Will a Roundabout Work Here?

Purdue Road School
March 29, 2005

Matthew Miller, PE
DLZ Indiana, LLC
36 South Pennsylvania St., Suite 360
Indianapolis, Indiana 46204

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
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*

**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

Bridge

2-phase signal
No turn lanes

CR 100 S

Dan Jones Rd.
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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>T</td>
<td>R</td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>2003 Existing</td>
<td>171</td>
<td>223</td>
<td>59</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>2007 Forecast*</td>
<td>321</td>
<td>668</td>
<td>128</td>
<td>97</td>
<td>164</td>
</tr>
<tr>
<td>2025 Forecast*</td>
<td>351</td>
<td>731</td>
<td>140</td>
<td>106</td>
<td>179</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PM Peak Hour (5-6 p.m.)</th>
<th>Eastbound</th>
<th>Westbound</th>
<th>Northbound</th>
<th>Southbound</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>T</td>
<td>R</td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>2003 Existing</td>
<td>48</td>
<td>79</td>
<td>29</td>
<td>52</td>
<td>207</td>
</tr>
<tr>
<td>2007 Forecast*</td>
<td>185</td>
<td>259</td>
<td>97</td>
<td>105</td>
<td>660</td>
</tr>
<tr>
<td>2025 Forecast*</td>
<td>202</td>
<td>283</td>
<td>106</td>
<td>115</td>
<td>729</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

Remove lift station

- Length of auxiliary lanes and additional through lanes per INDOT Manual
- 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.

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