ROUNDABOUTS FOR THE U.S.A.

by Michael J. Wallwork P.E.

Introduction:

For many years traffic signals have been seen by traffic engineers, officials and the public as a panacea for traffic problems. Often they fail to meet our expectations. Delays worsen, the type of collisions change rather than the number of collisions, and overall driver frustration increases with the proliferation of stopping points. Traffic signals are considered by many to be aesthetically ugly, they consume significant quantities of electricity and require costly maintenance. Traffic engineers are also required to spend many hours in court as lawyers for the plaintiff try to prove that traffic signals are the cause of the accident rather than their client.

Some progressive traffic engineers are now beginning to consider a safer, cheaper, more efficient and aesthetic alternate - THE ROUNDABOUT.

Roundabouts have been used around the world for many years as an alternative to traffic signals in controlling speed, managing traffic and reducing accidents in a number of circumstances:

- on residential streets.
- on major and minor roads, because of their greater capacity and lower accident rates.
- at freeway interchanges, because their operation improves as left turn volumes increase.
- at "Y", multi-leg or offset intersections where the approach angle, number of roads or off-set across roads have little effect on operation.

Traffic Operations Engineer,
Florida Department of Transportation,
Jacksonville, Florida. Member.

Despite this worldwide success, their use in the USA is limited. When the subject of roundabouts is introduced in the USA, the most frequent reaction has been "They won't work" because "Motorists won't be able to cope with them". This reaction apparently arises because many engineers associate roundabouts with traffic circles. The latter seem to have a poor reputation because of congestion, significant accident rates, poor entry conditions and the high speed of maneuvering. Even so, there are a few engineers and consultants who have seen the enormous benefits of roundabouts and have designed and installed them in the USA despite a dearth of information and design standards.

But if you look at roundabouts and traffic circles in detail you will see that they are like chalk and cheese: The only similarity is that drivers drive around a central island. The basic concepts for these two types of devices are as follows:

1. **Traffic Circles**

Traffic circles have to be large (300+ feet in diameter) to facilitate high speed merge maneuvers within the circulating roadway. If the merge area is inadequate, the capacity is limited. Approaches to a traffic circle are either perpendicular to the central circle, requiring entering vehicles to turn right through ninety (90) degrees, or are designed to permit a high speed entry, merge and exit. This high speed environment requires drivers to be highly competent and alert. With the aging of our population, high-speed intersection environments are becoming less desirable.

2. **Roundabouts**

Roundabouts are usually small (5 to 120 feet in diameter) with approaches that are tangential to the central island and vehicle speeds physically constrained to 10 to 20 mph. Motorists enter by selecting a gap in the circulating traffic. Their only decision is whether or not the approaching gap is large enough for them to safely enter the roundabout. If there are no circulating vehicles they can adjust their speed and enter without stopping. The small diameter, low speed entry and low circulating speeds provide a slow speed environment where drivers can and do select very small gaps, often as low as one second.

To illustrate the difference between a traffic circle and roundabout imagine that they are cut and stretched out as shown below:

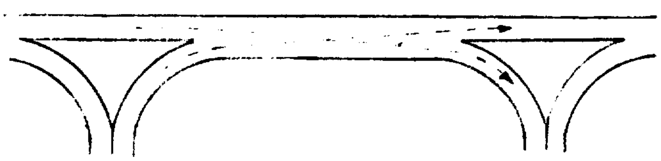

Figure 1
Traffic circle with high speed entry/exit

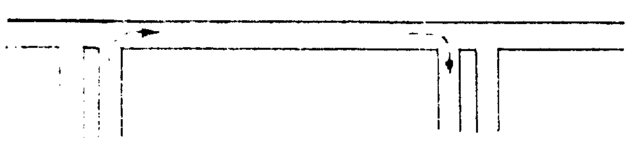

Figure 2
Traffic circle with perpendicular approach.

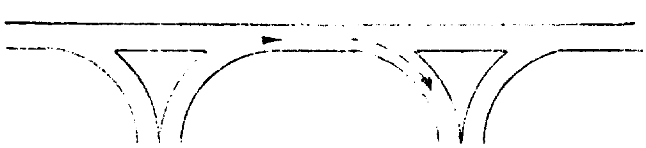

Figure 3
Roundabout

Figure 1 shows the typical traffic circle where high speed vehicles travel (circulate) along the top of the "Tee". To enter, drivers approach at speed, diverge right, and then must cross exiting traffic to merge left into the circulating roadway. If this merge distance is too short it limits capacity. High speeds force drivers to be cautious and select large gaps, thereby further reducing capacity.

In figure 2, entering motorists must turn hard right into a gap, then accelerate, to stay ahead of the approaching vehicle which is circulating at high speed. Consequently, drivers require large gaps to accomplish a safe merge. Because of the sharp turn, an approaching driver must stop before turning. Thus the required acceleration begins from a stop condition and reduces the driver's ability to take advantage of approaching gaps.

Drivers approach the roundabout in figure 3 tangential to the central circle, so that they may continue on without stopping if there is an approaching gap. On a multi-lane roundabout, because they must select a gap to enter the roundabout drivers can circulate and exit relatively unimpeded by other vehicles.

These illustrations show how roundabouts and traffic circles are dissimilar. Roundabouts and traffic signals are even less similar in concept and performance.

Roundabouts vs Traffic Signals:

1. Roundabouts have four (4) conflict points compared to thirty-two (32) at a four-way intersection controlled by a traffic signal or stop signs. Opportunities for a collision are thus substantially reduced by the roundabout design. No one can "run the red" and cause a right angle collision, nor make a mistake in selecting a gap in the approaching through traffic when making a left turn. Numerous research projects undertaken around the world show a fifty (50) to ninety (90) percent reduction in

accidents at roundabouts when compared to signalized intersections or four-way stop control. Accidents that do occur at roundabouts, rear-end or the merge type, are low speed, low impact collisions that result in few if any injuries.

2. By nature, traffic signals usually only permit two traffic movements to occur simultaneously in an intersection. Between phase changes, vehicles are only permitted to clear the intersection. No new vehicles may enter. This significant proportion of each traffic signal cycle is lost time - of no benefit to the approaching or waiting traffic. Compounding this inefficiency, any gaps that occur during the green phase (as is particularly common towards the end of the green phase) also represent lost time because no intersecting vehicle can legally move, except for right-turn-on-red. Lost time equals lost capacity. This lost time/capacity concern is increasing, as more traffic signals are coordinated, with longer cycle times, and resulting longer headways at the end of the main street or both through phases.

In contrast, it is possible for vehicles to enter even the smallest roundabout simultaneously from each approach with no lost time. The only restriction on entering a roundabout is the availability of gaps in the circulating traffic. Most of the time approaching vehicles do not have to stop, because as motorists approach a roundabout they can see other approaching vehicles, circulating vehicles, and available gaps in the circulating traffic. The driver can then adjust his speed to match and enter an approaching gap, or stop if no suitable gap exists. That is the only decision required. If uncertain, the driver may stop until a suitable gap occurs.

This simple decision making process, which occurs at low speed, is, in my view, the major reason for ready acceptance of roundabouts by drivers around the world and at the few hundred roundabouts in the USA. It is well documented in traffic engineering references that as speed decreases drivers select smaller gaps, travel at shorter headways, and thereby use available roadways more efficiently.

A typical example of this effect occurred when I worked in Melbourne Australia. Two signalized intersections with which I am familiar, Loyola Avenue/Twickenham Crescent and Fitzroy Street/Canterbury Road were converted to roundabouts without any change in approach conditions. All of the existing vehicle queues disappeared immediately. Years later a traffic count showed that there had been an approximately thirty (30) percent increase in traffic through the first intersection.

This graphic example of the direct comparison between the capacity of a roundabout and that of traffic signals, at the same intersections, encouraged others to replace traffic signals with roundabouts and even to choose roundabouts instead of traffic signals as an initial solution at problem intersections.

Roundabout Capacity:
What is the capacity of a roundabout? The breakdown point has been projected to occur at around 4500 vph, AADT around 90,000. However, in Melbourne, Australia, at the intersection of Royal Parade/Peel Street/Flemington Road, a three lane roundabout has a peak hour input of 5,500 vehicles, AADT of approximately 200,000, and average delay is only approximately ten (10) to twenty (20) seconds. Another, at Spencer Street/Riverside Avenue, carries 4400 vph at peak, including more than 20 percent commercial vehicles, and an AADT of 90,000. Both roundabouts have trams running through the middle at one (1) to three (3) minute headways with absolute right-of-way over circulating traffic. Less than one tram/car accident per year occurs.

In Daytona Beach, Florida, on State Road 430 at the Sea Breeze bridge over the intercoastal waterway, a single lane roundabout carries 2500 vehicles in the peak hour and an AADT of 66,000. In Spartanburg, South Carolina, a two lane roundabout with four approach roads plus freeway diamond interchange ramps carries an AADT of 77,000 vehicles.

Despite an early start for roundabouts in the USA, supported by some ITE founders and the "father" of Traffic Engineering in the USA, William Phelps Eno, they quickly faded from use. This occurred even though the gyratory control of traffic was considered the most intelligent option. The key concept that traffic engineers need to grasp is that, by physically restricting speeds, drivers are given time to make decisions. Even if they choose incorrectly, a collision is not necessarily the outcome because of the low speed of all involved vehicles.

In recent years several roundabouts have been constructed in Gainesville and Jacksonville, Florida. The City of Seattle discovered roundabouts about ten (10) years ago and now can't build them fast enough. Various developers have built them in Florida and South Carolina, but they have yet to receive general endorsement by traffic engineers.

Conclusion:
In concluding, I predict that engineers will increasingly realize that traffic signals are not the cure-all that they have been promoted to be and, adopting a more international outlook, will proliferate roundabouts in this last major bastion of the traffic signal. Roundabouts will be used in residential streets to reduce speeds and accidents, and on arterial roads to reduce accidents and provide a higher capacity. In all instances they will be more cost effective and aesthetic, leading to public acceptance first, and public preference in the foreseeable future.

References

1. K. Todd, "A History of Roundabouts in the United States and France", Transportation Quarterly Vol 42, No. 4, October 1988, (599-623).

2. National Association of Australia State Road Authorities, Roundabouts A Design Guide, Australia 1986.

3. Institute of Traffic Engineers and National Conservation Bureau "Traffic Engineering Handbook 1941, pp. 214-216.

4. Siew Mun Leong, Peter Muzuick, and George List, "Traffic Capacity and Delay at Roundabouts - The State of the Art", Working Paper for Unsignalized Intersection, Sub-Committee, Committee A 3A10, Transportation Research Board.

5. Institution of Traffic Engineers - Residential Street Design and Traffic Control, 1989.

6. R. L. Pretty, "Alternative Methods of Intersection Control Subject to Warrants", Traffic Engineering and Control, June/July 1983.

7. Al Maas, "Roundabouts", AASHTO Quarterly, April 1988.

8. C. Maycock and R. D. Mall, Accidents at 4-Arm Roundabouts, Transportation and Road Research Laboratory Report 1120.

9. N. Lalani, "Roundabouts; Impact on Accidents", Greater London Intelligence Quarterly, No. 32, September 1975.

10. N. Lalani, "The Impact of Accidents of the Introduction of Mini, Small, and Large Roundabouts at Major/Minor Priority Junctions", Traffic Engineering and Control, Dec. 1975.

11. G. Scott Rutherford, Robert L. McLaughlin and Edward Von Barstel, Traffic Circles for Residential Intersection Control. "A comparison with yield signs based on Seattle's Experience".

12. Transportation Research Board 64th Annual Meeting, Washington, DC, Jan. 1985.

13. Calvin Morman, "Experience with Roundabouts in the Australian Cap[ital Territory", Second National Conference on Local Government Engineering 1983