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Modern Roundabouts are Here to Stay

Roundabouts Built in All 50 US States

Key Roundabout Characteristics

Roundabouts are a subset of circular intersections...
Features that Distinguish Roundabouts

- Priority to circulating vehicles
- Yield control
- Etc.

Roundabouts are NOT Rotaries!

Roundabouts are NOT Neighborhood Traffic Circles!

Basics in Size and Context

- Three major categories of roundabouts
  - Mini-roundabout
  - Single-lane
  - Multilane
- Variety of potential contexts
  - Urban versus rural
  - Low-speed versus high-speed environment
  - Auto-oriented versus multimodal
  - First roundabout in community versus previous history

Basic Comparison of Roundabout Categories

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Mini-Roundabout</th>
<th>Single-Lane Roundabout</th>
<th>Multilane Roundabout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirable maximum entry design speed</td>
<td>15 to 20 mph</td>
<td>20 to 25 mph</td>
<td>25 to 30 mph</td>
</tr>
<tr>
<td>(25 to 30 km/h)</td>
<td>(30 to 40 km/h)</td>
<td>(40 to 50 km/h)</td>
<td></td>
</tr>
<tr>
<td>Maximum number of entering lanes per approach</td>
<td>1</td>
<td>1</td>
<td>2+</td>
</tr>
<tr>
<td>Typical inscribed circle diameter</td>
<td>45 to 90 ft</td>
<td>90 to 180 ft</td>
<td>150 to 300 ft</td>
</tr>
<tr>
<td>(13 to 27 m)</td>
<td>(27 to 55 m)</td>
<td>(46 to 91 m)</td>
<td></td>
</tr>
<tr>
<td>Central island treatment</td>
<td>Fully traversable</td>
<td>Raised*</td>
<td>Raised*</td>
</tr>
<tr>
<td>Typical maximum service volumes</td>
<td>≤15,000 veh/day</td>
<td>≤25,000 veh/day</td>
<td>≤45,000 veh/day</td>
</tr>
<tr>
<td>* (may have traversable apron)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Why Roundabouts?

- Roundabouts are being considered as viable or even preferred alternatives due to a number of potential benefits:
  - Safety performance
  - Operational performance
  - Environmental benefits
  - Land use boundary definition
  - Access management
  - Operations and maintenance costs
  - Aesthetics

Safety Performance

- Roundabouts have a proven safety record for reducing motor vehicle crashes, particularly fatal and injury crashes
- Experience is due to basic contributing factors:
  - Reduced vehicle speeds
  - Reduced driver decisions
  - Reduced conflict points
  - Reduced conflict severity
### U.S. Experience
**NCHRP Report 572 Results (May 2006)**

<table>
<thead>
<tr>
<th>Group Characteristic before Conversion (sample size)</th>
<th>% Reduction in All Crashes</th>
<th>% Reduction in Injury Crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites (55)</td>
<td>35</td>
<td>76</td>
</tr>
<tr>
<td>Signalized (9)</td>
<td>48</td>
<td>78</td>
</tr>
<tr>
<td>All-way stop (10)</td>
<td>No significant change</td>
<td>No significant change</td>
</tr>
<tr>
<td>Two-way stop (36)</td>
<td>44</td>
<td>82</td>
</tr>
</tbody>
</table>

### Operational Performance
- Can be more efficient than conventional alternatives

### Environmental Benefits
- Generally lower fuel consumption and emissions
- Less impervious surface

### Land Use Boundary Definition
- Commercial w/ angle parking
- Residential

### Access Management
- Use roundabouts at major intersections to facilitate U-turns
- Allow restricted access at intermediate access points

### Operations and Maintenance Costs
- May have little equipment to maintain
Aesthetics and Community Enhancement

- Can be a visual anchor to a community

Primary Guidance Documents

- Highway Capacity Manual
- Highway Safety Manual
- Manual on Uniform Traffic Control Devices
- AASHTO Green Book
- Public Rights of Way Accessibility Guidelines
- IES Roundabout Lighting Design Guide

Overview (cont.)

- Based on established and emerging U.S. practices and recent research
  - Less exclusive reliance on international practice
  - More US empirical experience and examples
- Alignment with other documents
  - Highway Capacity Manual 2010
  - 2009 Manual on Uniform Traffic Control Devices
  - IESNA Roundabout Lighting Design Guide

Philosophy

- Principle-based approach (performance-based design)
- Recognizes roundabouts, as with any intersection treatment, requires the balancing of competing objectives
- Flexibility is provided to encourage independent designs and techniques
  - Tailored to particular situations
  - Emphasizes performance-based evaluation of designs
  - Allows development of new techniques
- More than one way to achieve an acceptable design

Chapter 1: Introduction

- What is a roundabout?
- How are they different from other circular intersections?
- Scope and purpose of the guide

Chapter 2: Roundabout Considerations

- General characteristics
  - Advantages and disadvantages
    - Safety
    - User decisions
    - Operations
    - Spatial considerations
    - Access management
    - Environmental factors
    - Operations and maintenance costs
    - Traffic calming
    - Aesthetics
- User considerations
- Policy and legal issues

Chapter 3: Planning

- New information on range of potential applications
  - Intended to demonstrate breadth of feasibility
  - Discussion of considerations for each typical application
- Updated user education materials
- Examples of applications

Kittelson & Associates, Inc.
Chapter 3 (cont.):
Updated planning-level capacity figure

Flow Types at a Roundabout: Aggregations of Turning Movements
- Entering flow ($v_e$)
- Circulating flow ($v_c$)
- Exiting flow ($v_{ex}$)

Planning-Level Volume Thresholds

<table>
<thead>
<tr>
<th>Sum of Entering Plus Conflicting Flows (veh/h)</th>
<th>Number of Lanes Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1,000</td>
<td>1 lane likely ok</td>
</tr>
<tr>
<td>1,000 – 1,300</td>
<td>1 lane might be ok, 2 lane may be needed</td>
</tr>
<tr>
<td>1,300 – 1,800</td>
<td>2 lane likely ok</td>
</tr>
<tr>
<td>&gt; 1,800</td>
<td>More than 2 lanes may be needed</td>
</tr>
</tbody>
</table>

Chapter 4: Operations
- Chapter presents subset of HCM procedure (incomplete without HCM 2010)
- Explicit recognition of use of calibrated alternative tools to analyze situations not covered by HCM models

Roundabout Guide Outline
1. Introduction
2. Roundabout Considerations
3. Planning
4. Operations
5. Safety
6. Geometric Design
7. Application of Traffic Control Devices
8. Illumination
9. Landscaping
10. Construction and Maintenance Appendices

Capacity Models in HCM 2010
Other Elements of Procedure

- Lane use assignment
- Level of Service
  - Based on control delay
  - LOS assigned to each lane, approach, and intersection
  - Delay thresholds same as for TWSC due to similar delay formulation and driver decision process
- Explicit recognition that HCM procedures are not the only way to analyze roundabouts (or other facilities)
- Applicability to roundabouts
  - Geometric configurations not included in HCM model
  - Oversaturated conditions requiring multiple-period analysis
  - Interaction effects with other intersections
- Need for calibration

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Chapter 5: Safety

- Principles
- Observed safety performance
- Crash prediction methodologies
  - Intersection level
  - Approach level
- Builds on NCHRP Report 572 research incorporated into the Highway Safety Manual

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Chapter 6: Geometric Design

- Initial Operational Analysis
- Identify Initial Design Elements
- Other Input (env, PI)
- Single-Lane Roundabouts
- Multilane Roundabouts
- Mini-Rbts
- Iterate
- Check Performance
- Design Details and Applications

Chapter 6 (cont.): Principles

- Fastest path
- Path alignment
- Design vehicle
- Non-motorized design users
- Sight distance and visibility
- Visibility/view angles
Chapter 6 (cont.): Fastest Path

- Emphasis on controlling entry speed
- Paths drawn ignoring lane striping

Chapter 6 (cont.): Fastest Path (cont.)

- Recognition of acceleration and deceleration effects
- Suggested maximum theoretical speeds
  - Single lane: 25 mph
  - Multilane: 25-30 mph
- Less numerical emphasis on speed consistency
  - Can be achieved with low entry speeds

Chapter 6 (cont.): Path Alignment

- Aim vehicles before entering conflict areas

Chapter 6 (cont.): Design Vehicle

- Consider during earliest planning stages
- Multilane roundabouts: Issue of side-by-side travel continuing subject of research and best practice

Chapter 6 (cont.): Non-motorized Design Users

- Pedestrians of all abilities, bicyclists of all abilities
- Integrate into design process
- User dimensions affect key roundabout dimensions
  - Splitter island width
  - Crossing width
  - Crossing location
  - Sidewalk width

Chapter 6 (cont.): Sight Distance and Visibility

- Stopping sight distance on all approaches, departures, and within roundabout
- Intersection sight distance
  - Revised critical headway value: 5.0 s
- Visibility of intersection
  - Especially important in higher-speed environments
Chapter 6 (cont.): Visibility/View Angles
- Need to consider human factors when looking to left

Example of Principles: Alignment
- Offset left, radial, and offset right each have their place
- Each circumstance requires its own solution, with principles determining tradeoffs
- Words “preferred”, “acceptable”, and “avoid” have been removed

Promoting Good Path Alignment at Multilane Roundabouts
- Range of alignments may be appropriate
- Proportion of approach alignment offset to left of roundabout center

Multilane Roundabout: Managing Conflicts
- Desire to minimize likelihood of vehicles entering next to exiting vehicles
Chapter 6 (cont.): Mini-Roundabouts
• New material based on latest practices

Chapter 6 (cont.): Pedestrian and Bicycle Treatments
• Updated to reflect latest research, practices, and policies

Ch 6 (cont.): Design Trade-off Example
• Larger ICD (140 ft)
• Larger central island
• Greater central island visibility
• More right-of-way impacts

Ch 6 (cont.): Design Trade-off Example (cont.)
• Smaller ICD (125 ft)
• Less right-of-way impact
• Smaller central island
• Reduced visibility on approach

Chapter 6: Expansion from Single-Lane to Multilane Designs
• Encourages consideration of interim configurations

Chapter 6: Expansion from Single-Lane to Multilane Designs (cont.)
• Discusses trade-offs with expansion to outside versus inside

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Chapter 7: Application of Traffic Control Devices
- Complements 2009 MUTCD
- Discusses applications of signs, markings, and signals/beacons

Signing and Markings: Typical Layouts

Applications of Signals and Beacons

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Chapter 8: Illumination
- Provides several useful resources for roundabout lighting
- Discuss principles
  - Visibility from a distance
  - Visibility of key conflict areas
- Lighting levels
- Equipment type/location
- Pole location
- Example illumination layouts

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Chapter 9: Landscaping
• Emphasis on visibility and focus of driver attention
• Discussion of tradeoffs with art and other features

Chapter 9: Landscaping (cont.)
• Expanded discussion of landscaping context
  – Lower speed urban environments typically provide more flexibility than higher speed suburban or rural environments

Chapter 10: Construction & Maintenance
• Construction staging scenarios
• Maintenance considerations

Roundabouts 101
• Introduction
• Latest Practices
  – Pedestrian Treatments
• Potential Applications for Florida
Pedestrian Treatments

- Evolving practice over past decade
- Influenced significantly by research findings on the use of roundabouts by those who are blind or visually impaired
- US Access Board has issued proposed final rulemaking covering public rights of way

Pedestrian Needs at Roundabouts: Benefits

- Few reported pedestrian crashes
- Speed-controlled environment
- Splitter island provides refuge to enable two-stage crossing

Pedestrian Needs at Roundabouts: Challenges

- Pedestrians must assess gaps or have drivers yield to them
- Entries/exits with more than one lane more difficult

Wayfinding

- Well defined walkway edges
- Separated walkways
- Detectable warnings
- Perpendicular crossings
- Contrasting crosswalk markings

Pedestrian Needs at Roundabouts: Challenges

- Pedestrians with vision impairments have particular difficulty identifying and accepting gaps or yields at multilane crossings

Sidewalk Design

Alternative design where additional right-of-way is available

Minimal right-of-way requirement

Walking ramp is accessible to people with mobility and vision impairments

Elevated sidewalk area for pedestrian use
Public Rights of Way Accessibility Guidelines (PROWAG)

- http://www.access-board.gov/prowac/index.htm
- Key provisions specific to roundabouts:
  - Detectable edging where crossing is not intended
  - “Pedestrian-activated signal” for all multilane entries and exits
- US Access Board is considering comments submitted to docket
- FHWA and ITE actively working with US Access Board to develop practical solutions

NCHRP Report 674 Research

- Treatments tested at multilane roundabout in Golden, Colorado
  - Raised pedestrian crosswalks
  - HAWK signal (pedestrian hybrid beacon)
- Both show promise in improving accessibility
- Applicability to higher volume conditions unknown

NCHRP Report 674 Test (Golden, CO): Raised crosswalks

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- HAWK signal (pedestrian hybrid beacon)
- Both show promise in improving accessibility

Pedestrian Hybrid Beacon (PHB) Operation

- 1 Blank for drivers
- 2 Flashing yellow
- 3 Steady yellow
- 4 Steady red
- 5 Wig-Wag
- Return to 1

NCHRP Report 674 Test (Golden, CO):
Pedestrian Hybrid Beacon (PHB)

- Pedestrian delay decreased threefold
- Blind pedestrians tended to cross when they could hear a gap, not necessarily when audible walk signal was given
- 13% of vehicles did not stop on solid red
Rectangular Rapid Flashing Beacon

- First tests at midblock crossings: St. Petersburg, FL
- First application at roundabout: Oakland County, MI
- Other recent applications: Springfield, OR; Olympia, WA
- Being tested under FHWA research project for accessibility (ongoing)

Other Recent or Ongoing Research

- Accommodation of oversized trucks (“superloads”)
- Practices for accommodating standard trucks at multilane roundabouts
- NCHRP Project 03-100: Analysis of roundabouts in corridors
- FHWA study of mini-roundabouts

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Other Recent or Ongoing Research (cont.)

• FHWA research on four topics:
  – Effectiveness of Rectangular Rapid Flashing Beacon (RRFB) at multilane roundabout pedestrian crossings
  – National calibration and update of capacity models
  – Assessment of environmental models (air quality, noise)
  – Assessment of fatal and severe injury crashes
• Local capacity calibration for states: Georgia, Kansas, Wisconsin

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Potential Applications for Florida

• Important to consider the context in identifying a good application
• Location
  – New roadway system
  – Retrofit to existing intersection
• Local history
  – First roundabout in an area?
  – Roundabouts have gained acceptance

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Variety of Roundabout Uses

• Residential Subdivisions – Modesto, California
• Small Towns – Howard, Wisconsin
• Urban Centers – Towson, Maryland
• High-Speed Rural Roadways – Paola, Kansas
Variety of Roundabout Uses (cont.)

Tourist Routes – Astoria, Oregon

Large Developments – South Jordan, Utah

Northern Climates – North Pole, Alaska

Near Schools – Clearwater, Florida

Photos: Lee Rodegerdts

Commercial Center: Margate, FL

Gateway in Major Tourist Area: Clearwater, FL

MD 216, Scaggsville, MD

La Jolla Blvd., San Diego (Bird Rock neighborhood), CA

Avon Road, Avon, CO

Photos: Lee Rodegerdts
Where to Exercise Care with Roundabouts?

- Physical or geometric complications
- Proximity of significant generators
- Proximity of other traffic control devices
- Proximity of bottlenecks
- Problems with grades and unfavorable topography
- Intersections of major road with minor
- Heavy pedestrian and/or bicycle movements
- Located within a coordinated signal network
- A history of previous poorly executed projects

Exercising care does not automatically mean NO!

- Operational modeling or specific design features may minimize likelihood of significant problems
- Coordination with and support from other agencies (e.g., local fire department)
- Specific mitigation actions may be required
- Weigh the political climate if there is opposition—seek allies at all levels
- Depending on context, may want to avoid marginal locations

Conclusion

- Roundabouts are seeing increased use throughout the United States
- They should be an alternative on the table for strong consideration
- They are often but not always the best choice for a given location—use good judgment
- They are versatile – can be used in a variety of situations

Thank You!

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