Roundabouts
(Be Brave and Be Careful!)

Presenter:
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BURGESS & NIPLE
Engineers ■ Architects ■ Planners
Presenter Background

- B.S. and M.S. Civil Engineering
- 16-years experience in Transportation and Traffic engineering and planning
- Roundabout Convert!
- ITE Roundabout Taskforce Member
Presentation Overview

- **Part 1 - Basics**
  - Definitions / history
  - Benefits / concerns
  - Key design features

- **Part 2 – Case Studies**
  - Wide range of situations where roundabouts provide an excellent intersection solution
  - Lessons learned
Part 1A: What is a roundabout?

- Examples
- Other circular intersections (what is not a roundabout)
- Key definitions/features
A Roundabout...

- ... is an intersection with a generally circular shape.
- ... requires all entering traffic to yield to circulating traffic.
- ... has appropriate geometric features to ensure slow entering and circulating speeds.
The Modern Roundabout
Examples
Examples
Example Roundabout(s)
Example Roundabout(s)
Roundabouts are a subset of circular intersections...
Other Circular Roadway Designs

- The Neighborhood Traffic Circle
Other Circular Intersection Designs

- The Rotary
Other Traffic Circles: Fort Worth, TX
Conversion of Rotary to Roundabout: Kingston, NY

Photo: New York State DOT
A brief history of roundabouts

1905: Columbus Circle in NYC

1997: Added to HCM

1900-1950: Rotaries built in U.S.

1970s: First modern use in France, Australia

1980s: First modern use in Germany

1966: Mandatory “give-way” rule adopted in UK

First modern use in UK

1990: First modern use in U.S.

2000: FHWA’s ROUNDABOUTS: An Informational Guide
Key Roundabout Features

- Bicycle treatment (optional)
- Counterclockwise circulation
- Circulatory roadway
- Central island
- Sidewalk (optional)
- Landscaping buffer
- Entrance line
- Splitter island
- Truck Apron (if necessary)
- Accessible pedestrian crossing
Key Dimensions

- **Typical ICD**
  - Single Lane 110-130’
  - Double Lane 150-180’
Part 1B: Why choose a Roundabout?

- Benefits
- Considerations
Why Roundabouts (vs. signals)?

- Much safer
- More efficient (less delay)
- More aesthetic design opportunities
- Reduced noise
- Reduced vehicle emissions – greener!
- Lower operating costs (and less energy consumption)
- Access management
- Less R/W required for approach lanes
Roundabouts are Safer

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Change in Total Crashes after Conversion</th>
<th>Change in Severe Injury after Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Four-Way Intersections</td>
<td>-35%</td>
<td>-76%</td>
</tr>
<tr>
<td>Signalized urban</td>
<td>TOO FEW</td>
<td>-60%</td>
</tr>
<tr>
<td>Signalized Suburban</td>
<td>-67%</td>
<td>TOO FEW</td>
</tr>
<tr>
<td>All-Way Stop Controlled</td>
<td>SIMILAR</td>
<td>SIMILAR</td>
</tr>
<tr>
<td>Two-Way Stop Controlled Urban</td>
<td>-72%</td>
<td>-87%</td>
</tr>
<tr>
<td>Two-Way Stop Controlled Suburban</td>
<td>-32%</td>
<td>-71%</td>
</tr>
<tr>
<td>Two-Way Stop Controlled Rural</td>
<td>-29%</td>
<td>-81%</td>
</tr>
</tbody>
</table>

Source: NCHRP 572
Fewer Conflict Points

- Reduces number of conflict points from 32 to 8
Reduced Severity of Conflicts

- Severity related to relative velocities of conflicting streams

- Rear-end
- Sideswipe
- Angle
- Angle
- Head-on

Least severe

Most severe
Roundabouts are Usually More Efficient

- Roundabout gives higher capacity and lower delays than All-Way Stop Control under same conditions
- Roundabout likely to have higher delays than Two-Way Stop Control if TWSC is operating without problems
- Roundabout within capacity will generally produce lower delays than signal under same conditions
  - Generally design for maximum 0.85 of capacity each approach
Maximum ADT (4-leg intersection)

Source: Roundabouts: An Informational Guide
Pedestrian Crash Statistics

- British study
  - Shows that all three main classifications of roundabouts produce lower pedestrian crash rates

- Dutch Study
  - Shows reductions in crash rates after intersections where changes from signalized to roundabouts
  - 89% reduction in pedestrian injury crashes
Signalized Intersections Safe for Peds?

- 4 vehicle/pedestrian conflicts for each leg:
  - Right turns on green (legal)
  - Crossing movements on red (high-speed, illegal)
  - Left on green (legal for permitted phasing)
  - Right on red (typically legal)
Pedestrian Crashes at Roundabouts

- 2 conflicts exist for each crossing
  1. Conflict with entering vehicles
  2. Conflict with exiting vehicles
Lower speed is safer for pedestrians

- Chance of pedestrian death increases with vehicle speed

- 15% chance at 32 km/hr (20 mph)
- 45% chance at 50 km/hr (30 mph)
- 85% chance at 65 km/hr (40 mph)

Source: United Kingdom
Space Requirements

Source: NCHRP 572
Exercise Care When

- Buildings or expensive property on corners
- Other traffic control devices are close by
- Bottlenecks are close
- There are steep grades and unfavorable topography
- There are heavy pedestrian and/or bicycle movements
- Located within a coordinated signal network
Part 1C: Key Design Considerations
Cyclist Movements at Roundabouts – Circulating as a Vehicle

Fewer conflict points with motor vehicles

Bikes re-enter bike lane

Lower motor vehicle speeds (15-20 mph)

Bikes merge with motor vehicles

Source: NCHRP 572
Cyclist Movements at Roundabouts – Circulating as a Pedestrian

Source: NCHRP 572
Pedestrians
Revised Draft Guidelines for Accessible Public Rights-of-Way

- R305.6.2 Signals. At roundabouts with multi-lane crossings, a pedestrian activated signal complying with R306 shall be provided for each segment of each crosswalk, including the splitter island.

- YOU MAY WANT TO PLAN FOR THIS!

- NCHRP 3-78

- Oakland County, MI Lawsuit
Critical Design Features

- Speed profiles
- Path overlap
- Phi Angle
- Truck design
- Sight distance (Landscaping)
- Lighting
Speed Profiles

- Design to slow traffic
- Smooth transitions - relative “R” speed differences should be less than 12-mph, preferably less than 6-mph
Path Overlap

- On multi-lane roundabouts
- Guide drivers into proper lane
- Can cause and above average # of crashes
Phi Angle

- 20-40 degrees preferred

**Figure 14. Method 1 Phi Measurement**

Source: Wisconsin DOT
Truck Paths
Sight Distance (Landscaping)

- Don’t block critical sight distances
- Reducing sight distance will help to reduce traffic speeds
- Use landscaping to make roundabout apparent
Lighting

- Illuminate pedestrians and bicyclists
- Illuminate curbs and vehicle path
- Make driver aware of approaching roundabout
Maintaining Traffic During Construction

- Keep it as simple as possible
- Use closures and detours where possible
- Identify critical movements and seasonal factors
- Minimize constructing in “pieces”
MOT (continued)

- Wider roundabout footprint can be an advantage
- Be careful using “temporary” roundabouts
  - Safety
  - Use full pavement markings & signing
- Lighting should be operational
- Public perception (first impression!)
QUESTIONS?
Part B: Case Studies

- Wide range of applications
- Key issues/characteristics
- Lessons learned
U.S. 33 and S.R. 161/Post Road Interchange - Dublin, Ohio

- Diamond Interchange
- Three-lane roundabouts at the exit ramp terminals
- Three-lane roundabout at an adjacent intersection
- 2010 Construction
ODOT & FHWA Approval

FIGURE 1
PROPOSED ROUNDBOUD ALTERNATIVE:
YEAR 2030
## Operational Benefits

### 2030 Delay and LOS for East Ramp Terminal Intersection

| Intersection Leg                | LOS and Average Vehicle Delay (seconds) |  |  |  |  |  |  
|---------------------------------|----------------------------------------|---|---|---|---|---|---|
|                                | RODEL (Roundabout) | aaSIDRA* (Roundabout) | HCS** (Signalized) |  |  |  |  
|                                | 2030 AM | 2030 PM | 2030 AM | 2030 PM | 2030 AM | 2030 PM |  
| North Leg (Off-Ramp)           | A 3.0   | A 3.6   | B 14.0   | B 16.3   | D 53.2   | D 43.0   |  
| West Leg (SR 161)              | A 3.6   | A 3.0   | A 9.4    | A 6.4    | D 53.9   | D 48.0   |  
| South Leg (University)         | A 4.8   | A 6.6   | B 19.0   | C 25.5   | D 47.1   | D 48.7   |  
| East Leg (SR 161)              | A 1.8   | A 2.4   | A 4.6    | A 4.4    | C 20.7   | D 39.4   |  

### 2030 Delay and LOS for West Ramp Terminal Intersection

| Intersection Leg                | LOS and Average Vehicle Delay (seconds) |  |  |  |  |  |  
|---------------------------------|----------------------------------------|---|---|---|---|---|---|
|                                | RODEL (Roundabout) | aaSIDRA* (Roundabout) | HCS** (Signalized) |  |  |  |  
|                                | 2030 AM | 2030 PM | 2030 AM | 2030 PM | 2030 AM | 2030 PM |  
| North Leg (Hyland Croy)        | A 3.0   | A 3.0   | B 19.7   | C 20.8   | D 39.9   | D 48.1   |  
| West Leg (SR 161)              | A 3.0   | A 2.4   | A 7.5    | A 6.5    | D 35.2   | C 32.7   |  
| South Leg (Off-Ramp)           | A 2.4   | A 2.4   | B 17.3   | B 14.5   | D 47.4   | D 47.0   |  
| East Leg (SR 161)              | A 2.4   | A 2.4   | B 14.6   | B 18.6   | D 45.8   | D 47.3   |  

Issues

- Ramp metering
- Speed vs. truck design
- 2-lanes vs. 3-lanes
Sawmill Parkway Extension
Delaware County, Ohio

- 6.5 miles
- 6 proposed roundabouts
- Roundabout study requested by public
- Detailed study performed
- 2009 -2011 Construction
24 – Hour Delay Comparison

### 2009 Daily Intersection Delay

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Total Delay (hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyatts</td>
<td>38</td>
</tr>
<tr>
<td>Clark-Shaw</td>
<td>11</td>
</tr>
<tr>
<td>Bean-Oller</td>
<td>7</td>
</tr>
<tr>
<td>Ford</td>
<td>9</td>
</tr>
<tr>
<td>Bunty-Station</td>
<td>8</td>
</tr>
<tr>
<td>US 42</td>
<td>6</td>
</tr>
<tr>
<td>Section Line</td>
<td>11</td>
</tr>
</tbody>
</table>

### 2030 Daily Intersection Delay

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Total Delay (hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyatts</td>
<td>181</td>
</tr>
<tr>
<td>Clark-Shaw</td>
<td>61</td>
</tr>
<tr>
<td>Bean-Oller</td>
<td>28</td>
</tr>
<tr>
<td>Ford</td>
<td>78</td>
</tr>
<tr>
<td>Bunty-Station</td>
<td>31</td>
</tr>
<tr>
<td>US 42</td>
<td>29</td>
</tr>
<tr>
<td>Section Line</td>
<td>51</td>
</tr>
</tbody>
</table>
### Peak Hour Travel Time Comparison

<table>
<thead>
<tr>
<th>Intersection Scenario</th>
<th>Sawmill Parkway Extension Travel Time in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2009 AM</td>
</tr>
<tr>
<td>All signals and/or stop signs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NB</td>
</tr>
<tr>
<td>All roundabouts except stop sign at Ford, Clark-Shaw, Owen-Fraley/Slack relocated</td>
<td>8.55</td>
</tr>
<tr>
<td>All roundabouts except Owen-Fraley/Slack relocated</td>
<td>8.61</td>
</tr>
</tbody>
</table>
Crash Reduction

- Assumptions:
  - Two-lane 30% fewer crashes
  - Single-lane 50% fewer crashes
  - 1.0 crashes/MEV non-roundabout
Right-of-Way Comparison
Issues

- Trucks
- Farm Equipment
- Unfamiliarity
- City/ODOT preference for signal at U.S. 42
Triangle Project - Hilliard, Ohio

- 2 closely spaced urban roundabouts
- Schools/pedestrians
- High traffic volumes
- 2010 planned construction
Signalized Alternative

- Multiple turn lanes
- Turn restrictions
- Businesses
Roundabout Alternative

- All traffic movements maintained w/ good access management
- Right-of-way benefits
Public Concerns

- School Children
- Offset Crosswalk / Pedestrian signal?
Micro-simulation (VISSIM)
Avery Road South Corridor Study Dublin, Ohio

- 2/3 mile roadway widening for future volumes
- Redevelopment
- Access management needs
Three Scenarios Evaluated

- **Common Features:**
  - Major intersection locations
  - Median
  - Access consolidation

- **Varying Features:**
  - Roundabouts and Signals
  - Service Roads
Alternate Left Turn Access
Alternate Left Turn Access
Issues

- Young pedestrians
- Trucks

- Middle roundabout constructed 2007
Richland Avenue

- Ohio University Campus
- Safety and Bridge Deck
- City wanted to investigate roundabout
  - Safety
  - Aesthetic Gateway
  - No “sea” of asphalt
  - Avoid bridge widening
  - Better pedestrian facility
- 2010 Construction
### Signalized SR 682 / Richland

<table>
<thead>
<tr>
<th>Approach</th>
<th>LOS and Average Vehicle Delay (sec)</th>
<th>Maximum Approach V/C</th>
<th>95th Percentile Queue Length (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2030 AM</td>
<td>2030 PM</td>
<td>2030 AM</td>
</tr>
<tr>
<td>Eastbound</td>
<td>D 35.3</td>
<td>D 37.9</td>
<td>0.60</td>
</tr>
<tr>
<td>Westbound</td>
<td>C 26.0</td>
<td>C 32.5</td>
<td>0.59</td>
</tr>
<tr>
<td>Northbound</td>
<td>C 27.3</td>
<td>C 26.4</td>
<td>0.79</td>
</tr>
<tr>
<td>Southbound</td>
<td>D 35.1</td>
<td>C 30.8</td>
<td>0.89</td>
</tr>
</tbody>
</table>

### Roundabout SR 682 / Richland

<table>
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<tr>
<th>Approach</th>
<th>LOS and Average Vehicle Delay (sec)</th>
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<th>95th Percentile Queue Length (ft)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2030 AM</td>
<td>2030 PM</td>
<td>2030 AM</td>
</tr>
<tr>
<td>Eastbound</td>
<td>B 12.8</td>
<td>C 22.4</td>
<td>0.178</td>
</tr>
<tr>
<td>Westbound</td>
<td>B 18.8</td>
<td>B 15.4</td>
<td>0.696</td>
</tr>
<tr>
<td>Northbound</td>
<td>A 4.9</td>
<td>C 23.6</td>
<td>0.307</td>
</tr>
<tr>
<td>Southbound</td>
<td>B 10.3</td>
<td>B 18.6</td>
<td>0.178</td>
</tr>
</tbody>
</table>
Public Meetings

- Side-by-side exhibits with VISSIM simulation
- Matrix evaluation
- Educational materials
## Alternatives Evaluation

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Improve safety at the intersection of Richland Avenue and SR 682 by eliminating geometric and other design deficiencies and reducing congestion related crashes (Need Element).</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2. Provide for acceptable side street traffic operations at Darby Lane / Richland Avenue intersection (Need Element).</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3. Improve deck and perform other needed maintenance items for Richland Avenue Bridge over the Hocking River (Need Element).</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4. The project should safely accommodate pedestrians &amp; bicycle traffic through the intersection of SR 682 and Richland Avenue and through the project area, providing connections in existing and future locally planned improvements in the corridor (Project Goal and Objective from P&amp;N).</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>5. Include excellent urban aesthetic design elements where feasible in the corridor</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6. Limit project costs to the available ODOT funding: 29% City matching funds, and contributions from Ohio University</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>7. Avoid negative environmental impacts, especially in the parkland and the Hocking River</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>8. Reduce vehicular speeds on SR 682 and Richland Avenue while not significantly reducing capacity</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9. Adequately accommodate and enhance public transit service</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10. Support special event traffic (vehicles and pedestrians)</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>11. Maintain Richland Avenue as a critical fire response route both during and after construction</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>12. Maintain service road to Ohio University Golf Course</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
Public Feedback

- People liked:
  - Slower traffic
  - Traffic safety
  - Pedestrian / bike safety
  - Efficiency/capacity
  - Aesthetics - Gateway
  - Less fuel consumption

- Concerns:
  - Confusing for locals at first
  - Confusing to elderly, visitors, freshmen
  - Pedestrian / bike safety
  - Efficiency/capacity
  - Education
  - Crossing at grade for blind

![Roundabout Opinion Chart](chart.png)
Issues / Considerations

- Bridge is very close to intersection
  - Could not meet all preferred design criteria (but are close)
- Steady volume of pedestrians (college students)
  - Dual crossing system – tunnel and at-grade
  - Pedestrians forced to one side (because of bridge)
- Special Events
VISSIM Model
Summary

- Roundabouts are a great solution for a wide variety of locations
- There are some critical design features
- Be brave!
- But be careful!
Questions & Comments

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