

Section E

Guidelines For Roundabouts

This section provides guidelines on roundabouts, including planning and designs for people, bicyclists and motor vehicles. This section provides guidelines detailing when and how to apply these recommendations.

Roundabouts

Born in America, these circular intersections remained largely un-built and unrecognized throughout North America until the past ten years. During the past thirty years, significant development and refinement of roundabouts took place in Europe, Australia and New Zealand and they are now becoming popular once again in the United States.

In the last decade as many as 200 roundabouts have been built in Florida alone, with hundreds more in North Carolina, Maryland, Vermont, Michigan, Kansas, Missouri, Colorado, Washington, Oregon, Hawaii, and California. Many transportation agencies, including the Federal Highway Administration, the Institute of Transportation Engineers, and the American Association of State Highway Transportation Officials, now endorse their use. The Insurance Institute for Highway Safety recommends that they be evaluated for most intersections. At least six states now have manuals guiding their use, placement and design.

Question: Why, after so many years of not building roundabouts is the U.S. considering them in many regions and locations?

Answer: Largely because roundabouts outperform almost all other styles of intersections in moving vehicles, retaining small compact intersections, adding aesthetics and bringing back human scale and pedestrian-friendly features. Although controversial, roundabouts are proving their worth to many skeptics — one town, one person, one user group at a time. The acceptance rate for roundabouts before installation is almost always 30%, and post-installation approval rates jump to 70%

Shown below and left:

Gateway entry into Fort Pierce, Florida. This place was once an ugly, dysfunctional four lane signalized intersection. All approach roads are now two lanes each, handling more traffic than before, and with no delays. Pedestrians find crossing pleasant. The site is part of Fort Pierce's entry into town and the 21st Century. The treatment is the result of forward thinking transportation planners, traffic engineers, and city designers and the formation of inter-agency partnerships. Geometric changes were funded by the Florida Department of Transportation, while landscaping was paid for by the City of Fort Pierce. Typical of most single-lane roundabouts, it is capable of handling up to 25,000 vehicles, 2,500 during peak hours.

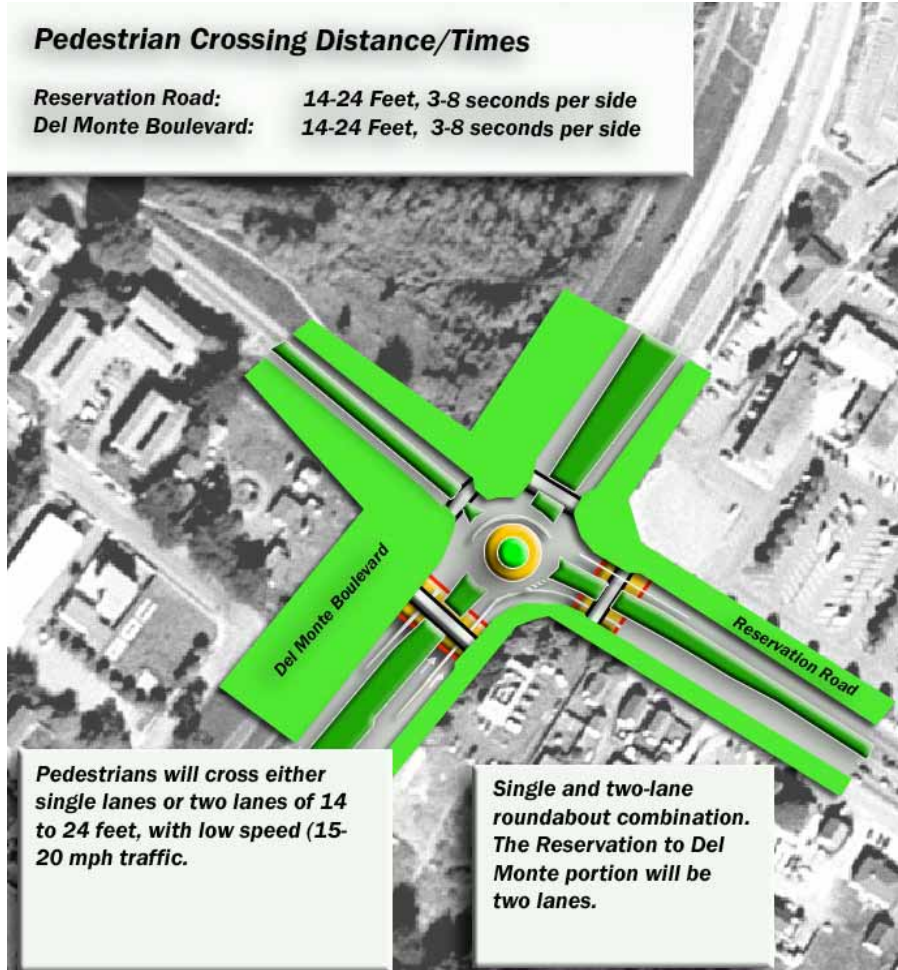




Pedestrian Crossing Distance/Times

Reservation Road: 14-24 Feet, 3-8 seconds per side
Del Monte Boulevard: 14-24 Feet, 3-8 seconds per side

Today the intersection of Del Monte Boulevard and Reservation Road is overly wide, with high speed turns. A single lane roundabout should be modeled and tested to convert this intersection into a compact gateway. If proven workable in an engineering study, the roundabout would add many benefits to the emerging town center such as making it easy to gain access to open space, the new proposed library and many other amenities.



Pedestrians will cross either single lanes or two lanes of 14 to 24 feet, with low speed (15-20 mph traffic).

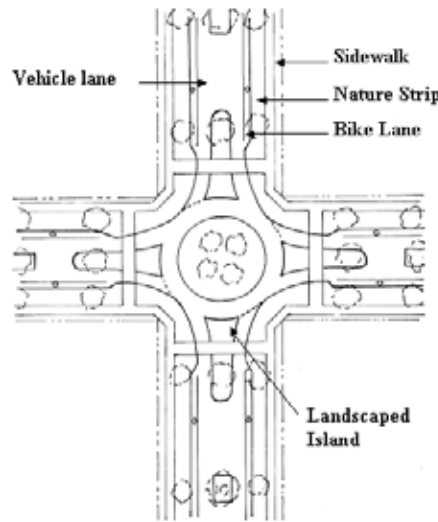
Single and two-lane roundabout combination. The Reservation to Del Monte portion will be two lanes.

Roundabouts Policy

Roundabouts should be evaluated for all major primary roadway intersections. When roundabouts are chosen as the best design they will be designed, constructed, maintained and operated for pedestrian-friendly speeds (typically 15-20 mph in commercial areas and 20-25 mph in more remote locations).

Various parts and features of roundabouts appear in these two illustrations. Common elements include center islands, truck aprons, splitter islands, circulating lanes, sidewalks, medians and other gateway features. Single lane roundabouts can often handle up to 20-25,000 vehicles per day. Some single lane roundabouts can handle even higher numbers.

ROAD DESIGN CONCEPTS



- Slows down traffic
- Safe for pedestrians
- Attractive
- Environmentally friendly

ROUNDABOUT





Roundabout Parts Detailed

Roundabouts have central islands and truck aprons to guide the deflection of cars while handling the rear wheels of large trucks. Splitter islands help slow arrival and departure speeds, providing islands to shorten pedestrian crossings. Engineers use combinations of medians, flares, curb extensions and the raised truck aprons to set deflection paths that reduce motorist speeds to appropriate levels (in urban areas to 15-22 mph).

Medians have openings for pedestrians to get into and out of the street with minimum delay. Although these islands are not always possible, all larger roundabouts have them, allowing pedestrians short crossings between non-motorized zones.



Roundabouts Beautify Towns

Each of these two sets of scenes depict before and after conditions at roundabout controlled intersections.

Signal and stop control intersections have a number of disadvantages including a general lack of charm. With traffic slowed to 15-20 mph it is possible to increase landscaping and the attractiveness of important corners.

Roundabouts Improve Traffic Flow

Today many motorists are traveling through stark and unwelcoming Gridley, California on Highway 99 at high speeds. In the second scene below the signals are removed and replaced with a roundabout. Should the conversion occur, speeds would be lowered to 30 mph through town, and 15-22 mph at each intersection.

The change in travel time through town improves with the elimination of signals. Today the journey takes approximately two and a half minutes. With the roundabout scenario, time and speed drop to one minute and forty-five seconds, and vehicles will move at an appropriate speed of 30 mph, rather than at 50 mph.



Before and After Intersections

As a general rule, properly designed roundabouts benefit pedestrians by reducing potential for injuries by 50%, reducing conflicts from six to one at a time, reducing delay waiting for signals, and greatly increasing motorists' yielding behavior. Roundabouts also calm traffic up to four or five street approaches at once, help green up an area and reduce ambient noise levels, all while moving motorists. Often through use of more efficient roundabouts streets can be kept to just 2-3 lanes, instead of expanding to 4-5 lanes. This has direct and great benefit to all pedestrians, motorists and residents.



Roundabouts Keep People Moving Safely

Roundabouts are used throughout the world in countries such as Europe, Australia and in recent years here in the United States to reduce injury accidents, traffic delays, fuel consumption, air pollution and construction costs, while moving more traffic and enhancing intersection beauty. They have also successfully been used to control traffic speeds in residential neighborhoods and are accepted as one of the safest types of intersection design.



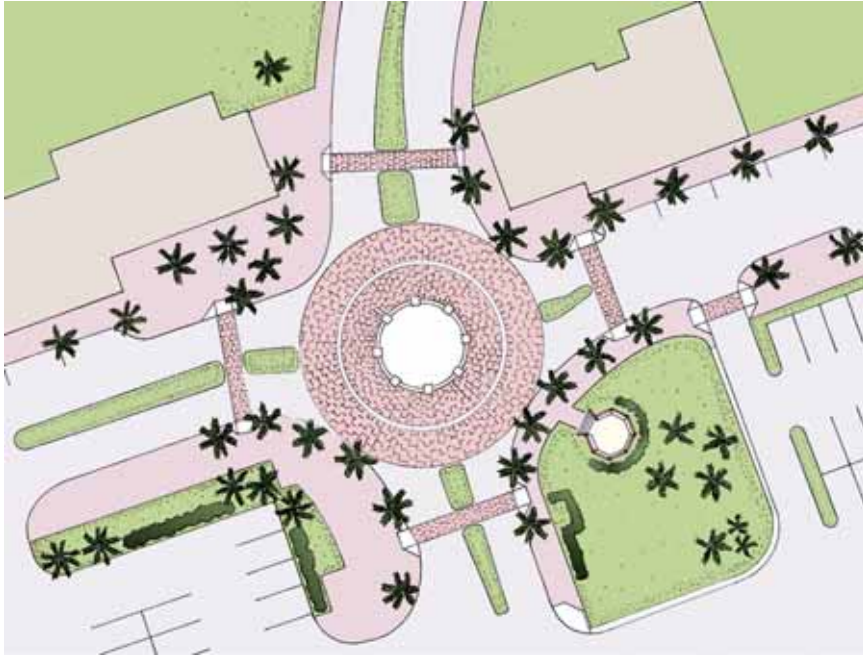
Circles, Roundabouts and Mini-



Roundabouts are circular intersections but very different from traffic circles or rotaries used previously in this country. The major differences between traffic circles and roundabouts are:

- **Yield at Entry:** At roundabouts the entering traffic yields the right-of-way to the circulating traffic. This yield-at-entry rule keeps traffic from locking-up and allows free flow movement.
- **Deflection:** The splitter and center island of roundabouts deflect entering traffic and reinforce yielding.
- **Flare:** Entry to roundabouts often flares out from one or two lanes to two or three lanes at yield lines to provide increased capacity (ability to move traffic).
- **Speed:** Roundabouts are designed for slow vehicle speeds. Pedestrian-friendly roundabouts do not permit higher speeds common to circles.
- **Size:** As a general rule, roundabouts fill the space of a baseball infield, while circles can fill the entire playing field. Thus, size and right-of-way differences are vast.





The Fort Pierce roundabout takes advantage of good quality area buildings, adjacent marina, gazebo and other community building elements. This intersection was once a blemish on the town. A tall high voltage pole was moved, four lanes of signals were taken down and the area was transformed into a prominent gateway and celebration place.

The intersection is now a focal point of arrival and the site of annual Christmas, Easter, Fourth of July and other celebratory events for this largely working class agricultural town.





Architectural and Landscaping Details:

Roundabouts, like the best buildings, have many elements that please the heart of those attracted to take a stroll to the most central place in the neighborhood or town.

Quality roundabouts take advantage of pavement textures and color, styles and materials used in curbing, floral beds, trees, shrubs, pilasters, bollards, lamps, posts, banners, monuments and fountains.

Engineers, architects and landscape architects need to work together to achieve the best geometric, operational, functional controls, and then assure that treatments enhance neighborhoods or town centers.

There is far more room for creativity when designing a roundabout than a more conventional signal or stop control intersection.



Roundabout Safety

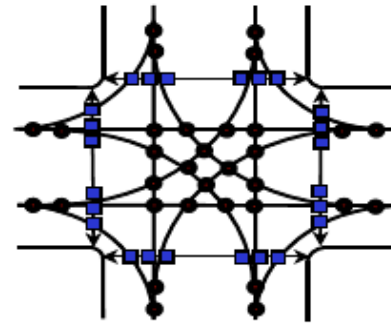
Roundabouts provide improved safety for all roadway users. This includes motorists, pedestrians, bicyclists, truck drivers and emergency responders. All types of crashes are reduced by 39%. More significantly, injury crashes are reduced by 73%, and incapacitating or fatal crashes can be lowered by as much as 90%. In a large number of cases, U.S. roundabouts that have been open for 6-10 years have had no reported crashes, compared to 6-10 crashes per year prior to conversion (e.g. Montpelier, Vermont, Bradenton Beach, Florida).

As a general rule, pedestrian crashes are reduced 50%, while the severity of injuries is reduced dramatically. This reduced injury level is based on speed. Only 5% of pedestrian crashes are fatal at 20 mph, versus an 80% fatality rate for pedestrians hit at 40 mph.

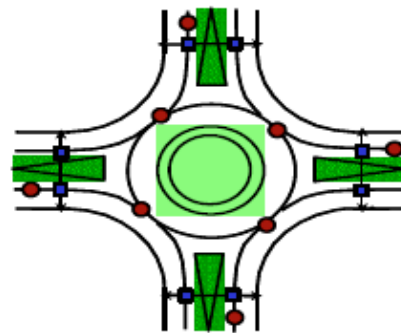
Based on experience in Holland, bicyclists can anticipate a 30% reduction in crashes.

As can be seen in the accompanying charts, roundabouts reduce the number of potential crashes from 32 to only 8. Meanwhile the angle of the crash is dramatically reduced from highly lethal T-Bone crashes, to those at less dangerous angles. Crash speeds are also greatly reduced, from speeds as high as 30-50 mph to just 10-20 mph.

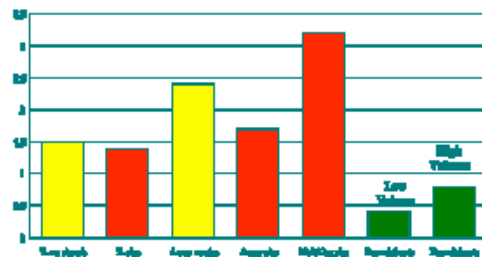
The reduced crash potential is the result of increased reaction time and a direct view of the impending crash. Motorists and pedestrians have more time to see an impending danger and take appropriate action.



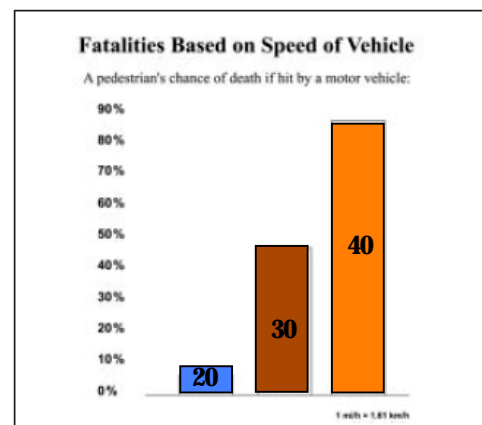
● 32 Vehicle to vehicle conflicts
■ 24 Vehicle to pedestrian conflicts



● 8 Vehicle to vehicle conflicts
■ 8 Vehicle to pedestrian conflicts



Comparative crash rates for roundabout versus stop and traffic signal control



Illustrations by: Michael Wallwork, P.E.

Pedestrian Crossing Details

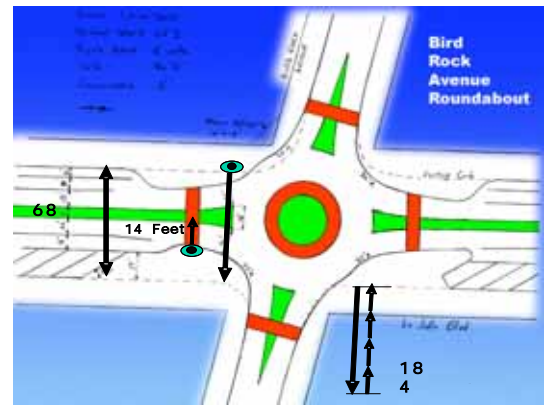
Most pedestrians find roundabouts safer and friendlier to cross than conventional intersections. As shown in the top illustration, roundabouts allow designers to reduce crossing distances from 40 to 70 feet down to as little as 12-14 feet at a time. As shown in this illustration crossing times drop from 16-20 seconds down to 3-4 seconds and the street is compressed from 5 to 2 lanes.

Pedestrians cross roundabouts one car length back from the circulating lane. Pedestrian-friendly designs keep motorist speeds to 15-22 mph. At these speeds the vast majority of motorists yield. The few who do not may create a gap behind them forcing the next motorist to yield (see fourth photo from top).

Exiting from the middle to the far side requires pedestrians to search for an exiting motorist. If speeds are kept low pedestrians may proceed. The position of the crossing allows motorists a safe place to yield while pulling out of the circulating roundabout lane.

On two-lane roundabouts (normally used when traffic volumes exceed thresholds of 25,000 vehicles per day) pedestrians cross at least 40 feet from the circulating roundabout lane. This allows two vehicles to stack (see bottom photos, Clearwater, Florida).

Under rare cases, signals can be installed at roundabouts to create gaps when it may be necessary to thwart unusual volume and braking faced by motorists. The following page details such a setting in Olympia, Washington, where the roundabout is midpoint on a steep (9%) downgrade. Vehicle volumes are high. Pedestrians activate the signals by stepping up to a crossing point on the downhill leg of the intersection only.





Are Signals Ever Needed at Roundabouts?

Rarely. Signals at roundabouts are the rare exception, not the general rule. Free-flow movement of vehicles and pedestrians is one of the great benefits of roundabouts, and generally should not be altered. However, there are exceptions. In the bottom photo we show the signals in use at the Clearwater, Florida two-lane roundabout. There are peak seasons and peak hours (60,000 vehicles and 8,000 pedestrians daily) where this signal is activated to help empty circulating queues. Signals are only needed for a few hours per month.

For pedestrian treatments, signals are being installed on this high volume two-lane entry in Olympia, WA where few gaps in traffic are anticipated, and complicated by a 9% downhill grade. As pedestrians approach the crossing they will be automatically detected, and the signal system will be activated.





Crossing Details

Motorists need strong, compelling information alerting them to the need to slow down before entering roundabouts. A combination of geometric, operational, and landscaping features alert them to the change in conditions. Lane width reductions, curb extensions, splitter island flares, yield markings, signs and high emphasis pedestrian crossings all reduce most motorists' tendency to speed and increase their desire to yield to pedestrians.

Crossings should be kept reasonably compact. In almost all cases physical crossing distances of 12-14 feet to splitter islands can be achieved.

Easy entry to and exit from the street can often be achieved by keeping crosswalk openings as wide as crosswalks (usually 8-12 feet). Median openings in splitter islands are generally kept flat, with very slight crowns to allow for drainage.

Tactile treatments assist people with visual impairment to recognize and respond to edges. This is especially important when ramps are kept low.

The bottom photo shows a mistake in the median cut. . . the pedestrian is ramped up and then back down again. This approach creates problems for all pedestrians, but especially for those in wheelchairs, who must now balance on the crest.



Roundabouts and Bicycles





Bicyclists have two choices at roundabouts. Since motorist speeds are brought down to their level, many bicyclists prefer to take a lane and circulate as normal traffic. Under no circumstances should bike lanes go through roundabouts, or any intersection for that matter. Bike lanes are terminated from 75 to 200 feet before roundabouts, and are picked up 50-200 feet later.

Many rights-of-way allow for wider sidewalks and bike ramps. This allows bicyclists a choice. Those too timid to ride through the roundabout circulate around the roundabout on specially marked pathways.

Entry and exit ramps for bicyclists can be handled with tapers that slow them to appropriate speeds for sidewalk circulation. As sidewalks can be widened to true multi-use trails the entry angle can be enhanced to allow bicyclists to maintain their speed. Generally entry angles of 45 degrees are used.



Benefits Over Signal Systems

Safety — Roundabouts have been shown to reduce fatal and injury accidents from 75 to 90%. The reduction in accidents is attributed to slower speeds and reduced numbers of conflict points.

Low Maintenance — Roundabouts eliminate maintenance costs associated with traffic signals, which total approximately \$3,500 per year per intersection. In addition, electricity costs are reduced with a savings of approximately \$1,500 per year per intersection.

Reduced Delay — By yielding at the entry rather than stopping and waiting for a green light, delay is significantly reduced.

Capacity — Intersections with a high volume of left turns are better handled with a roundabout than a multi-phased traffic signal.

Environmental — A reduction in delay results in a decrease in fuel consumption and air pollution.

Aesthetics — The central island and splitter islands provide an opportunity to beautify the intersection with landscaping.



Bus, Delivery Truck and Large Fire Equipment

Roundabout Size — Roundabouts are designed to handle the largest size vehicles appropriate to the location. Although many primary roadways must accommodate all sizes up to standard sized semi-tractor trailers (WB-50) some state agencies prefer to accommodate up to a super-semi (WB-65).

Shown here is a more typical WB-50 design. Large buses, delivery vehicles, sanitation vehicles and fire equipment rarely exceed a wheel base of WB-40. Many roundabouts are designed to allow these large vehicles to make U-turns. The upper four scenes are on Grandview Drive in University Place, Washington (near Tacoma). A series of five roundabouts on this roadway accommodate frequent buses, large numbers of gravel trucks from a nearby quarry, many school buses and high volumes of the nearby county public works truck fleet.

Truck drivers and neighbors find roundabouts beneficial. Stop signs and stop signals often create delays, full braking, and stop and go starts. Most truck drivers adjust their speed to select a gap, and enter roundabouts at 8-12 mph, which means they do not have to drop to their lowest gears. This saves time, wear and tear and reduces noise in neighborhoods.

Shown below: The same size bus shown in the previous scene is attempting to travel the circle without using the truck apron designed for its use. Although this can be done, it sometimes forces the driver to travel at exceptionally low speeds (5 mph) and turn with great effort. Experienced bus drivers travel through roundabouts at speeds of 8-12 mph.



Size of Vehicles

Although roundabouts are capable of handling all turning movements of all size vehicles, care should be taken to not oversize roundabouts for larger vehicles than those needed for the neighborhood and area of town being served. In some cases state agencies seek full accommodation of the largest trucks made, assigned by functional category of their road.

Although in many cases this is appropriate, there are a number of other instances where truck bypasses, use of the town grid and other solutions can be worked out.

Shown here are a variety of vehicles able to maintain safe speeds through pedestrian-friendly roundabouts. Even the largest trains and light rail can be accommodated in an average roundabout.

Roundabouts handle a variety of vehicles, including tractor-trailers and even trains. Designers often have a choice of giving full support to all size vehicles in all possible turn patterns, or to restrict the unusual vehicle to certain turn restrictions.

For instance, it is possible to make a more compact intersection if semi-trailers are not permitted to turn left at some roundabouts. This is often possible if the roadway is part of a larger grid pattern, and is not a principal state road. Trains and light rail can roll through roundabouts just as they do in other types of intersections.



Truck Aprons and Two-Step Curbs

At especially tight intersections the speed of vehicles can be controlled while allowing for the largest trucks (WB-65). Two-step curbs are rarely used, but when needed they help designers keep tight intersections compact in constrained rights-of-way.

The bottom two scenes show the Manchester, Vermont roundabout that had special two-step curbs installed to allow the very rare WB-65 (wheel base) super-semi truck to make all turns. Although this may not have been desirable, the adaptation fits, controls entry and exit speeds, and presents no unusual challenges to pedestrians.

All truck aprons and two-step curbs require significant structure (6-8" of concrete and rebar) to handle the rare but very heavy loads they are asked to handle.

Curb height of truck aprons and two-step curbs are critical. Generally three inch high curbs are used on truck aprons. When less than this height is used problems can occur. Some motorists may ride right over them, and some vandals may drive their cars onto truck aprons to leave skidmarks. Contrasting the color of materials is highly recommended.

In the scenes below only a 1-1.5 inch height was used for the truck aprons. Motorists seeking to go through the intersection at higher speeds will be able to enter and exit at up to 30 mph by riding over the truck apron. The cost of rebuilding these islands will be quite high. Avoid such costs by using appropriate 2.5 to 3.0 inch apron heights in the original construction.





School Roundabouts

Perhaps the fastest growing roundabout type is at schools. Parents and teenage drivers create so much chaos near schools that many communities attend to these locations first. Since the first known school-based roundabout was opened in Montpelier, Vermont in the mid-1990's at least 47 school roundabouts have been opened across the country.

School roundabouts are no different from other roundabouts. Again the focus is on maximizing traffic capacity and diminishing speeds to safe levels.

Grandview Drive (shown above) used to stack up to a quarter mile of traffic under a conventional 4-way stop. Traffic from three schools, two parks and a large quarry operation caused the stacking. Since the roundabout has been opened, the largest traffic queue experienced is six cars.



Roundabout Landscaping

Appropriate landscaping materials not only improve the sense of place, personality and character of intersections and gateway entries, but can significantly add to safety.

Landscaping Rules:

- 1. Precede intersection with landscaping:** Treatments should precede the actual intersection by as great of a distance as can be afforded (up to 500 feet).
- 2. Keep ground cover below 30 inches and use slow growth plants:** Strong contrasting plant materials are preferred. Motorists need to see to their left. At slow speed roundabouts seeing over center islands is of less importance, since motorists only need information that is 6 seconds out.
- 3. Use tall trees or vertical elements:** Trees planted at regular intervals give approaching motorists a sense of containment and help them assess speed. Trees can often be seen 300 to 500 feet out, and help motorists detect a change in conditions ahead.



Landscaping makes roundabouts more attractive and safe. Through effective use of ground cover and tall vertical features, motorists are given strong visual information that they are to slow and proceed. Poorly landscaped medians and roundabouts can surprise motorists.





The intersection at Bridgeport in Bradenton Beach, Florida handled 18,000 vehicle trips daily before being converted to a roundabout (top and bottom photos). The conversion was made to reduce the great number of pedestrian deaths (average one per year). Florida Department of Transportation safety monies were used. The roadway conversion so outclassed the existing restaurants that all three rebuilt their façades. This, in turn, helped support the revitalization of the Main Street. Eight years later area shop owners report that, "Since the roundabout went in we haven't had a single collision, let alone an injury." The roundabout is designed to handle the largest trucks on straight-through movements and WB-30 delivery trucks on left hand turns.



Pavement markings and signing. New federal guidelines on signage, pavement markings and other operations features for roundabouts are now available. It is essential that motorists be given clear and precise information that they are to always yield on entry. Other markings help identify crosswalks, directional flow and other operational needs. In general, the better a roundabout is landscaped the less redundancy is needed in signing. Designers should understand that roundabouts are meant to be attractive and not a sign storage yard.

Note in the photo to the right that traffic is backed up (more than a mile) on the main road at a signal, but the two roundabouts are allowing vehicles to flow steadily to their destinations.

Use pedestrian scale lighting at all crossing areas. Lighting on the median and center island not only provides an enhanced gateway, it helps motorists see the change in condition hundreds of feet out.

Although two-lane roundabouts are still uncommon in our country, highly successful applications are being tested in a number of states. The Clearwater Beach roundabout has become very successful after a number of early modifications. The fountain was eventually removed due to the high cost of operation, ongoing drought conditions, creation of too much noise screening the sound of traffic for people with visual impairments, and wind spray.



Clearwater, Florida. America's current top performing roundabout was once seven intersections and a civic center with a parking lot. Traffic capacity was limited to 40,000 vehicles per year, and lengthy traffic queues extended for up to 7 miles. Prior to the roundabout there were 35 reported crashes per year. Many of them were injury crashes. There has been only one injury crash in the three years since the roundabout has been open, and no pedestrian or bicycle crashes have been reported (down from 4 a year prior to the roundabout)

Once the new roundabout was opened it handled peak volumes of 55,000, and 8,000 pedestrians. Although modifications have been made to the original designs, including the elimination of the fountain, the roundabout has added another 15,000 beach users to the area economy, and greatly increased the number of people walking here.



1. Fact or Myth:

Roundabouts cannot be placed near signalized intersections.

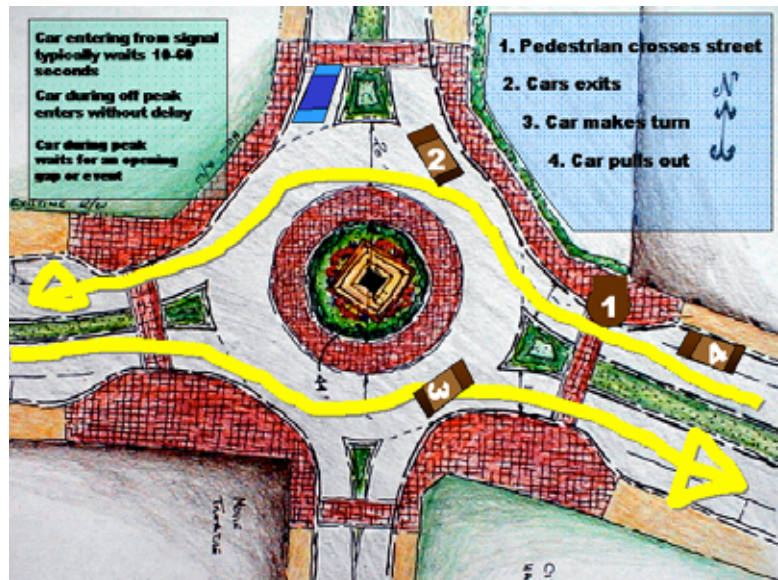
Mostly Myth: The Davis, California roundabout shown here is within 300 feet of one of the largest signalized intersections in town. This former four-way stop intersection was at capacity a number of hours a day, especially as the nearby signal would release. A fatal crash convinced the community they had to try something else. A roundabout was placed here, and has emptied the buildup, smoothed traffic, and stopped motorists from risky behavior which included running the stop sign to make it to the light in time.



2. Fact or Myth:

Roundabouts prevent motorists on side streets from entering.

Mostly Myth: As shown in the illustration to the right, most hours of the day roundabouts aid motorists entering from side streets, since in off-peak hours there are many gaps. During peak hours motorists on side streets need an event to enter, such as a motorist exiting, pedestrian crossing, motorist pulling out for parking, motorist exiting, etc. As a general rule, there are more than adequate gaps to create better side street entries than when signals are used.



3. Fact or Myth:

Roundabouts delay emergency responders

Mostly Myth: Compared with four-way stops and many signals, where long queues can exist, emergency responders find they can improve their response times. In recent tests in Santa Barbara, California and Gainesville, Florida responders proved they can improve their times an average of 8 seconds per intersection when mini-circles or roundabouts are substituted for less efficient four-way stops and other types of intersection controls.

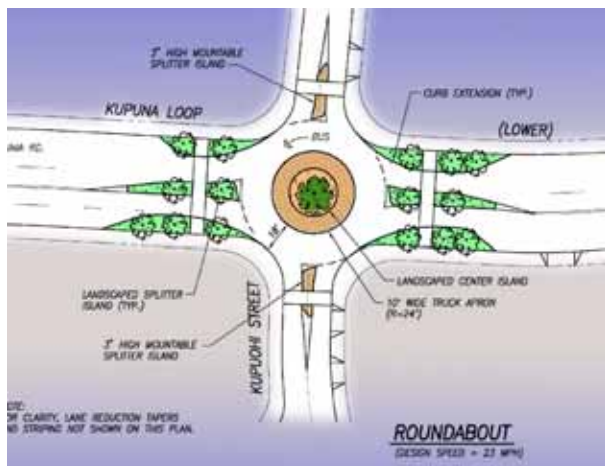


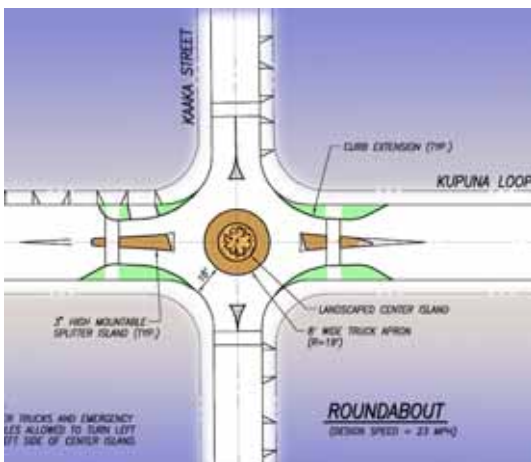
Roundabouts Details

This section describes several common pitfalls of designing and detailing construction of roundabouts.

Truck aprons need to be raised a full three inches above the circulating lane. If the truck apron is flat or nearly flat motorists learn to ride over it to maintain higher speeds. This creates dangerous conditions for them, other motorists and pedestrians, who now face higher travel speeds. Truck aprons help set the deflection path that controls entering and exiting speeds.

Splitter islands should be cut slightly inward as shown in the bottom two photos. This cut allows the occasional oversize vehicle to complete tight turns while allowing designers to keep entering and exiting motorist speeds under control. Note that pavement markings create a clear route of travel for motorists and help keep their speeds down.





Roundabouts fit in many places. Shown on this page are a variety of designs illustrating how roundabouts fit equally well in a large campus environment, at standard four cross intersections, tee intersections, and other areas. At times they are fully landscaped on all approaches, and in some tight locations splitter islands are kept as a concrete material, or painted. Although roundabouts do not fit in all locations, they are one of the most diverse, flexible treatments designed for keeping people and cars in motion. Chances are good that they will one day replace 10-30% of many signalized and unsignalized intersections.