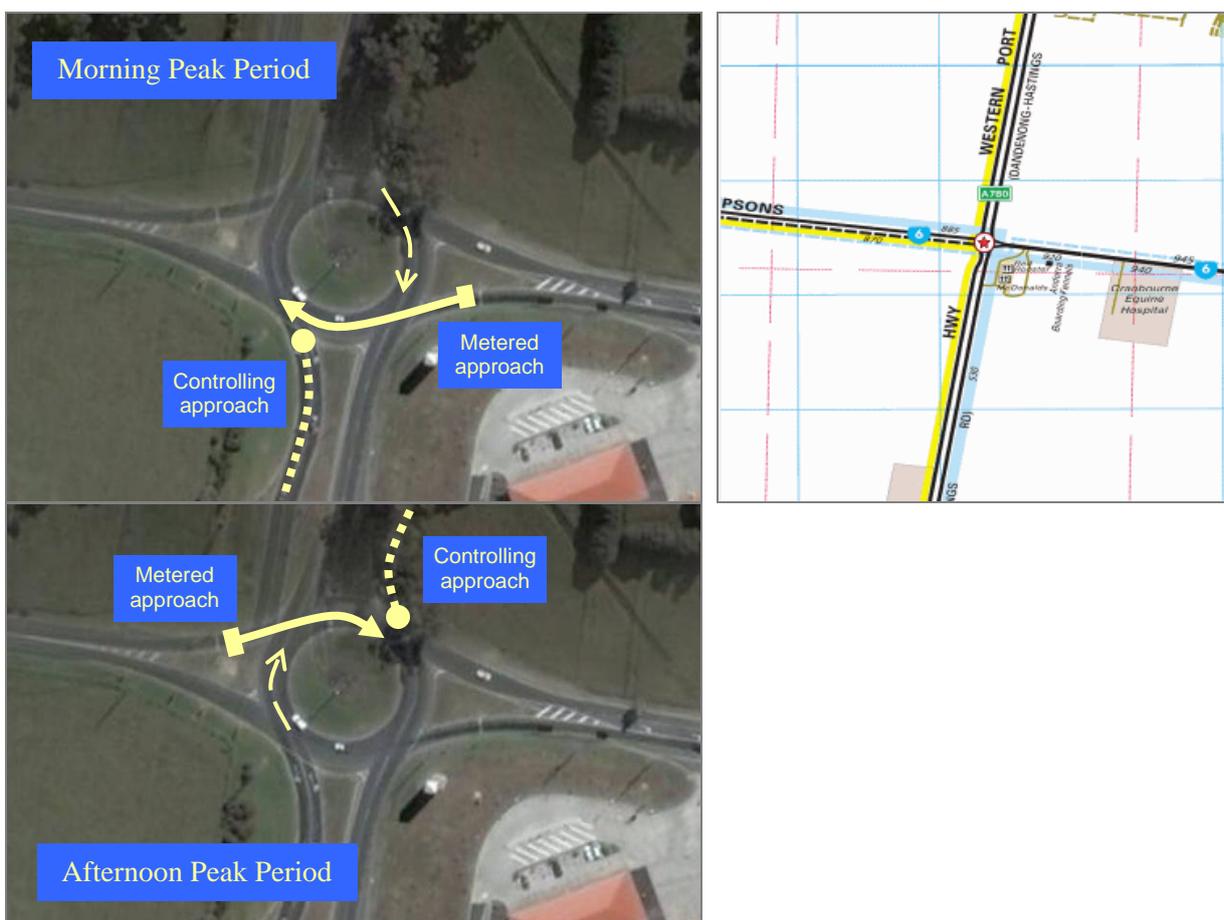


Figure 4 - Intersection of Dandenong-Hastings Road and Thompsons Road, Lyndhurst (Site No. 3172)