Outline

✓ Current research on pedestrian and bicycle treatments
✓ Restricted crossing U-turn (RCUT) intersection
✓ Median U-turn intersection (MUT)
✓ Quadrant roadway (QR) intersection
✓ Displaced left-turn (DLT) intersection
✓ Diverging diamond interchange (DDI)
Current Research on Pedestrian and Bicycle Treatments

NCHRP 07-25: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges
• Completion date: 9/20/2019

Background
• New alternative intersection/interchange designs being built in US
• Safety issues to pedestrian/bicyclists by reversing traffic lanes

Research objectives
• Develop a guide to improve pedestrian/bicycle safety at alternative intersections and interchanges
• Include planning, design, and operational treatments
Restricted Crossing U-turn Intersection
Restricted Crossing U-Turn (RCUT) Intersections

- Redirects left-turn and through movements from side street approaches
  - Right turn followed by U-turn maneuver at median opening
  - Median opening 1,000 feet to 1,500 feet downstream
- Can be signalized, stop, or yield controlled

RCUT intersection in Emmitsburg, MD
Suitable Location for RCUTs

- On median divided highways
- Suitable intersections for RCUT
  - Moderate through and/or left-turn volumes on major street
  - Low through and left-turn traffic volumes on side street
  - Three or four legs

RCUT intersection in Troy, MI
Pedestrian Movements at RCUTs

- Major street crossing is generally one diagonal path
  - Longer than conventional intersection
- Allows pedestrians to cross the main street between one (B to C) but not both pairs of opposing corners (not A to D)
- Median islands can provide pedestrian refuge

Pedestrian movements in a RCUT intersection
Accommodation for Pedestrians and Bicyclists at RCUTs

Apply RCUT design in areas that favor preferred pedestrian movements (B to C)
- Suitable for suburban environment with separated lane use and low pedestrian traffic

Provide wayfinding signing for pedestrians
- Install barriers to channelize pedestrians
- Provide accessible devices to assist disabled pedestrians
Pedestrian and Bicycle Movements at RCUTs
Ped & Bicycle Movements at RCUTs W/Cycle Track
Alternative Pedestrian Movements at RCUTs

- Shorten the path to cross the arterial
- Decrease pedestrian exposure to moving vehicles on main street

RCUT with minor street approaches offset
Alternative Pedestrian Movements at RCUTs

Pedestrian Movements at Three-leg Intersection

Pedestrian Crossing at U-Turn

- Require additional signal on mainline to stop through traffic
- Decrease pedestrian exposure
- PHB Can also be used
Bicycle Movements at RCUT Intersections

- **Option 1 (blue line)**
  - Cross the major road with the pedestrians on the sidewalks of the “Z” crossing
  - Preferred option for bicycle movements

- **Option 2 (red line)**
  - Cross the major road near the left-turn lanes if no crosswalk is available

- **Option 3 (green line)**
  - Cross by moving with the vehicle traffic
  - Makes a right turn, a U-turn, and then a right turn onto the minor road
Median U-turn Intersection
Median U-Turn (MUT) Intersections

- Eliminate direct left-turns from major and minor approaches
- Two-step for left-turn maneuver
  - Turn right onto the main road
  - Make a U-turn at a median opening downstream
- Traffic control for MUT
  - Signalized
  - Stop controlled
  - Yield controlled
- Other name for MUT
  - Michigan left-turn
  - Median U-turn crossover
  - Boulevard turnaround
  - Michigan loon
Suitable Location for MUTs

- On median divided highways
- Intersections suitable for MUT
  - Moderate to heavy through traffic volumes
  - Low to moderate left-turn traffic volumes
  - Three or four legs
  - Minor road volume to total intersection volume less than or equal to 1/4
- Typically a corridor treatment is applied at signalized intersections
- Also used at isolated intersections to alleviate specific traffic operational and safety problems
Pedestrian Movements at MUT Intersections

- Two-phase pedestrian crossing
  - Pedestrian crosses one direction of the major street during the first signal phase
  - Pedestrian crosses the other direction during a second signal phase
  - Usually some delay between the phases
- Median islands can provide pedestrian refuge
- Small delay to pedestrians because of only two signal phase and short cycle length
Accommodation for Pedestrians and Bicyclists at MUTs

- Allows pedestrians to cross major street during minor street through and right-turn signal phase
- Pedestrians encounter fewer conflicting traffic streams than at a conventional intersection
- Two-phase signal create a shorter signal cycle length
  - Allow more pedestrian phases per hour
  - Allow less wait times between walk signals
- Through and right-turning bicyclists navigate the same as a conventional intersection
Alternative Pedestrian Movements at MUTs

Median U-Turn with No Through Movement
Pedestrian and Bicycle Treatments at MUTs
Pedestrian and Bicycle Treatments at MUTs W/Cycle Track
Pedestrian and Bicycle Treatments at MUTs W/Left-turn Boxes
Bicycle Movements at MUT Intersections

- Through and right-turning bicyclists from a side street
  - Encounter high green time percentages for their movements

- Left-turning bicyclists from the side street
  - Can use pedestrian crosswalks to cross the major street and then cross the far side street
  - Use the U-turn crossovers

- Cyclists wanting to turn left from the main street
  - Can use pedestrian crosswalks to cross side street leg and then the far major street leg
  - Continue down to U-turn crossover
Quadrant Roadway Intersection
Quadrant Roadway (QR) Intersections

- One main intersection and two secondary intersections linked by a connector street in any quadrant of the intersection
- Reroutes all four left-turn movements onto a street that connects the two intersecting streets
- Secondary intersections are typically signalized, but can also be unsignalized

A) Left turn movement from the arterial

B) Left turn movement from the cross street
Location for Quadrant Roadway (QR) Intersections

- At locations with an existing roadway that can be used as the connector roadway
- Intersections suitable for QR
  - Heavy through and left-turn volumes on the major and minor streets
  - Four-leg intersection
Pedestrian Movements at QRs

- Extra crossings for pedestrians
  - East and westbound pedestrians crossing at crossing F
  - North and southbound pedestrians crossing at crossing I
- Pedestrians conflict with right-turn vehicle
  - Similar to the conflicts at conventional intersections
Bicycle Movements at QRs

- Through bicyclists on both intersecting streets
  - Relatively longer green times
  - Favorable progression
- Right-turning movements
  - Three not affected
  - The fourth has a shorter travel distance
- Choices for left-turning cyclists
  - Follow the vehicular paths
  - Follow the crossing paths of pedestrians at the main intersection

QR intersection in Huntersville, NC
Accommodation for Pedestrians and Bicyclists at QRs

- No left-turn pedestrian/vehicle conflicts at the main intersection
- Only two or three signal phases at the intersection
  - Shorter cycle length reduce pedestrian delay
- Potentially shorter walking distance due to curved connecting roadway

QR intersection in Huntersville, NC
Displaced Left-turn Intersection
Displaced Left-turn Intersections

- DLT Features
  - Relocate the left-turn movement to the other side of the opposing roadway
  - Eliminate the left-turn phase for this approach
  - Reduce numbers of traffic signal phases and conflict points
  - Improve traffic operations and safety

Displaced left-turn intersection in Shirley, NY
Pedestrian Movements at DLT Intersections

- **Left-turn lanes at DLT**
  - between opposing through lanes and right-turn lanes
  - Counterintuitive to pedestrians

- **DLT design to accommodate pedestrian crossing**
  - Wide geometric footprint
  - Short signal cycle length

- **Median islands provide pedestrian refuge**
Accommodation for Pedestrians and Bicyclists at DLTs

▸ Provide pedestrian refuges between opposing through lanes
  • Increase pedestrian safety
  • Minimize vehicular delay

▸ Design right-turn channelized islands to accommodate pedestrians

Displaced left-turn intersection in Dayton, OH
Accommodation for Pedestrians and Bicyclists at DLTs (cont’d)

Provide wayfinding signing for pedestrians

- Direct pedestrians through the intersection to desired destinations
- Reduce pedestrian confusion
- Encourage pedestrians to use designated travel paths through the intersection

Displaced left-turn intersection in Shirley, NY
Accommodation for Pedestrians and Bicyclists at DLTs (cont’d)

Provide accessible devices to assist pedestrians with disabilities

- Use locator tones at the pedestrian signals
- Install specialized surface treatments at the quadrants and median refuges
- Accessible Pedestrian Signals (APS) recommended

DLT intersection in West Valley City, Utah
Pedestrian and Bicycle Treatments at DLT
Pedestrian and Bicycle Treatments at DLT W/Cycle Track
Diverging Diamond Interchange
Diverging Diamond Interchanges (DDI)

- Arterial traffic crosses to the other side of the roadway between the freeway ramps
- Vehicles can turn left onto/off freeway ramps without stopping or crossing opposing lanes of traffic
- Can be designed as an overpass or underpass
- Also known as a Double Crossover Diamond
Location Suitable for DDIs

- Heavy left-turn traffic volumes onto/off freeway ramps
- Limited roadway width for left-turn lanes between ramp intersections
- Limited right-of-way area to expand
- Without adjacent traffic signals or nearby driveways

DDI on I-75 in Sarasota, FL
Accommodation for Pedestrians and Bicyclists at DDIs

- Fewer conflicting traffic streams
- Central island serves as refuge between each stage or signal phase
- Bicycles can utilize pedestrian paths or vehicle paths with bike lanes
Accommodation for Pedestrians and Bicyclists at DDIs

Diverging Diamond Interchange

- Bike Lane
- Pedestrian Walkway
- Pedestrian-Only Lights
- Traffic Lights (Location of stop shown. Lights may be placed on far side of an intersection.)

Schematic, not to scale

Pedestrians have reduced crossing distances
Pedestrian Movements at DDIs

- Can cross freeway ramps and/or main street
- Cross on outside or through interchange
- Only cross one direction of traffic is allowed at a time
- Pedestrians have reduced crossing distances
Alternative Pedestrian Movements at DDIs

- Pedestrians have shorter conflict times
- More traditional and familiar path

- Crossing at signalized locations
- Crossing movement is controlled by signals
Questions?
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