FHWA Innovative Initiative:
Intersection & Interchange Geometrics

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Every Day Counts (EDC)

• Encourages the rapid deployment of existing, proven technologies to:
  • Shorten project delivery
  • Enhance highway safety
  • Protect the environment
  • Reduce Congestion

• First launched in 2010 (“EDC 1”)
• EDC 2 started in 2012, ends in 2014
• EDC 3 to follow EDC2
Every Day Counts 2 Innovations

**Accelerating Project Delivery**
- Programmatic Agreements
- Locally Administered Projects
- Geospatial Data Collaboration

**Reducing Construction Time**
- 3D Engineered Models for Construction
- Accelerated Bridge Construction
- Intelligent Compaction

**Innovative Contracting**
- Design Build
- CMGC
- Alternative Technical Concepts

**Safety, Mobility & Environment**
- **High Friction Surface Treatments**
- **Intersection and Interchange Geometrics**
- National Traffic Incident Management Responder Training (SHRP 2)
- Implementing Quality Environmental Documentation
Why Intersection and Interchange Geometrics?

Intersections represent about \( \frac{1}{4} \) of all traffic fatalities...

...and HALF of all severe crashes

Intersections are a major safety issue and may become bottlenecks along high volume roadways

Source: Mark Doctor, FHWA
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

Source: Mark Doctor, FHWA
In addition to Safety...

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

Source: Mark Doctor, FHWA
What are Intersection & Interchange Geometrics?

Innovative designs that:

• Improve the way **people** move across intersections
• Eliminate, relocate or modify conflict points
• Strategically optimize traffic control

“cho·re·og·ra·phy”
Benefits of Intersection & Interchange Geometrics

**SAFETY**
- Fewer, less severe conflict points
- Speed management potential
- Significant crash reductions

**MOBILITY**
- Less delay
- Reduced congestion
- New/more pedestrian and bike opportunities

**VALUE**
- Smaller footprints
- Less ROW
- Decreased costs
- Quicker construction
EDC IIG Innovations

- Diverging Diamond Interchange (DDI)
- Restricted-Crossing U-Turn (RCUT)
- Displaced Left-Turn (DLT)
- Medial U-Turns
- Roundabouts

Source: FHWA-RD-09-060
IIG Common Denominators

• Fewer and/or less severe conflict points
• Changes how left-turns are handled
• Synchronizing movements across intersection and between legs
• Optimal traffic control
• Speed calming advantages
• “Best Value” solutions

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
• Proven in both low-speed urban and high-speed rural environments
• Effective for both corridor and spot improvements

78-82% Reduction in Severe Crashes¹

Source: FHWA

¹. AASHTO Highway Safety Manual, Chapter 14
Roundabout Opportunities

Roundabouts at interchanges

Mini-Roundabouts

Source: FHWA

Source: Google Earth
Jackson Co. GA (2013)

Lake Ozark MO (2014)
Lake Stevens WA

BEFORE

AFTER
U-Turn Intersections

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

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

ThrU Turn

Source: Wisconsin DOT
Source: FHWA-RD-09-060
Source: Utah DOT
## 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 unsignalized (“J-Turn”)

Source: Wisconsin DOT
Unsignalized RCUT (aka J-Turn)

- Cross street through traffic turns right
- Cross street left turn traffic moves through
- Arterial traffic no different than conventional intersection
- Cross street traffic must turn right
- Cross street left turn and through traffic makes a U-turn in the wide median

Source: Google®, U.S. Geological Survey, Data SIO, NOAA, U.S. Navy, NGA, GEBCO.
Signalized RCUT (aka Superstreet)

SR 4 Bypass at Symmes Rd Fairfield, OH
Before: 54 crashes (2 fatalities, 8 injuries)

After: 10 crashes (0 fatalities, 0 injuries)
Missouri Evaluation of J-Turns

Analysis of 5 sites converted to J-turns

- 35% total crash reduction
- 54% reduction in all severe crashes
- No fatal crashes post-installation

In a public survey regarding trip time perceptions resulting from the J-turn, the majority said there was no adverse effect
Maryland J-Turn Experience

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

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)
RCUTs for Peds & Bikes

- Preferred option
- Potential option (if no crosswalk)
- Legal but undesirable option

- "Z"
- Signalized Mid-block
- Median Cross
- Barnes Dance (exclusive pedestrian phase)
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
U-Turn Intersections: ThrU Turn

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
Median U-Turn Intersection MI Safety Experience (Grand River Ave)

Replaced conventional signalized intersections

• **60% reduction** in total crash frequencies
• **75% reduction** in total injuries
• Reduction by type
  – **(17%)** rear-end crashes
  – **(96%)** angle crashes
  – **(61%)** side-swipe crashes

(Kach, et. al.)
MUTs & Peds/Bikes

Exhibit 3-7. Left turn options for bicycles.

Two-stage crossing

Single-stage crossing
Displaced Left Turn (DLT)

AKA Continuous Flow Intersection or CFI
Key DLT Characteristics

- Left turns begin at a crossover in advance of main intersection; completed simultaneously with adjacent and opposing through movements.
- Conflict points reduced from 32 to 28 (full) or 30 (partial).
Peds & Bikes at DLTs
Consider bicycle crossing of the left turn and right turn movement.

Bicycle exposure to right turning vehicles.

Lane shared with motorized vehicles.
Utah DLT Experience

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

Before and After Comparison for BANGERTER HIGHWAY IMPROVEMENTS
Diverging Diamond Interchange

- Option for signalized right turns (with no RTOR)
- Unopposed, free-flowing lefts to freeway
- Reverse curvature upstream of crossover
- Left turns from freeway are yield- or signal-controlled
- Directional crossover for through movements at greater than 30°, recommended 45°
- Right turns typically yield to lefts on on-ramp
- Option to carry downstream left turn through upstream crossover
- Option for right turn with acceleration lane
Key DDI Characteristics

• Geometry crosses traffic to left side of roadway between ramp terminals; left-turn movements now unopposed

• 2-phase signals; highly efficient

• Low-speed movements
Other Noteworthy DDI Attributes

• Relatively small footprint
• Existing bridge can often be salvaged on retrofits
• Versatile alternative for low and high volume locations
• Non-motorized accommodation
### Early DDI Safety Results

#### Crash Reductions By Crash Type

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

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

- **Conventional Diamond**
  - 26 conflict points

- **Diverging Diamond**
  - 14 conflict points
Peds & Bikes at DDIs

- Center walkway
- Channelization islands
- Outside walkway/sidewalk
Emphasizing Ped Convenience

Provide adequate sight distance for vehicle approaches to crosswalks

Provide one vehicle length storage downstream of crosswalks for yield-controlled vehicle movements

Tight radii for right turns to reduce speeds at crosswalk - left turn not affected

Crosswalk behind stopbar for signalized vehicle turns
Bicycle Options & Benefits
Current Deployment: Roundabouts

- Open to Traffic
- Construction In-Progress
- Study/Planning/Design Stages
- No Activity

States:
- AK
- AZ
- AR
- CA
- CO
- CT
- DE
- FL
- GA
- HI
- ID
- IL
- IN
- IA
- KS
- LA
- ME
- MD
- MA
- MI
- MN
- MS
- MO
- MT
- NE
- NV
- NH
- NJ
- NM
- NY
- NC
- ND
- OH
- OK
- OR
- PA
- PR
- RI
- SC
- SD
- TN
- TX
- UT
- VA
- VT
- WA
- WV
- WI
- WY
- DC
Current Deployment: Diverging Diamond Interchanges

- **Open to Traffic**
- **Construction In-Progress**
- **Study/Planning/Design Stages**
- **No Activity**
Current Deployment: **U-Turn Intersections** (MUT and/or RCUT)
Current Deployment: Displaced Left-Turns

- Open to Traffic
- Construction In-Progress
- Study/Planning/Design Stages
- No Activity
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.
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NEW! Outreach & Education

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All Video Case Studies and Info Videos on FHWA YouTube Channel
For more information...

Please visit the Website
www.fhwa.dot.gov/everydaycounts/

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