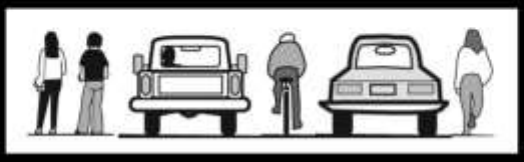
Designing for Pedestrian and Bicycle Comfort and Safety

I-STEP Program Workshop – Brasov, RO

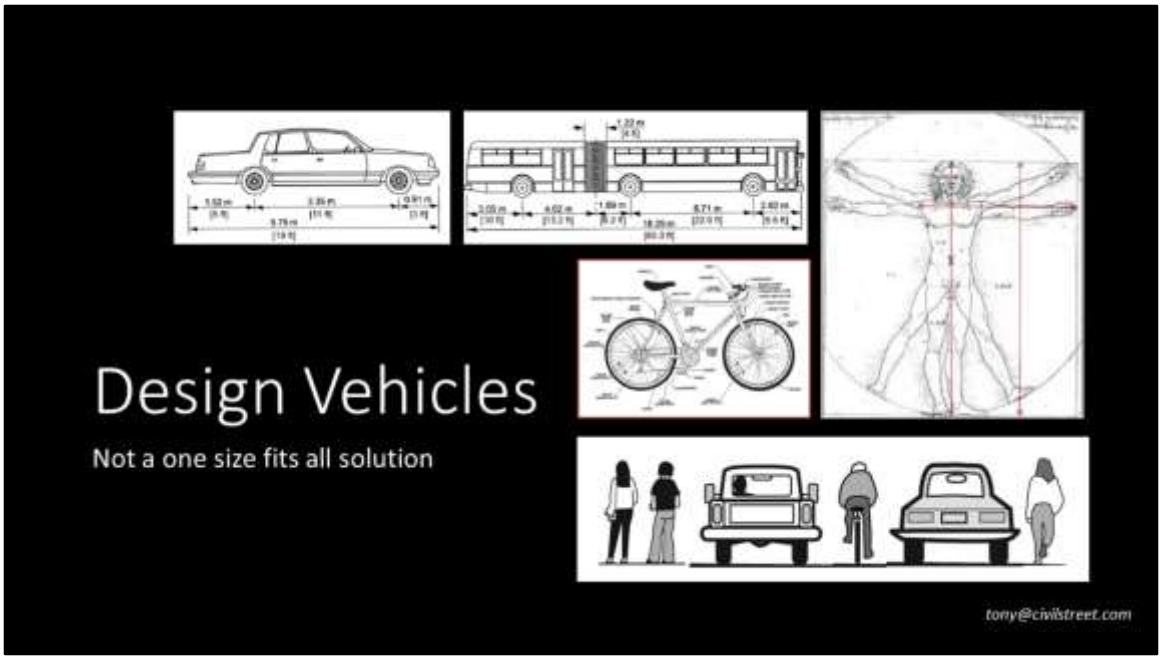
July 1, 2015

Tony Hull, Civil Streets – Minneapolis, MN USA



tony@civilstreet.com

The need for us to better focus on people (bicyclists and pedestrians) on our roadways calls for us to rethink much of our approach to planning, design and operation of our roadways.



The essence of designing roadways is understanding the design vehicles that will use the roadway and how each will interact in a way that is safe, convenient and equitable.

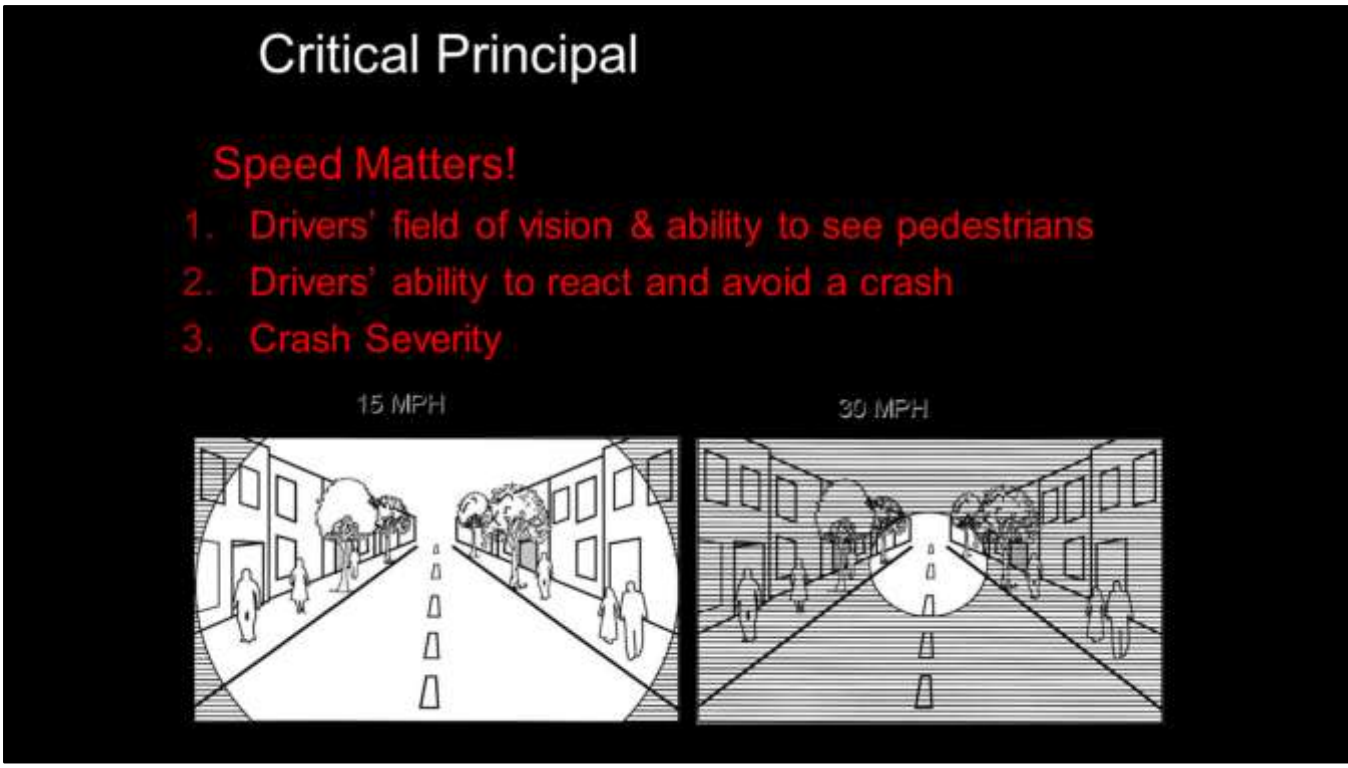
The motor vehicle is traditionally the most widely understood of the design "vehicles". Much of the state of practice for design has a linear focus on the performance characteristics of motor vehicles, including travel speeds, lane widths, and turning radii. Sometimes our efforts to accommodate the largest vehicles can result in "overdesign" of roadways that has unintended consequences that impact bicycles, pedestrians and the quality of the roadside environment. It is essential that we adequately define the user needs of the street to design for the appropriate users while controlling for the occasional larger vehicle that may need to transverse the route.

Bicycles are fairly consistent in design and operational characteristics but can vary in size, type and user capabilities. Additionally predicting where bicycling will occur requires us to improve our understanding of the perception of bicyclists in terms of comfort, safety, and convenience.

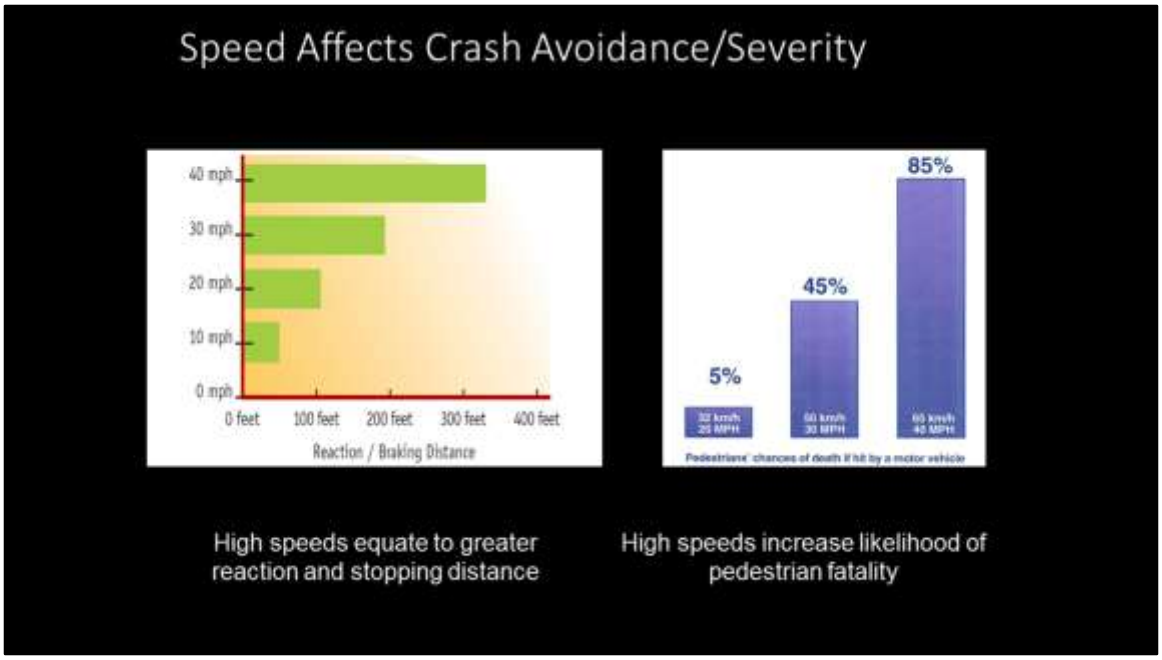
The pedestrian is the least defined user of the roadway. People come in all shapes sizes and abilities and present the greatest challenge to fully accommodate within our roadways. Good design for the pedestrian will facilitate safe accommodation for all modes.

The majority of our issues and conflicts for sharing roadways are associated with our intersections. Intersections represent the conflict points where pedestrians, bicycles and motor vehicles must cross paths. Good intersection design results from providing clear indications of right-of-way and a common understanding of appropriate behaviors.

There are several key principles to consider about bicyclists and pedestrians when it comes to street crossings.



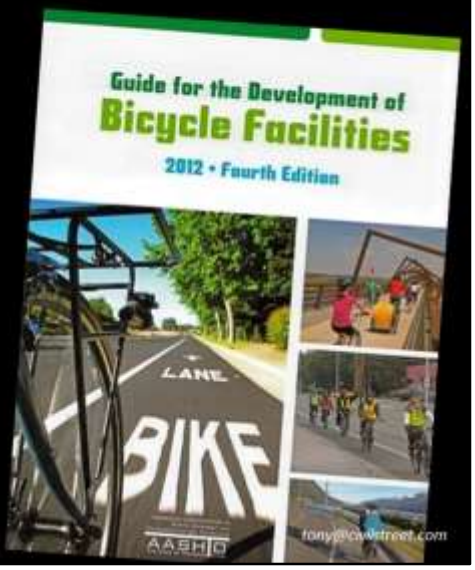
Too many drivers think they have the skills to drive fast, but driving is a complex task, and a distraction can have tragic results at high speeds. Each of these points will be explained in greater detail in the following slides.



As in any crash type, the likelihood that a crash will occur increases with speed, as the distance traveled during reaction time is increased, and braking distance also increases. But after a crash occurs, the chances of killing or severely injuring a pedestrian increase exponentially with speed.

AASHTO Guide for Development of Bicycle Facilities
Chapter 5 – Intersection Design

- Crossing types:
  - Mid-block
  - Sidepath
  - Grade separated
- Selecting intersection control
- Assessing crossing treatments



What is referred to here as a mid-block crossing can also be looked at as creating a new intersection.
Many states statutes define bicycles as vehicles and highways as any public way open to vehicular traffic.
Thus a shared use path is a highway/street, albeit one on which motor vehicles are prohibited, and
an intersection between a path and any other street should be treated similarly to any other intersection of two streets.

Intersection Design Principles

- Good geometric design
- Thorough understanding of behaviors and operating characteristics of all users
  - Pedestrians
  - Bicyclists
  - Motorists
- Appropriate assignment of right-of-way

tony@civilstreet.com

What is the general reaction of a driver (bicyclist or motorist) to a stop sign?
Unless forced to stop by traffic on the cross street, typically just a rolling stop.
There needs to be a good reason to install a a stop sign.
What is your general reaction/response, as a traffic engineer, to requests for neighborhood stop signs? - - generally no

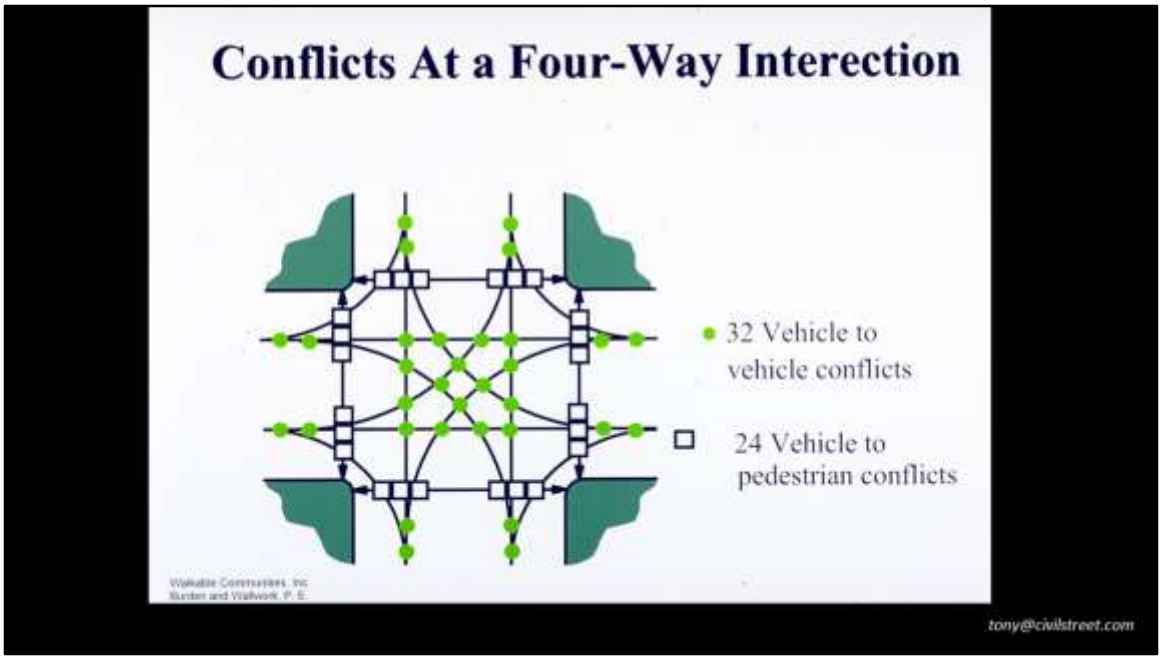
What is the general rule of traffic at an uncontrolled intersection?
Driver on left yields to driver on right.

With path crossings we need to understand the needs and speed of different users.
Conspicuousness
Maintain sight lines
Flat grades
right angles
Effective traffic control
Sufficiently spaced intersections

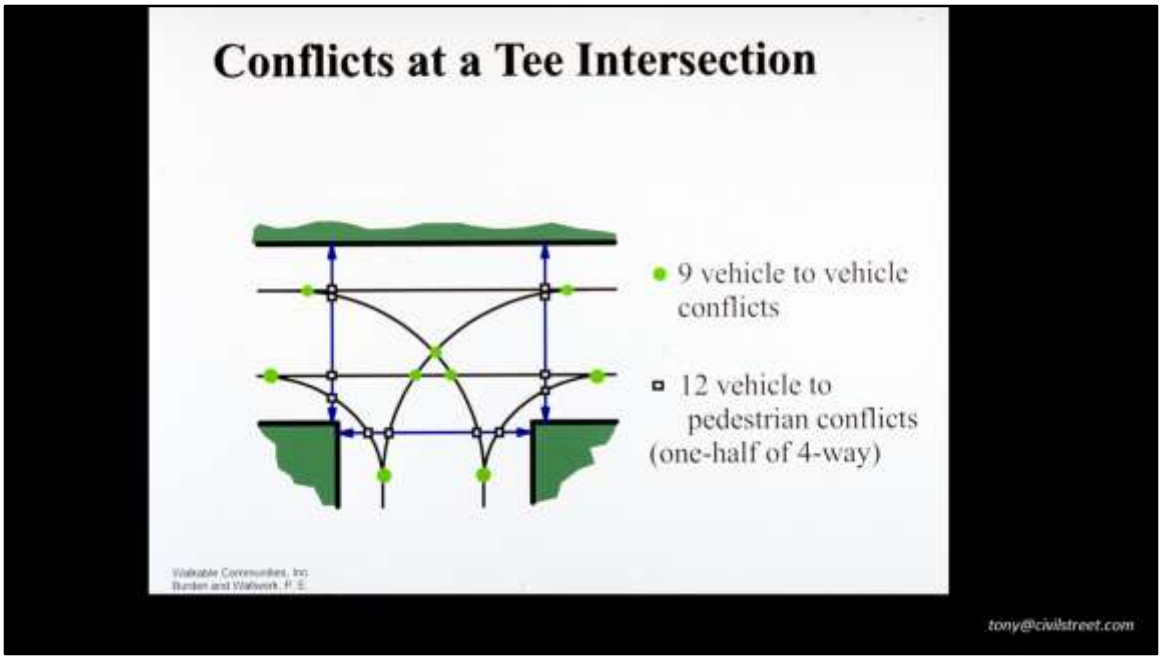
Curb ramp design is important as well, to both wheelchair users and bicyclists.
Especially the transition from the street at the curb to the ramp.

Use this slide to emphasize the idea that to provide safer places for people to cross, they have to consider human desire lines; people won't travel far out of direction to a crossing just because that's where traffic engineers think people should cross. The data is inconclusive in that we don't know whether any given pedestrian is safer when crossing at an intersection or when crossing midblock, especially if there is a raised median. The next slides will clarify that it is legal to cross midblock; pedestrians simply have to yield to traffic, unless a crosswalk is marked.

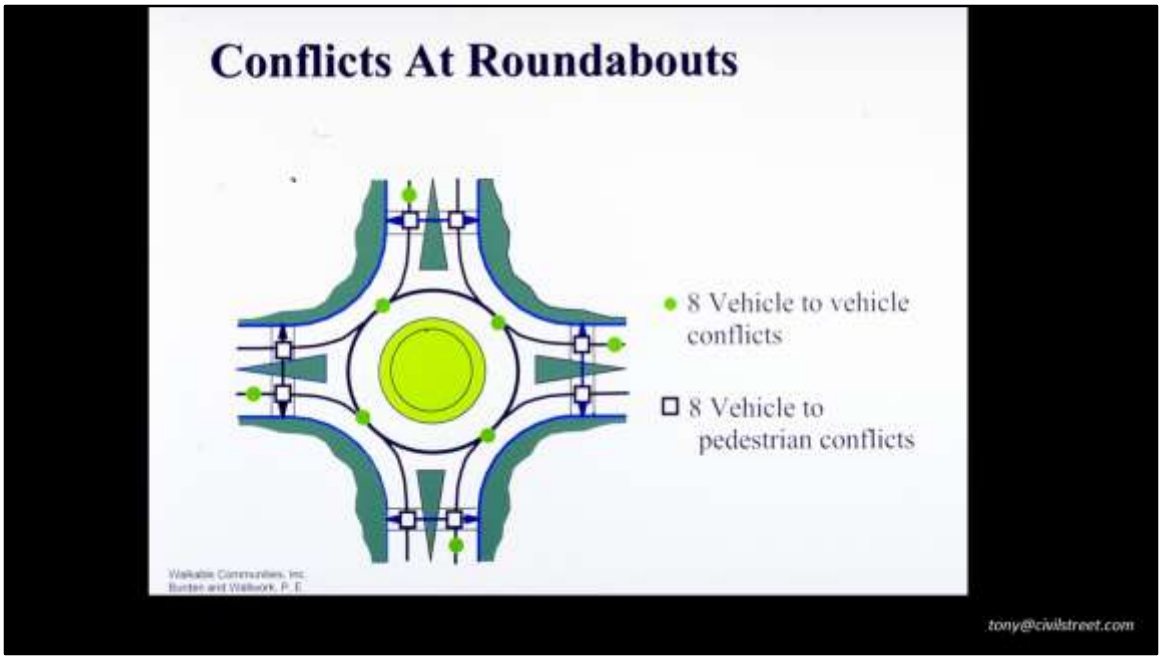
These photos present an interesting example of how people choose differently. Both photos are taken along Fletcher Avenue in Hillsborough County, Florida (near Tampa), and both feature a couple walking with a young child. The couple in the right photo chose to cross midblock about 60 feet from a signalized intersection using the left turn lane as a refuge, while the couple in the right photo chose to cross at a signalized intersection. Both pictures show possible conflicts (on the left, cars might pull into the left turn lane as they are standing there; and on the right, cars turning right on a concurrent green signal are a common source of conflicts, like the van behind the family).



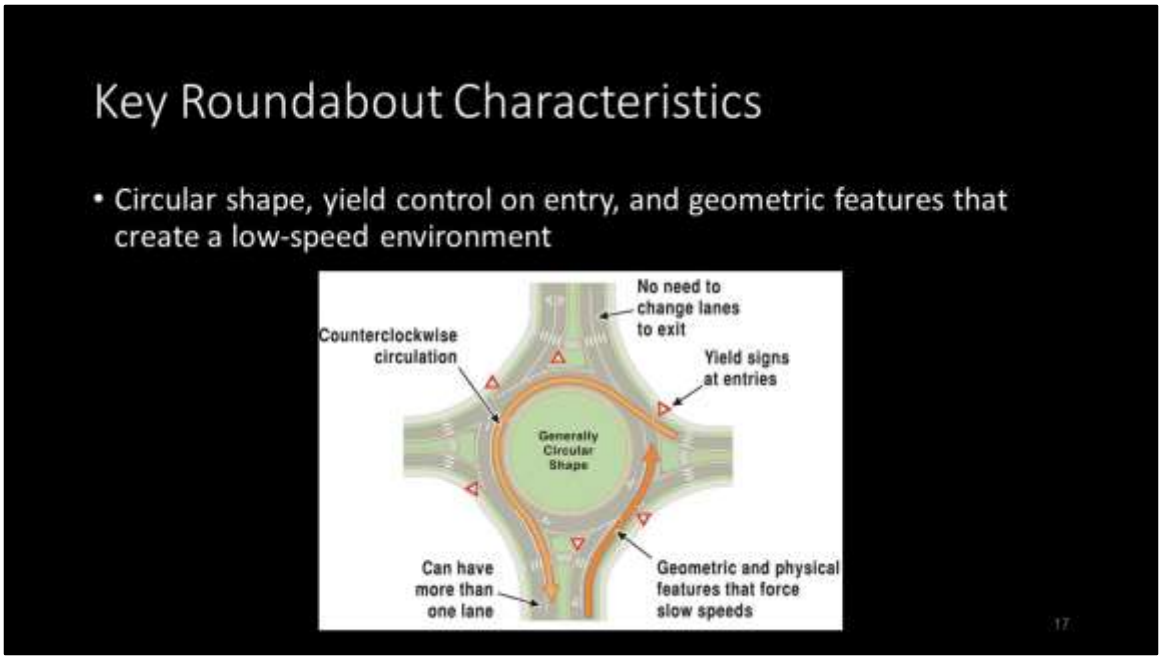
Four-way intersections are the most common type of intersection but also represent the maximum conflicts for vehicles, bicycles and pedestrians. Four-way intersections can be designed for safety and comfort, but only with a full understanding of the conflict points and principles for reducing conflicts.



The “T” intersection greatly reduces the number of potential conflicts, but also has broader implications for network connectivity and accessibility.



Roundabouts, when designed effectively, have been proven to be an effective tool for managing conflicts for all users. One caveat, roundabouts work best as single lane facilities, with each added lane in an approach or within the circulatory route, travel speeds and the number of potential conflicts greatly increase to the point that some complex roundabouts can exceed the number of conflict points of a traditional four-way intersection. The added complexity of navigating these roundabouts can lead to undesirable behaviors, including speeding.

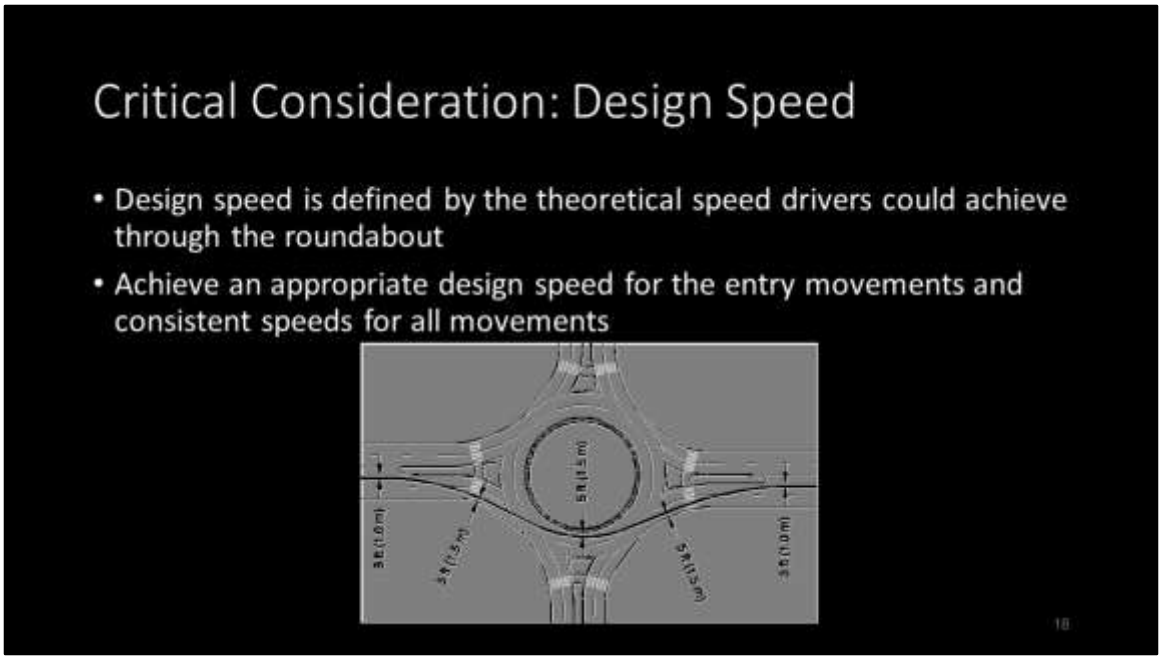


A modern roundabout has the following distinguishing characteristics and design features:

- Channelized approaches;
- Yield control on all entries;
- Counterclockwise circulation of all vehicles around the central island; and
- Appropriate geometric curvature to encourage slow travel speeds through the intersection.

Modern roundabouts are different from other types of circular intersections in use in some parts of the United States. Roundabouts are typically smaller than the large, high-speed rotaries still in use in some parts of the country, and they are typically larger than most neighborhood traffic calming circles. Further discussion can be found in the Roundabout Guide.

(See the Mini-Roundabout Technical Summary for more information about mini-roundabouts).



Achieving appropriate vehicular speeds entering and traveling through the roundabout is a critical design objective as it has profound impacts on safety. A well-designed roundabout reduces vehicle speeds upon entry and achieves consistency in the relative speeds between conflicting traffic streams by requiring vehicles to negotiate the roundabout along a curved path. Generally speaking, although the frequency of crashes is most directly tied to volume, the severity of crashes is most directly tied to speed. Therefore, careful attention to the design speed of a roundabout is fundamental to attaining good safety performance.

The recommended design speed of a roundabout is primarily a function of the number of lanes rather than the design speed of the intersecting roadways. The design speed of a roundabout is defined by the theoretical speed that drivers could achieve through the roundabout if taking the fastest path alignment through the roundabout without regard to lane line striping, if present. This figure illustrates the construction of the fastest vehicle path at a multi-lane roundabout. In practice, actual speeds through the roundabout will be less than these theoretical values, as drivers will be decelerating into the roundabout, yielding to other users, and staying within their lanes (for multilane roundabouts). For single-lane roundabouts, typical maximum theoretical entering speeds of 20 to 25 mph are recommended; for

multilane roundabouts, typical maximum theoretical entering speeds of 25 to 30 mph are recommended. This design technique ensures that speeds observed in practice will fall within a reasonable range.

Local Example Roundabout

Pros

AESTHETIC: Landscaping and design treatments compliment Brasov – gateway feature to old downtown (Beautiful cities require beautiful infrastructure!)

CROSSWALK PLACEMENT: Good visibility and placement of crosswalk connecting transit mall

CROSSWALK PLACEMENT: Crosswalk is placed outside of roundabout in an area where vehicle acceleration is occurring. This reduces the directness of connections for pedestrians (also on sout approach where the natural flow of pedestrians from the transit center is channeled a block out of the way

Cons

LACK OF SPLITTER ISLANDS: Splitter islands improve physical deflection and provide safe direct pedestrian connections

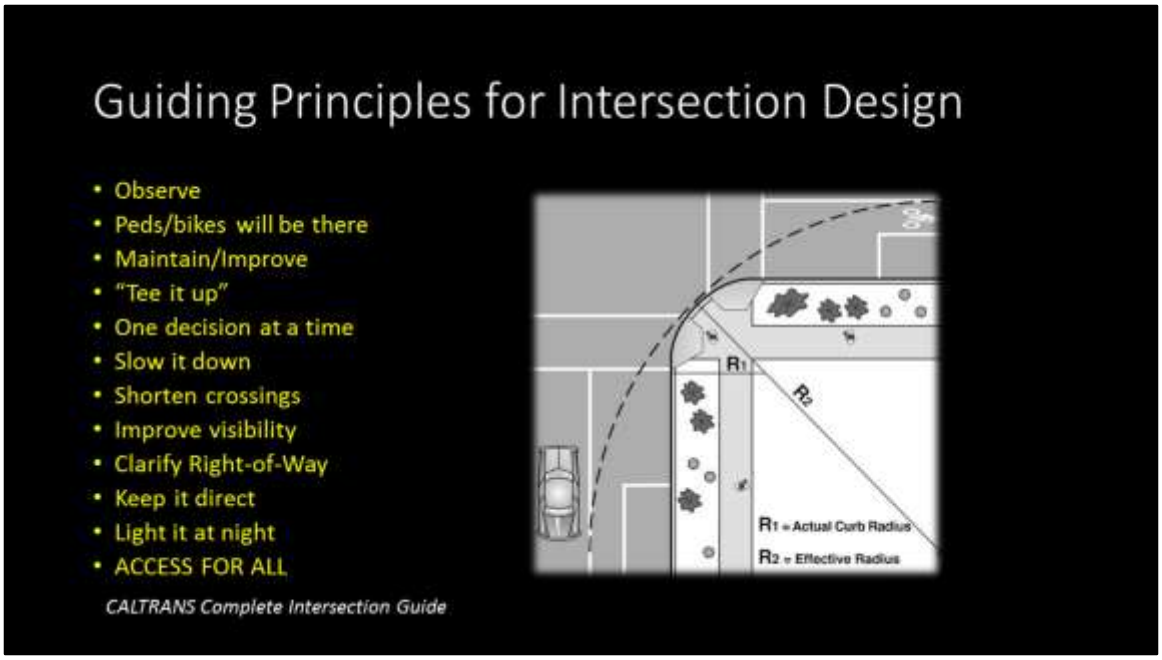
TOO MANY ENTRY LANES: Four lanes of traffic increases vehicle conflicts within the circulation route, consider fewer internal circulation lanes to tighten geometry and reduce weaving conflict

This local example of a roundabout in Brasov has some positive attributes, but also has some geometric elements and other complexities that may be less than optimal for the urban context.

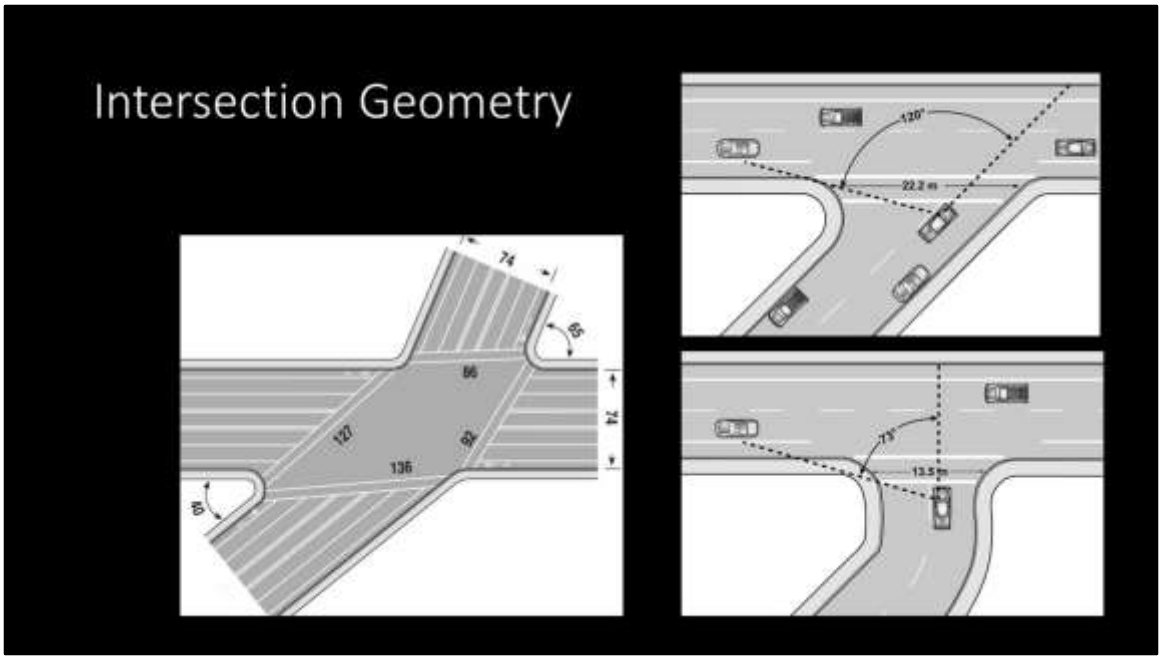
Local example: illustration of crossing issues

This slide illustrates one of the unintended consequences of local roundabout design where the crosswalks have been moved to mid-block away from the roundabout, probably due to the number of entry and circulation lanes and potential travel speed of vehicles within the roundabout. To get from A to B is a short distance as a crow flies, but to navigate the crossings around the roundabout the trip distance for walking is more than doubled as a pedestrian is forced to walk down from one crosswalk to another and yet another to get to the destination. These out-of-the-way movements are likely to result in pedestrians becoming frustrated in possibly crossing at undesignated locations where they may be less safe. **The solution** – provide safe crossings at more convenient locations by embracing traditional elements of good roundabout design [next slide].

This example of a roundabout in the state of Washington is likely to handle the same capacity but provide the appropriate vertical deflection elements such as center island placement, splitter islands and other associated offsets that will reduce speeds and facilitate safe crosswalk placement within the functional area of the roundabout. This design in more appropriate for urban context where pedestrians and bicyclists are anticipated.



These are some simple guiding principles for intersection design that help avoid some of the design issues that can diminish the safety of an intersection for all users. The illustration demonstrates how an actual curb radius can be kept to a minimum when the approach and receiving lanes are offset to allow for a larger "effective" radius of the intersection. This can be accomplished on urban streets where on-street parking or bicycle lanes create additional effective space the can accommodate turning needs, especially for buses and large trucks without increasing the actual radius [and crossing distance] of the curb, improving connections for sidewalks and crosswalks at the intersection.

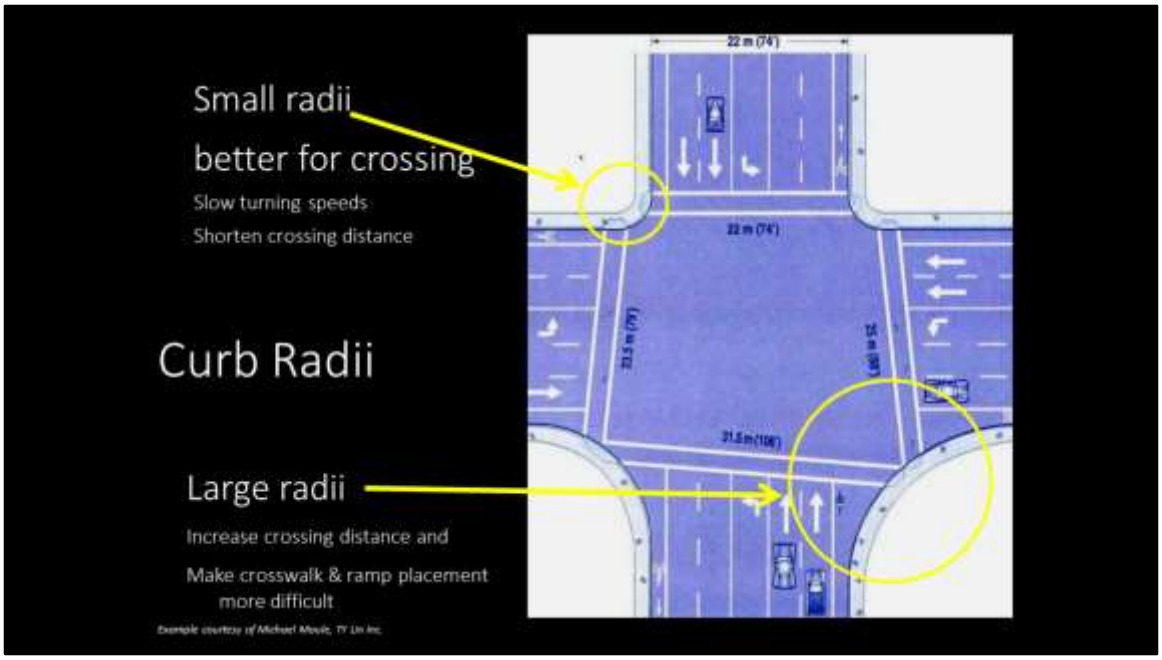


The effect of expanding curb radii has several critical impacts to the safety and operation of an intersection

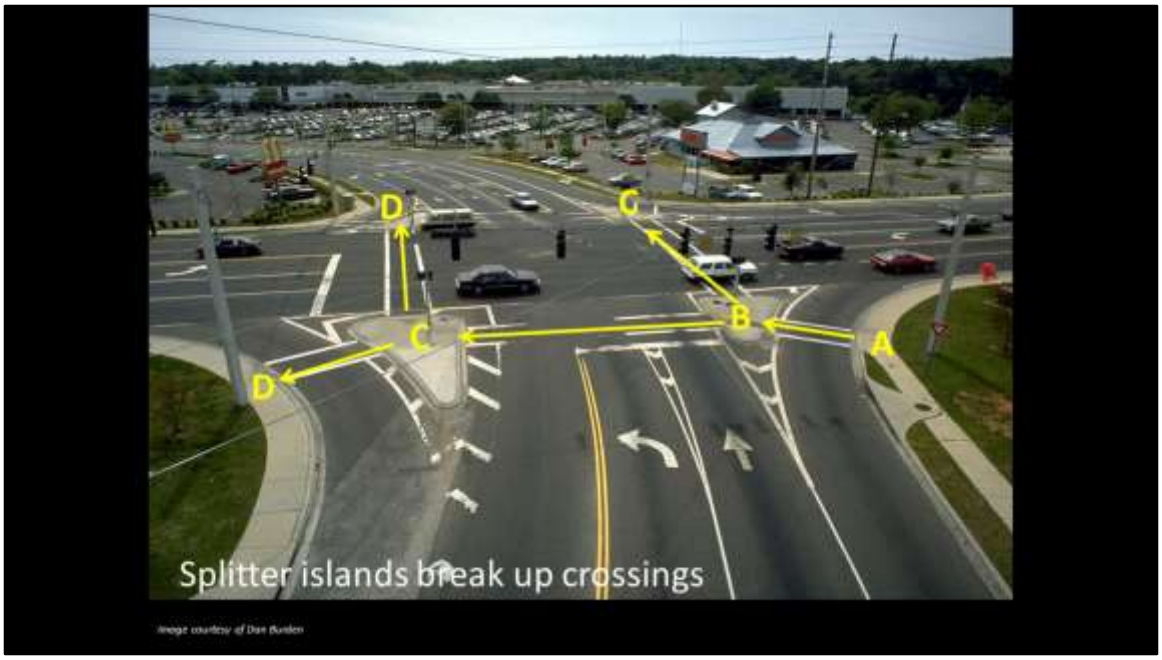
Sight lines become skewed forcing drivers to exceed the normal field of vision to identify key conflicts, this also increases the likelihood the miss arriving conflicts in the opposite direction. (EXAMPLE: Driver top left is approaching from bottom leg for a right turn, the angle he needs to turn his head to see the primary conflict with W-E motor vehicle traffic takes away attention from potential pedestrian crossings from the right).

Tighter radii decrease turning speeds, while wide radii greatly increase the speed at which vehicles can make a turn without stopping.

Wider radii increase the distance from the curb line that crosswalks need to be marked in some cases even doubling this distance for pedestrian crossings which increases pedestrian exposure to risk and increases the amount of time needed to be programed for a signal to allow pedestrians to clear the intersection.



Design guides point out the obvious consequence of large corner radii: long crosswalks. But there are other negative consequences: they “pull the intersection apart” and make it hard to place ramps and crosswalks where pedestrians want to cross.

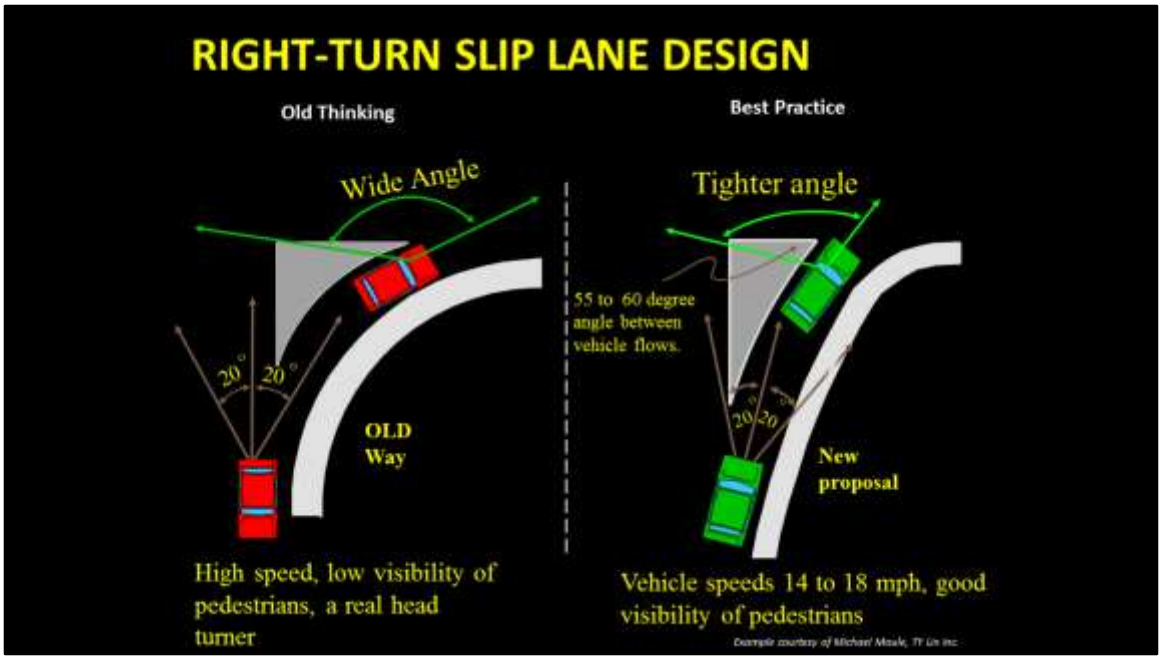


In the United States many larger intersections can be modified to include refuge islands that allow for the larger turning radius needed to accommodate truck traffic, while reducing the crossing distance for pedestrians. The shorter crosswalks also minimize the time needed to allow for pedestrians to cross during the signal cycle.

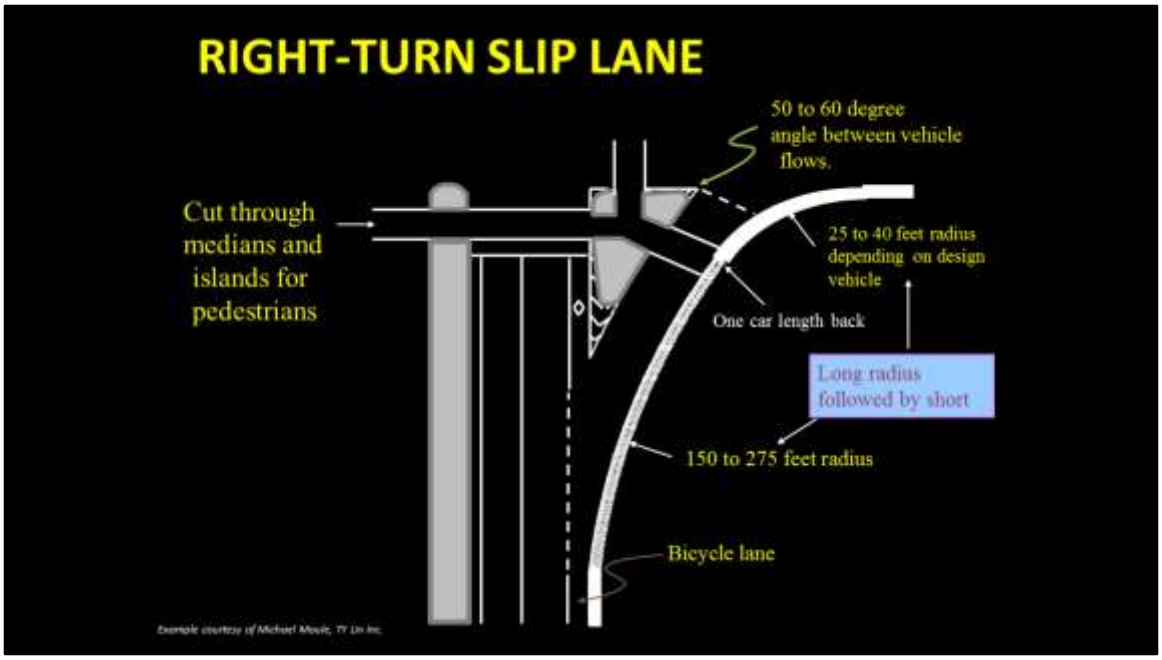
RIGHT-TURN SLIP LANES

Image courtesy of Dan Burden

Our traditional right turn slip lanes were focused on accommodating higher speeds for turning movements. The thinking was that this improves operations and efficiency by moving traffic faster. In reality, these designs increase danger of crashes especially for pedestrians.

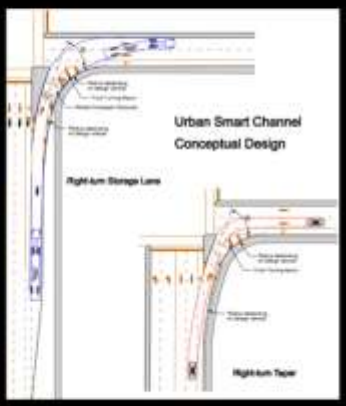


The tighter angle design as shown on the right, seems only slightly different, but the impacts on the speed and positioning of the turning vehicle will greatly reduce speed and increase the visibility of conflicts while making the turn.



This slide provides a bit more detail of the geometry for what we call a “three-point decreasing radius” right-turn slip lane design. This is especially useful for turns from higher speed roadways where motorists will benefit from greater reduction in speed before managing the conflicts at the intersection.

Urban Smart Channel [Ottawa, Canada]



Sometimes retrofitting the physical geometry of an intersection is cost prohibitive in the near term. The Urban Smart Channel uses paint to tighten the radius and space of the right turn slip lane. This also improved the ability of trucks to be accommodated at these locations as they are able to trail across the paint to make wide turns. One caveat – Where driver behavior is a concern, paint may not be effective in channeling drivers who wish to go fast despite markings and signage.

This example of a slip turn in Brasov, demonstrates the wider radius and higher speed design that can increase danger for pedestrian collisions or vehicle to vehicle crashes where right-turning vehicles are accelerating through the turn and having to extend their field of vision to an angle that forces them to be looking behind at the expense of seeing conflicts in front of the vehicle [such as a pedestrian entering the crosswalk].

This other example from Brasov, shows some of the better slip turn designs and the use of a physical island to better manage the conflicts with right-turning vehicles and pedestrians while providing refuge islands that allow the pedestrian to be in a better position to wait and cross with a shorter overall crossing distance. This is a more appropriate design for urban areas.

Crossing Islands

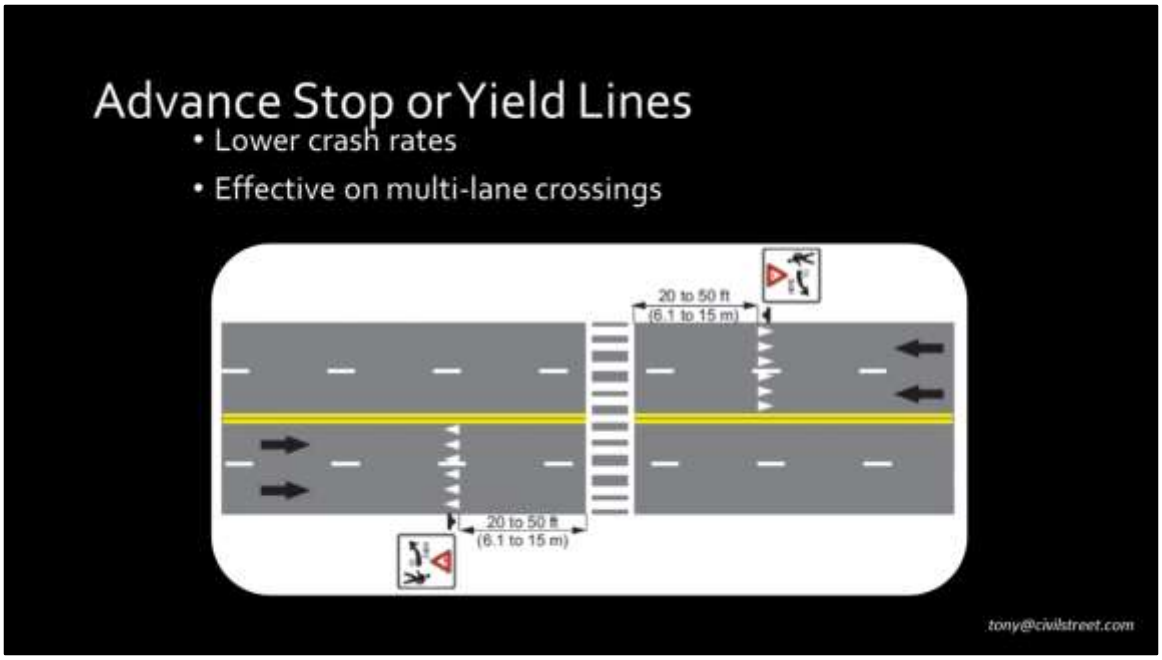
- Lower crash rates
- Beneficial at:
  - High roadway volumes
  - Wide crossings
  - Crossing 3 or more lanes
- Widths
  - Minimum width: 6 feet
  - Preferred width: 10 feet
    - consider platoons, two-way path traffic and combination vehicles such as a bicycle and trailer

tony@civilstreet.com

The most effective treatment to add to a path crossing is a refuge island since it reduces exposure to traffic.
6 ft is the minimum but is tight, even for one bike.
A bicycle and trailer combination is 10’ long, thus it is desirable for a median to be 10’ wide.
Also consider how many bicyclists may have to use the refuge island at one time.
May want to widen the flat area / cut-through area to accommodate more bicyclists as well as bicyclists traveling in both directions.
If you have to go with the minimum 6’, it is helpful to elongate the refuge and angle the crossing so that a longer bike, such as one with a trailer, can fit sideways in the middle.

The fact that Romanian drivers have a high compliance for stopping for a pedestrian in a crosswalk is a positive, but the habit of coming to a stop at the crosswalk has some disadvantages and can result in some of the most dangerous conditions for pedestrians. The illustration above shows this problem when the vehicle in the closest travel lane comes to a stop at the crosswalk and the pedestrian proceeds to cross. A vehicle in the other lane may not be aware of the pedestrian crossing and may overtake [despite being illegal in the US, this is common] resulting in a potential high speed conflict that is exacerbated by the fact the neither the drive or pedestrian are in a reasonable position to see the conflict.

The solution to this is to position a stopping location in advance of the crosswalk so vehicles, when stopping are a few car lengths back from the crossing allowing for better visibility of these other conflicts for both the pedestrian and the overtaking driver, who are much more likely to avoid the crash.



FROM THE US Manual on Uniform Traffic Control Devices (MUTCD) Page 5-52, Figure 5-23, Advance Yield Signs and Markings

Advanced stop or yield lines, based on MUTCD, have also been shown to help reduce crashes and create safer crossings for path users. These are supplemented by the Yield (or Stop) Here For Pedestrians sign. Refer to your state laws if it is yield or stop for pedestrians in crosswalks.

The advanced yield line helps prevent multiple threat crashes.
Once the first driver stops at the yield line, another driver approaching from the rear still has a view of the crosswalk and time / distance to stop for a pedestrian before reaching the crosswalk.

Example: Local application – Advance Stop Bar

Local illustration of how an advance stop bar could be employed [with accompanying signage indicating to STOP HERE FOR PEDESTRIAN IN CROSSWALK] to reduce the multiple threat conflict.

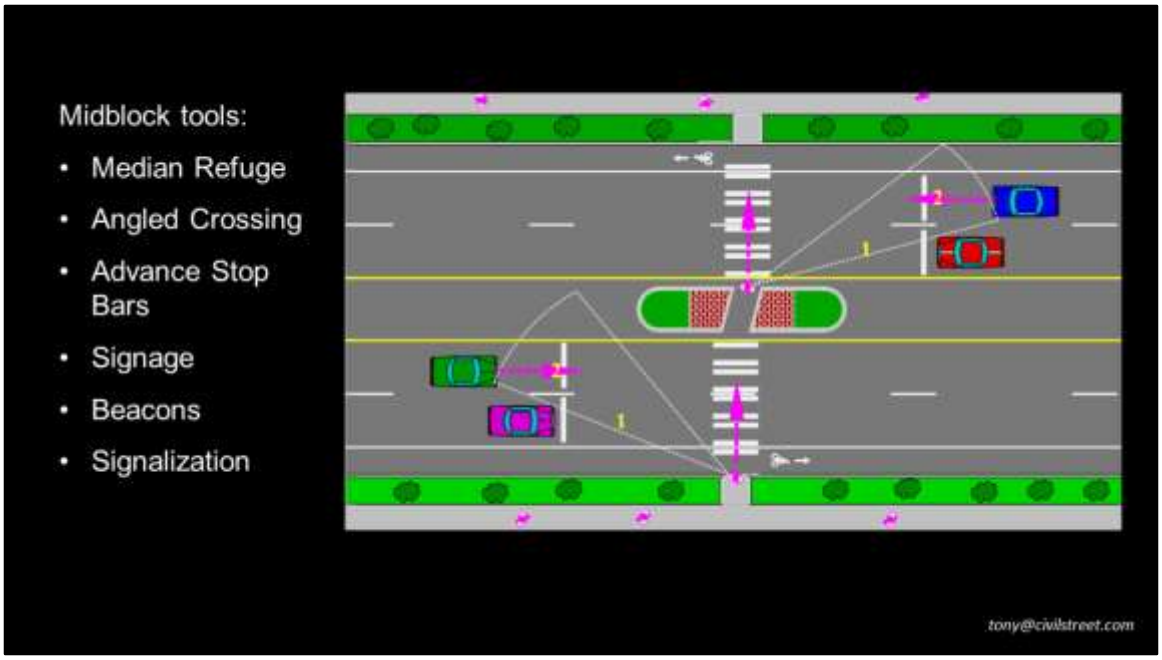


Illustration of multiple mid-block crossing tools being used in conjunction to improve crossing safety and convenience.

Today there are numerous publications and websites that provide information on pedestrian safety design; most of the workshop information comes from these publications.

If available, distribute current list of publications to the participants.

Ask the participants for local or State publications or standards.

Instructors should have reviewed these local and State publications and standards when preparing for the workshop.

Discuss the fact that the Highway Safety Manual is a new document that is very useful for safety issues of all kinds.