National Use of Alternative Intersections

Mark Doctor – FHWA Resource Center
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What are Intersection & Interchange Geometrics?

Innovative designs that:

• Improve the way traffic makes certain movements
• Eliminate, relocate or modify conflict points
• Strategically improve signalization

Source: Mark Doctor, FHWA

Source: Missouri Department of Transportation
Why Intersection and Interchange Geometrics?

About half of all severe crashes occur at intersections.

As planned points of crossing and conflict, intersections are a major safety issue and may become bottlenecks along high-volume roadways.
Why Intersection & Interchange Geometrics?

- Growing traffic demands
- Scarce funding
- Restricted ability to add more lanes or build grade separations
- Need for improved safety for pedestrians, bicyclists and drivers

Source: Mark Doctor, FHWA
Intersection Conflicts

Conflicts Points at a Typical Intersection

16 Crossing Conflicts

32 Total Conflict Points

Source: North Carolina DOT
Intersection Safety Facts

Angle crashes account for over 40% of fatal crashes at intersections.
Left-turn crashes account for over 20% of fatal crashes at intersections.
Ped/Bike crashes account for 25% of fatal crashes at signalized intersections.
Changing the way we design intersections can save lives and allow more efficient and effective projects.
Benefits of Intersection & Interchange Geometrics

SAFETY
- Fewer conflict points
- Significant Before/After Crash Reductions

MOBILITY
- Less delay
- Reduced congestion

VALUE
- Less ROW
- Less construction costs
- Implemented quicker
Signalized Intersections

Typical signal scheme with “protected” left-turn phasing
Eliminating or strategically relocating left-turn movements from an intersection can provide more green time to through traffic.
Signalized Intersections

Eliminating or strategically changing how left turns are handled can allow more green time allocated to through traffic.

2 Phase

- Major Route Red (Minor Route Green)
- Clearance + Change Interval
- Major Route Green (Minor Route Red)

4 Phase

- Major Route Red (Minor Route Green)
- Exclusive Left-Turns
- Clearance + Change Intervals
- Major Route Green (Minor Route Red)

This is where efficiency is gained!
Featured Innovations
EDC2 IIG Innovations

- Roundabouts
  - Source: Jeff Shaw, FHWA

- U-Turn Intersections
  - Source: Wisconsin DOT

- Displaced Left Turn Intersections
  - Source: Mark Doctor, FHWA

- Diverging Diamond Interchanges
  - Source: Utah DOT
Roundabouts

- Modern designs are safer and more efficient than old circles and rotaries
- Measurable progress in last 10+ years, but still underutilized
Roundabouts Track Record

- Effective for both corridor and spot improvements
- Can complement other program goals such as Access Management, Active Transportation, etc.
- Proven in both low-speed urban and high-speed rural environments
Roundabout Opportunities

Mini-Roundabouts

78-82% Reduction in Severe Crashes\(^1\)

Roundabouts at interchanges

1. AASHTO Highway Safety Manual, Chapter 14
Outreach & Education are Critical to Success

- Toolbox of case studies documenting successful implementation of roundabouts from around the U.S.
Roundabouts
Roundabouts
U-Turn Intersections

Restricted Crossing U-turn (RCUT) (aka J-turn, Superstreet)

Median U-Turns (aka Michigan Left, Indirect Left)

ThrU Turn
### U-Turn Intersection Basics

#### Conflict Point Comparison by Intersection Type (2X2)

<table>
<thead>
<tr>
<th>Conflict Type</th>
<th>Conventional Signalized 4-leg</th>
<th>Median U-Turn</th>
<th>Restricted Crossing U-Turn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merging/Diverging</td>
<td>16</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Crossing (left turn)</td>
<td>12</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Crossing (angle)</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32</strong></td>
<td><strong>16</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>

Source: FHWA-RD-09-060
U-Turn Intersections: RCUT

Distinguishing Features:

- Cross street (minor road) traffic turns right, then accesses U-turn to proceed in desired direction.
- Main and U-turn intersections can be either signalized ("Superstreet") or not ("J-Turn")

Source: Wisconsin DOT
U-Turn Intersections: MU-T

Distinguishing Features

- Eliminates direct left-turns at main intersection
- Left turning traffic proceeds past main intersection to a U-turn location downstream
- Traffic then turns right at main intersection
- U-turn locations can be signalized and coordinated with main intersection

Source: FHWA-RD-09-060
Distinguishing Features

- Similar to MU-T in that direct left-turns are eliminated from main intersection
- Main difference is design of U-turn, substituting a paved bump-out or “loon” beyond the outside lane (or coinciding with a sidestreet tee intersection or driveway) for the wide median of a MU-T
U-Turn Intersections Safety

24 Total J-Turn Conflict Points

- 12 @ Main Intersection
- 8 Weaving
- 4 @ U-Turns

- 4 Crossing
- 10 Merge
- 10 Diverge

Figure 2: Turn Restrictions at Multi-Lane Highways

Source: FHWA-SA-09-020

Crash Reductions by Severity (MD RCUT sites)¹

<table>
<thead>
<tr>
<th>PDO</th>
<th>Injury</th>
<th>Fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>21%</td>
<td>42%</td>
<td>70%</td>
</tr>
</tbody>
</table>

1. Field Evaluation of a Restricted Crossing U-Turn Intersection (FHWA-HRT-11-067)
Displaced Left Turn (DLT) Intersection

Distinguishing Feature:
Left-turn movement (on one or more approaches) strategically relocated to the far-side of the opposing roadway via interconnected signalized crossover in advance of the main intersection.
Displaced Left Turn (DLT) Intersection

- Observed crash reductions of 60%
- Total travel time reduction

Before and After Comparison for
BANGERTER HIGHWAY IMPROVEMENTS
Displaced Left-Turn Intersections

- **Operational**
- **In Construction**
- **Advanced Design**
- **Under Study**
Diverging Diamond Interchange

Distinguishing Feature:
Geometry that temporarily channelizes traffic to the left side of the roadway (between the ramp terminals); thus allowing left-turn movements without the need for an exclusive signal phase.
What is a Diverging Diamond Interchange?

- Essentially a diamond interchange with crossover intersections at the ramp terminals

Source: Ohio DOT
What Makes the DDI Different?
What is a Diverging Diamond Interchange?

• Essentially a diamond interchange with crossover intersections at the ramp terminals
# Early DDI Safety Results

## Crash Reductions By Crash Type

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Total Crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-Turn Type</td>
<td>100%</td>
</tr>
<tr>
<td>Left-Turn Right Angle</td>
<td>72%</td>
</tr>
<tr>
<td>Total Crashes</td>
<td>46%</td>
</tr>
</tbody>
</table>

1. Diverging Diamond Interchange Performance Evaluation, MODOT, February 2011

**Conventional Diamond**
- 26 conflict points

**Diverging Diamond**
- 14 conflict points
DDI - Noteworthy Attributes

• Relatively small footprint
• Existing bridge can often be salvaged on retrofits
• Versatile alternative for low and high volume locations
• Non-motorized accommodation
Diverging Diamond Interchanges

- **Operational**
  - California
  - Texas
  - North Carolina
  - South Carolina
  - Alabama
  - Georgia
  - South Dakota
  - Idaho
  - Oregon
  - Nevada
  - Utah
  - Wyoming
  - Colorado
  - Kansas
  - Missouri
  - Kentucky
  - West Virginia
  - Virginia
  - Vermont
  - Connecticut
  - New York
  - New Hampshire
  - Puerto Rico
  - Hawaii

- **In Construction**
  - New Hampshire
  - Oregon
  - Nevada
  - Utah
  - Wyoming
  - Colorado
  - Kansas
  - Missouri
  - Kentucky
  - West Virginia
  - Virginia
  - Vermont
  - Connecticut
  - New York
  - New Hampshire
  - Puerto Rico
  - Hawaii

- **Advanced Design**
  - Alaska
  - Arizona
  - Idaho
  - Montana
  - North Dakota
  - Nebraska
  - South Dakota
  - Kansas
  - Nebraska
  - Minnesota
  - Iowa
  - Wisconsin
  - Michigan
  - Ohio
  - Indiana
  - Illinois
  - Indiana
  - Connecticut
  - New York
  - Pennsylvania
  - New Jersey
  - New Hampshire
  - Vermont
  - Connecticut
  - New York
  - New Hampshire
  - Puerto Rico
  - Hawaii

- **Under Study**
  - Alabama
  - Georgia
  - South Carolina
  - Tennessee
  - Wisconsin
  - Illinois
  - Michigan
  - Ohio
  - Indiana
  - Connecticut
  - New York
  - New Hampshire
  - Puerto Rico
  - Hawaii
Agencies include these EDC intersection designs in their evaluation processes or policies in a manner that ensures they are considered and evaluated alongside other improvement alternatives, and implemented when appropriate.
Key Issues/Challenges

• Lack of knowledge regarding these concepts
• Ambiguity on criteria for when to apply them
  – No formal screening process
  – No process to assess “best value”
  – Lack of tools to analyze operations
• Public/Political Reaction
  – Apprehension/Resistance to change
  – Fear of failure
Strategies for Advancing Deployment

- **Awareness and Outreach (communication and marketing)**
- **Training**
  - Web-based and instructor-led workshops
- **Knowledge and Information Exchange**
  - Peer Exchanges of successful practices and projects
  - Communicate and share lessons learned
  - Intersection and Interchange Geometrics website
- **Analysis Tools and Evaluation Processes**
  - HCM methodologies and use of screening tools such as CAP-X
Selected Resources

• **Alternative Intersections/Interchanges: Informational Report (AIIR)**

• **Roundabout Outreach and Information Toolbox**

• **Mobility Investment Priorities**
  - http://mobility.tamu.edu/mip/strategies.php
How can I get more information?

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