Will a Roundabout Work Here?

Purdue Road School
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Presentation Objectives

- Provide general information on the wide variety of roundabout applications
- Discuss an example roundabout feasibility study:
  CR 100 S & Dan Jones Road in Avon, Indiana
**Roundabouts: Pros and Cons**

**Pros**
- Good traffic operations/low delays
- High left turn volumes not a problem
- Very safe when designed properly
- Slows all traffic - calming effect
- Access management tool
- Look attractive
- Can be modified
- Construction cost (no need to widen approach roads)

**Cons**
- Conflicts with bicyclists circulating in roundabout
- Blind pedestrians have expressed concern
- Construction cost/ROW requirements at intersection
- Learning curve for drivers - uncertainty

**Example Applications**
- Safety problems
- Capacity problems
- Closely spaced intersections
- Unusual geometry
- Locations where signal would require bridge widening/reconstruction – Interchanges, etc.
- Locations where sight triangles are obscured for signals
**High Speed Rural Intersection - KS**

**Before**
- Crash problem as 2-way stop (25 injuries ‘93–‘97)
- Good safety, fair traffic operations as 4-way stop (‘98–‘01)

**After**
- Excellent safety/operation as roundabout – 3 PDO crashes (‘01–‘03)

65 mph approach speed

**Skewed Intersections - Safety**
**Congested Intersections**

Before – Level of Service E with traffic signal

After – Level of Service A with roundabout

**M-53 Interchange Roundabout**

Open for 3 months – 30,000 ADT, LOS A
20 year projection – 45,000 ADT, LOS A
Freeway Interchanges

Connecting Freeways
Closely Spaced Intersections

Closely Spaced Intersections
Constraint – Interchange Bridge

Mini Roundabout in Michigan
Tight Constraint – Rail Bridge

Unusual Geometry
**Is a Roundabout Right for This Intersection?**

- **Objective engineering evaluation**
  - Identify existing and expected problems
  - Generate & screen candidate alternatives
  - If no “fatal flaws”, detailed analysis & comparison using appropriate criteria
    - Traffic operations, safety, cost, etc.

- **NCHRP 457 Evaluating Intersection Improvements: An Engineering Study Guide**

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**Example: C.R. 100S & Dan Jones Rd. Avon, Indiana**

- Rural roads + urban traffic = congestion
- $1.4 M in Federal-aid for intersection upgrade

- Improve capacity
- Improve aesthetics (Avon Vision Plan)
**Project Approach**

- **Project Scoping Study**
  - Develop 2025 Traffic Forecast
  - Develop intersection improvement alternatives providing sufficient capacity
  - Compare alternatives
    - No Build
    - Reconstructed Traffic Signal
    - Modern Roundabout

**Existing Intersection**

- Two 11-ft lanes with 2-ft shoulder
- Sanitary lift station
- CR 100 S
- 2-phase signal
- No turn lanes
- Bridge
**Traffic Forecast**

A long-range traffic forecast is critical to ensure intersection design provides adequate capacity.

<table>
<thead>
<tr>
<th>AM Peak Hour (7-8 a.m.)</th>
<th>Eastbound</th>
<th>Westbound</th>
<th>Northbound</th>
<th>Southbound</th>
<th>Total</th>
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<td><strong>2003 Existing</strong></td>
<td>L91 223</td>
<td>59 40</td>
<td>41 15</td>
<td>433 48</td>
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<tr>
<td><strong>2007 Forecast</strong></td>
<td>321 668</td>
<td>128 97</td>
<td>161 36</td>
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<tr>
<td><strong>2025 Forecast</strong></td>
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<td>176 39</td>
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<table>
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<th>PM Peak Hour (5-6 p.m.)</th>
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<th>Westbound</th>
<th>Northbound</th>
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<td>207 112</td>
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<td><strong>2007 Forecast</strong></td>
<td>185 259</td>
<td>97 105</td>
<td>663 341</td>
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<tr>
<td><strong>2025 Forecast</strong></td>
<td>202 283</td>
<td>106 115</td>
<td>729 373</td>
<td>67 823</td>
<td>74</td>
</tr>
</tbody>
</table>

**Reconstructed Signal Design Features**

- 1 left turn, 2 through, 1 right turn lane on all approaches
- Curb & gutter, sidewalks
- Designed for Interstate tractor-trailer
- Length of auxiliary lanes and additional through lanes per INDOT Manual
- Remove lift station
- New CR 100 S bridge over Clark’s Creek
- Impacted home
**Initial Roundabout Layout**

Software analysis to determine diameter, entry lanes and other critical dimensions.

**Roundabout Location Flexibility**

Avoid bridge. Minimize impact on south side. Large NW quad impact. Limited impact on south side, but may impact bridge.

Shared south/north impact. Bridge not impacted.
Refining Roundabout Geometry

- Control fast paths
- Accommodate trucks
- Provide capacity

Modern Roundabout Design Features

- 197 ft inscribed circle diameter
- 2-lane (30 ft wide) circulating roadway
- 2-lane entry on all approaches
- Curb & gutter, sidewalks

15 ft wide truck apron
(Designed for Interstate tractor-trailers)

Located off-center
Remove lift station
WB to NB right turn bypass lane
**Comparison of Alternatives**

Key Criteria Considered:
- Projected traffic operation
- ROW requirements and relocations
- Estimated cost (construction and operation)
- Predicted safety
- Aesthetics
- Accommodation of driveways, peds, bikes

**Projected Traffic Operation**

- **No Build (evaluated with Synchro)**
  - LOS F, V/C > 1 on 3 approaches
  - Not a feasible alternative

- **Reconstructed Signal (with Synchro)**
  - AM Delay = 16.7 sec / LOS = B
  - PM Delay = 19.5 sec / LOS = B
  - Additional capacity of 27%

- **Modern Roundabout (with Rodel)**
  - AM Delay = 8.2 sec / LOS = A
  - PM Delay = 7.3 sec / LOS = A
  - Additional capacity of 18% - 27%
### Right of Way Requirements

- **Reconstructed Signal**
  - 2.86 acres new ROW
  - Relocate 1 home
  - Relocate sanitary lift station

- **Modern Roundabout**
  - 1.35 acres new ROW
  - No relocations
  - Relocate sanitary lift station
  - Signal required upstream/downstream widening due to high approach speeds

### Estimated Cost

- **Reconstructed Signal**
  - $3.40 M for design, construction, ROW
  - $2,290 for annual operation
  - Signal modernization required in ~15 years

- **Modern Roundabout**
  - $2.20 M for design, construction, ROW
  - $2,340 for annual operation

→ DLZ has performed direct comparisons at over 40 intersections. Roundabouts have been cheaper than signals at more than half of those.
**When are Roundabouts Cheaper?**

Signalized intersections with numerous turning lanes and signal infrastructure drive up costs.

Roundabouts often prevent the need for bridge widening/lengthening because they do not need as many turning lanes as signals.

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**Predicted Safety**

- **Reconstructed Signal**
  - Crash rate lower than existing due to geometric, traffic control, lighting improvements

- **Modern Roundabout**
  - Crash rate & severity much lower than signal based on several studies in U.S. and elsewhere

- Predictive analysis can be done where safety is a known problem
**Safety Statistics**

- Persaud et. al. (Insurance Institute for Highway Safety), 2000 (U.S.)
  - 23 U.S. intersections converted from stop/signal to roundabouts
  - 40% reduction in total crash frequency
  - 80% reduction in injury crash frequency
  - 90% reduction in fatal/incap. injury crash frequency
- Maryland DOT Accident Evaluation, 2004
  - ~15:1 benefit - cost ratio for installation of single lane roundabouts
- Many other studies with similar results
- Multi-lane roundabouts see crash rates approach those of signals, but severity is lower

**Aesthetics**

- **Reconstructed Signal**
  - Much more pavement area than exists
  - Minimal landscaping opportunities within ROW
  - Decorative signal and lighting hardware possible
- **Modern Roundabout**
  - Somewhat more pavement than exists
  - Central and splitter islands with landscaping opportunities
  - No signal hardware
  - Decorative lighting hardware possible
**Roundabouts as a Civic Feature**

- Accommodating Driveways, Peds & Bikes
  - Reconstructed Signal
    - All driveways reasonably accommodated
    - 1 possible future RIRO drive
    - Pedestrians accommodated with new sidewalk
    - Bicycles accommodated within travel lanes
  - Modern Roundabout
    - All driveways reasonably accommodated
    - 1 possible future RIRO drive
    - Pedestrians accommodated with new sidewalk
    - Separate path recommended for bicycles if usage ever becomes significant
**Why a Roundabout at CR 100 S & Dan Jones Rd?**

- >100% savings in intersection delay
- up to 60% fewer total crashes and 80% fewer injury crashes
- Costs $1.2 million less to construct
- Less than ½ the new ROW acquisition
- Does not require purchase of a home
- More opportunities for aesthetic enhancements

**Status of Dan Jones & CR 100 S**

- INDOT Design approval: March 2005
- Design complete: Spring 2005
- Construction: Late 2005 - 2006
So is a Roundabout Better than a Traffic Signal?

- Yes... in certain situations
- Roundabouts & signals are complimentary
  - Where one works, the other may struggle
- Large left turn flows = roundabout better
- Low turning flows = traffic signals do well
- Safety = roundabout ( ~ 60% fewer PIAs)
- Sometimes one fits ROW better
- Depends on cost & benefit in each situation
- Need to assess and compare both options

Credits

- R. Barry Crown (Rodel Software Limited) – miscellaneous information adapted for use in several slides
- Dave Sonnenberg (Ingham County Road Commission) – photos of Okemos roundabouts
- Edmund Waddell – photos of roundabouts in Avon, CO and Dimondale, MI
- Kansas DOT – Photos of roundabout in Kansas