Modern Roundabout Design
Current Practice
Overview

- Crash experience at Roundabouts
- Getting Started – Traffic Analysis
- Geometry – Balancing Capacity and Safety Concerns
- Design Guidelines
“Roundabouts are normally the safest form of at-grade junction over a wide range of entry flows and approach speeds” (1)

Safety Statistics from Insurance Institute for Highway Safety (IIHS)

- 2003 2.5 million crashes in US
- v/c ratios drop by 60% with roundabouts.
- In Maryland, and some other states, all high accident locations MUST be considered for roundabout.
- Crash Reduction in Maryland (April 5, 2004)
  - 70% Total Crashes
  - 86% Injury Crashes
  - 100% Fatal Crashes
More Recent Experience
2014 TRB Conference

• Minnesota (Andrew Plowman, WSB Associates, Inc.)
  – Increase in crashes on certain types of multi-lane roundabouts

• FHWA Research Center (Hillary Isebrands, FHWA)
  – General trend of increased Property Damage Only (PDO) Crashes
  – Types include failure to yield and incorrect lane use

• Ohio (Sam Bobko, Hatch Mott McDonald)
  – New roundabout where crashes increased significantly
Failure to Yield

Incorrect Lane Use

Graphics copied from presentation by Hillary Isebrands, FHWA, as presented at the TRB International Roundabout Conference in Seattle, WA on April 18, 2014.
How do we address these issues?
Research is Underway

- Pavement Marking
- Signing
- Education
- Design Principals
  - Proper Geometry
  - Avoiding Overdesign
  - Allowing for Future Expansion
Modern Roundabout Terminology

- Entry Width
- Splitter Island
- Inscribed Diameter
- Truck Apron
- Circulatory Roadway
- Central Island
- Pedestrian Refuge
- Cross Walk
Getting Started - Traffic Analysis

• Traffic data collection and projection
• Comparing approach volumes vs. circulating volumes
• Peak period analysis
• Preliminary geometric decisions
• Capacity Analysis (Capacity Software)
Approach volumes vs. circulating volumes
Approach volumes vs. circulating volumes

From Iowa DOT Design Manual (Chapter 6A-3)
- Single Lane Approach: Entering + Circulating < 1,200 vph
- Double Lane Approach: Entering + Circulating < 2,000 vph

From National Cooperative Highway Research Program (NCHRP) Report 672, Roundabouts, An Informational Guide
- Single Lane Approach: Entering + Circulating < 1,000 vph
- Double Lane Approach: Entering + Circulating < 1,800 vph

Our Example
South Approach : Entering (1,016) + Circulating (1,637) = 2,653 vph
This result indicates that at least two lanes are likely necessary for this approach. A more detailed capacity evaluation is recommended.
Preliminary Analysis

- Be sure to look at AM and PM peak periods.
- Calculating number of lanes/movements for each approach
- Look at balancing approach volumes.
Iowa DOT Design Guidelines

- Design Manual – Chapter 6A-3
  (Modern Roundabouts, General Guidance)
  - Definitions
  - Safety Benefits
  - Operational Guidelines
  - Feasibility Guidelines
Education

Roundabouts have been proven to be efficient and safe intersections. However, unless an educational effort is undertaken early in the planning and preliminary design process, there will likely be resistance from the community because roundabouts are not common in Iowa. In addition to the early efforts, education must continue through construction and after the opening of the roundabout.

It is important for drivers and planners to understand that roundabouts do not change the basic principles of navigating through an intersection. For example, if a driver wants to turn left, the driver gets into the left lane on the approach to the intersection; if a driver wants to go straight, the driver looks for signage and pavement markings on the approach to the intersection that indicate which lane would be appropriate for that movement. Negotiating a roundabout involves five simple steps:

1. Select the appropriate lane in advance of a roundabout located on a multi-lane roadway (based on the movement desired at the intersection, either left, through, or right).
2. Yield to pedestrians in the crosswalk.
3. Yield to vehicles in the circulating roadway.
4. Once in the circulating roadway, signal at the desired exit.
5. Yield to pedestrians in the crosswalk.

The Insurance Institute for Highway Safety (IIHS 2001) surveyed drivers before and after the construction of roundabouts in their areas. Before construction, 31% of drivers were in favor of the roundabout and 41% were strongly opposed. A few months after the construction was completed, 63% of drivers were in favor of the roundabout and only 16% strongly opposed the roundabout.

More information on obtaining educational materials can be found at the end of this memorandum.

Safety

Roundabouts have the ability to contribute to intersection safety by

- reducing all vehicular speeds,
- reducing the number of vehicle-vehicle and vehicle-pedestrian conflict points, and
- significantly reducing the most severe types of crashes (i.e., right-angle crashes are nearly eliminated).

Figure 6 (Robinson et al. 2000, Exhibit 5-2, p. 106) shows the reduction in vehicle-vehicle conflict points between a traditional four-approach intersection and a roundabout.

![Diagram of roundabout and traditional intersection with conflict points labeled: Diverging, Merging, Crossing](image)
### Table 6. Important factors when considering a roundabout

<table>
<thead>
<tr>
<th>Safety factors</th>
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<tr>
<td>Poor crash history (with injury crashes) at two-way stop-controlled or signalized intersections with high proportion of these crash types:</td>
<td>Right-angle crashes</td>
<td>Left-turn crashes</td>
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<td></td>
<td>Red light or Stop sign running</td>
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<td>Note: Four-way stop intersections and roundabouts have similar crash histories, whereas two-way stop-controlled and signalized intersections have much higher crash rates than roundabouts.</td>
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<table>
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<th>Non-motorized users</th>
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<td>High volume of pedestrians and high volume of vehicles</td>
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<tr>
<td>Sight-impaired pedestrians</td>
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<td>Note: Roundabouts provide an intersection environment for pedestrians where speeds are low and pedestrians only cross one direction of vehicular traffic at a time and find refuge in the splitter island. However, blind pedestrians can no longer rely on the sound of stopped vehicles to know when it is safe to proceed. Active research, NCHRP 3-78/3-78A, is investigating the need to provide additional guidance for pedestrians at multi-lane roundabouts, specifically blind and sight-impaired pedestrians. The recommendation by the U.S. Access Board suggests that all multi-lane roundabout pedestrian crossings be equipped with a pedestrian-activated signal to stop traffic (e.g., a high-intensity activated crosswalk [HAWK] signal).</td>
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- Generally advantageous location
- Additional investigation required
- Not recommended
Additional Design Guidance

- NCHRP, Report 672
- MUTCD, Chapter 3C, Roundabout Markings
- Other State Design Guidelines
  - Wisconsin, Washington, Colorado, Florida
Detailed Analysis/Preliminary Layout

• Capacity analysis comes next, to refine the design.
• Software available
  SIDRA, RODEL, Arcady, VISSIM Micro-simulation
• Preliminary Layout in CADD
  – It is often helpful to overlay the preliminary layout onto an aerial photo to assess physical constraints.
• Peer Review – Earlier the better
Geometry – Balancing Safety and Capacity

- Speed Control
- Entry Width
- Deflection
- Entry Path Overlap
- Design Vehicle
Fastest Path Measurements
Guidelines from NCHRP, Report 672

- Assumes no opposing traffic and drivers ignoring lane lines.
- Assumes drivers ignoring yield at entry.
- Determines sufficient deflection.
- Iterative process.
Fastest Path Measurements

• Create Guide Lines
  • 3’ from centerline on approach
  • 5’ from outside edge at splitters
  • 5’ from center island

• Draw Fastest Path
  • Tangent to guide lines
  • Use B-Spline in Microstation
  • Through movement is key for design
Fastest Path Measurements

• Measure R1 and R2
  – Measure minimum radius along approach near yield line, over a distance of 65’ to 80’

• Calculate speed for each radius
  – Recommended Maximum Speed for R1 is found in Exhibit 6-47 from Report 672
    • Mini-Roundabout (20 mph)
    • Single-Lane Roundabout (25 mph)
    • Multi-Lane Roundabout (25 – 30 mph)
  – Try to minimize R1 and R2 difference
Entry Geometry – Proper Deflection
Vehicle Path Overlap

Figure 5. Roundabout design that encourages vehicle path overlap, aerial view (left) and driver’s view (right)
Design Vehicle Accommodation

- Design for appropriate design vehicle
- Methodology for accommodating design vehicles
  - Allowing use of all lanes
  - Keeping vehicle in lane at entry
  - Keeping vehicle in lane through intersection
Case 2: Allows trucks to stay in lane in entry...
Case 3: Allows trucks to stay in lane through...

- WB-67 in Inside Lane
- WB-67 in Outside Lane

Small ~96’ CID!
Small ~160’ ICD!
Final Design Attributes

- Drainage Design
- Pavement Marking
- Signing
- Lighting
- Landscaping
Questions?