ENGINEERING EDUCATION
FOUNDATION OF AMERICA

EEFA STEM Taskforce Activity:
Matchbox Intersections

Activity Overview:

Participants will use matchbox cars to navigate through 4 different intersection configurations:

1. Traditional Intersection
2. Roundabout
3. Restricted Crossing U-Turn (R-CUT)
4. Diverging Diamond Intersection/Interchange (DDI)

This activity is very open ended and can be modified based on the age range of the participants. It is intended to be a discussion with participants about each intersection configuration.

Younger participants (K-8)

- Focus more on the types of intersections and how you drive/walk through them. Use the Matchbox Cars to show how the intersections are navigated.

Older (High School)

- Talk though what a conflict point is, road classifications as well as the MUTCD and different types of traffic control devices. Then split the kids into groups and give each group an intersection. Have them answer the questions for their intersection and bring it back to the group to talk through their answers. If you have time, have students rotate through to each intersection board.

Material List (provided):

- Intersection Boards (listed from simplest to most complicated)
  - Traditional Intersection
  - Roundabout
  - Restricted Crossing U-Turn (R-CUT)
  - Diverging Diamond Intersection/Interchange (DDI)
- Matchbox Cars
- Road Sign
- Conflict Point Markers

Important Terms for Activity:

Conflict Points (https://www.txdot.gov/content/dam/docs/design/project-delivery/innovative-intersection-fact-sheets.pdf)

- A conflict point is a location where the paths of two or more road users (for example, vehicles, pedestrians and cyclists) interact with one another, such as at road intersections. There is a strong correlation between the number of collisions that occur at an intersection and the number and severity of conflict points it contains.

- Crossing Point Conflict Points
  - Occur when road users cross paths with one another. Collisions that occur at crossing conflict points are commonly known as right-angle crashes and are typically the most severe
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- Diverging Conflict Points
  - Occur when a road user diverges from one path to another. These diverging crashes often involve rear end crashes as the front vehicle slows to turn.
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- Merging Conflict Points
  - Scenario in which road users are traveling in the same direction in different lanes simultaneously merge into the same lane. These crashes are typically referred to as sideswipes and are less severe than crossing conflicts.
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- Pedestrian Conflict Points
  - Where the pedestrian path crosses and vehicle path.

Roadway Classifications (https://www.fhwa.dot.gov/planning/processes/statewide/related/hwy-functional-classification-2023.pdf)

- Interstates
- Other Freeways & Expressways
- Other Principal Arterials
- Minor Arterials
- Major & Minor Collectors
- Local Roads

MUTCD (Manual on Uniform Traffic Control Devices)
(https://mutcd.fhwa.dot.gov/kno_11th_Edition.htm)

- Pavement Markings
- Signing
- Traffic Signals
- RRFB (Rectangular Rapid Flashing Beacon)

Questions and Answers for Discussion split by Intersection Type:

Traditional Intersection

Questions to discuss (younger to older):

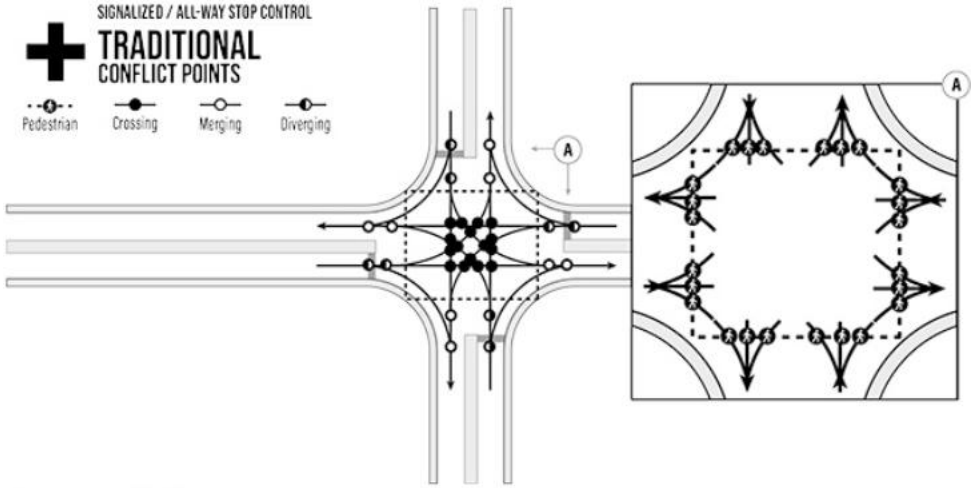
a. How do you navigate this intersection as a driver, as a pedestrian, on a bike?
b. What infrastructure is needed at this type of intersection? Signs, Signals, Pavement Markings, etc.
c. What makes this intersection useful? What are the pros?
d. What are the cons of this type of intersection?
e. Can you identify the conflict point of this intersection? What type of conflict points does this intersection have? May need to explain what a conflict point is and the types beforehand
f. How would navigating this intersection change for someone who is blind, deaf, in a wheelchair, etc.

Answers:

a. Talk about what users would be looking out for, signal color, stop signs, crossing vehicles, pedestrian crosswalks, etc. (This discussion can lead into the next talking points really well based on answers.)
b. Intersection can be signalized, all-way stop control, side street stop control, side street yield, or uncontrolled based on the road levels
c. Pros
    - Traditional concept that is easily understood and recognized
    - Less real estate needed
d. Cons

- Higher crash severity due to the number of crossing conflict points
- Creates more delay – vehicles are always required to stop
- Signals are high maintenance (electricity costs, timing adjustments, shorter life span than some alternatives)

e. Conflict points (see diagram below for locations)
   - 16 Crossing Point Conflict Points
   - 8 Diverging Conflict Points
   - 8 Merging Conflict Points
   - 24 Pedestrian Conflict Points



- Source: FHWA.
- https://highways.dot.gov/public-roads/winter-2022/03

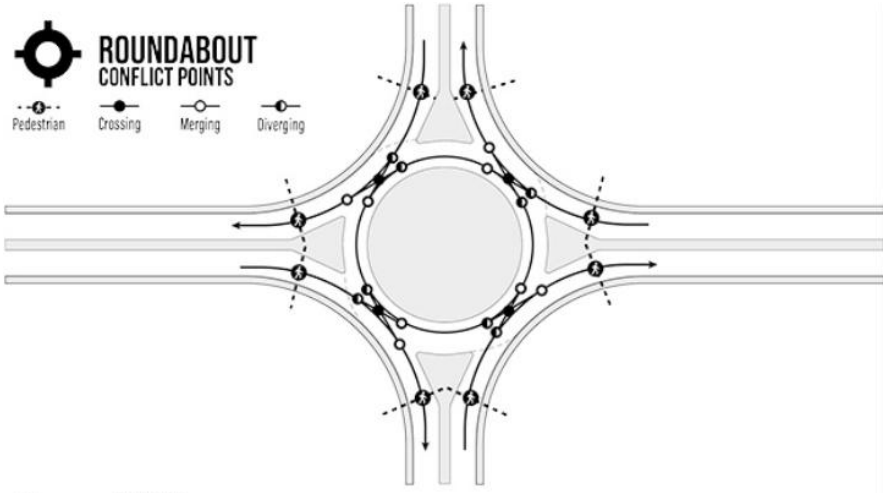
Roundabout

Questions to discuss (younger to older)

a. How do you navigate this intersection as a driver, as a pedestrian, on a bike?
b. What infrastructure is needed at this type of intersection? Signs, Signals, Pavement Markings, etc.
c. What makes this intersection useful? What are the pros?
d. What are the cons of this type of intersection?
e. Can you identify the conflict point of this intersection? What type of conflict points does this intersection have? May need to explain what a conflict point is and the types beforehand
f. How would navigating this intersection change for someone who is blind, deaf, in a wheelchair, etc.

Answers

a. Talk about what users would be looking out for, yield signs, crossing vehicles, pedestrian crosswalks/RRFBs, etc. (This discussion can lead into the next talking points really well based on answers.)
b. Intersection usually yield controlled, may have RRFBs for the pedestrian crossings
c. Pros
    - Fewer conflict points – less exposure or probability of crashes
    - Reduced crash severity since most of the conflict points are merging or diverging
    - Low maintenance
    - Less delay – only stop/yield if another vehicle is in the circle
d. Cons
    - Confusing to some drivers
    - Often require more right-of-way
    - Don't operate well at locations with high volumes of left turns
    - Can be challenging for trucks to navigate
e. Conflict points (see diagram below for locations)
    - 4 Crossing Point Conflict Points
    - 8 Diverging Conflict Points
    - 8 Merging Conflict Points
    - 8 Pedestrian Conflict Points



Source: FHWA.

- https://highways.dot.gov/public-roads/winter-2022/03

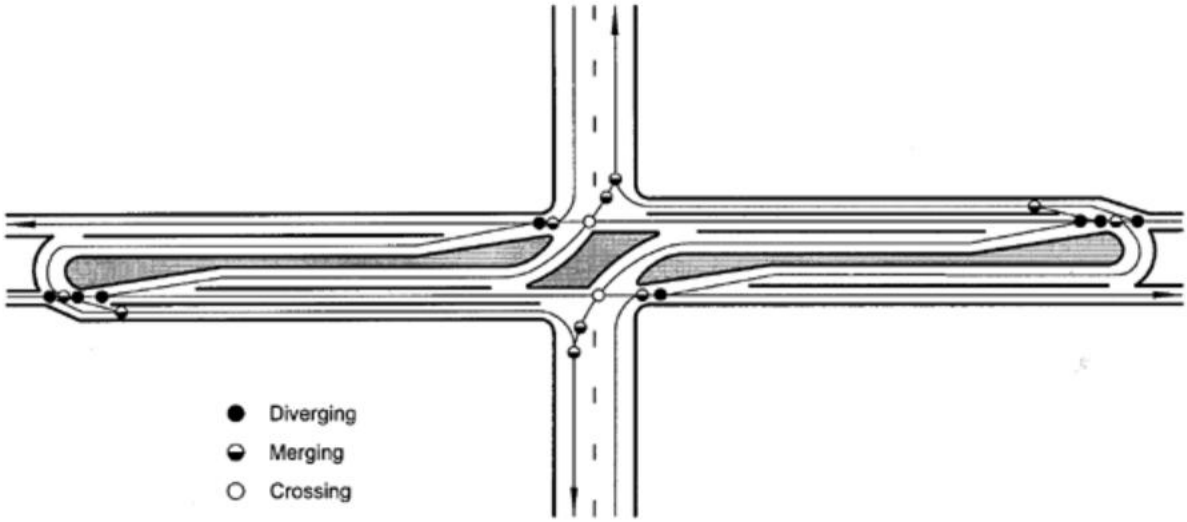
R-CUT (Restricted Crossing U-Turn)

Questions to discuss (younger to older)

a. How do you navigate this intersection as a driver, as a pedestrian, on a bike?
b. What infrastructure is needed at this type of intersection? Signs, Signals, Pavement Markings, etc.
c. What makes this intersection useful? What are the pros?
d. What are the cons of this type of intersection?
e. Can you identify the conflict point of this intersection? What type of conflict points does this intersection have? May need to explain what a conflict point is and the types beforehand
f. How would navigating this intersection change for someone who is blind, deaf, in a wheelchair, etc.

Answers

a. Talk about what users would be looking out for, signal color, stop signs, yield signs, crossing vehicles, pedestrian crosswalks/RRFBs, etc. (This discussion can lead into the next talking points really well based on answers.)
b. Intersection can be signalized, all-way stop control, side street stop control, side street yield, or uncontrolled based on the road levels
c. Pros
    - Fewer conflict points – less exposure or probability of crashes
    - All movements are still possible (can turn right, U-turn, then turn right to still connect with the cross street).
    - Allows minor road drivers to focus on one direction of travel at a time
d. Cons
    - May be confusing or counter-intuitive to drivers
    - Requires traveling a short distance “out of the way”
    - The time taken to travel the additional distance is **often less** than the time that a driver would’ve been waiting at the intersection for a gap to turn left.
    - Weaving - Can sometimes be difficult to merge into the left lane after turning right to make the U-turn and merging back to the right lane – the geometry needs to be designed for the specific location/traffic patterns
    - Difficult for large truck traffic to navigate
e. Conflict points (see diagram below for locations)
    - 2 Crossing Point Conflict Points
    - 4 Diverging Conflict Points
    - 10 Merging Conflict Points
    - 14 Pedestrian Conflict Points



https://www.fhwa.dot.gov/publications/research/safety/04091/10.cfm

DDI (Diverging Diamond Intersection/Interchange)

Questions to discuss (younger to older)

a. How do you navigate this intersection as a driver, as a pedestrian, on a bike?
b. What infrastructure is needed at this type of intersection? Signs, Signals, Pavement Markings, etc.
c. What makes this intersection useful? What are the pros?
d. What are the cons of this type of intersection?
e. Can you identify the conflict point of this intersection? What type of conflict points does this intersection have? May need to explain what a conflict point is and the types beforehand
f. How would navigating this intersection change for someone who is blind, deaf, in a wheelchair, etc.

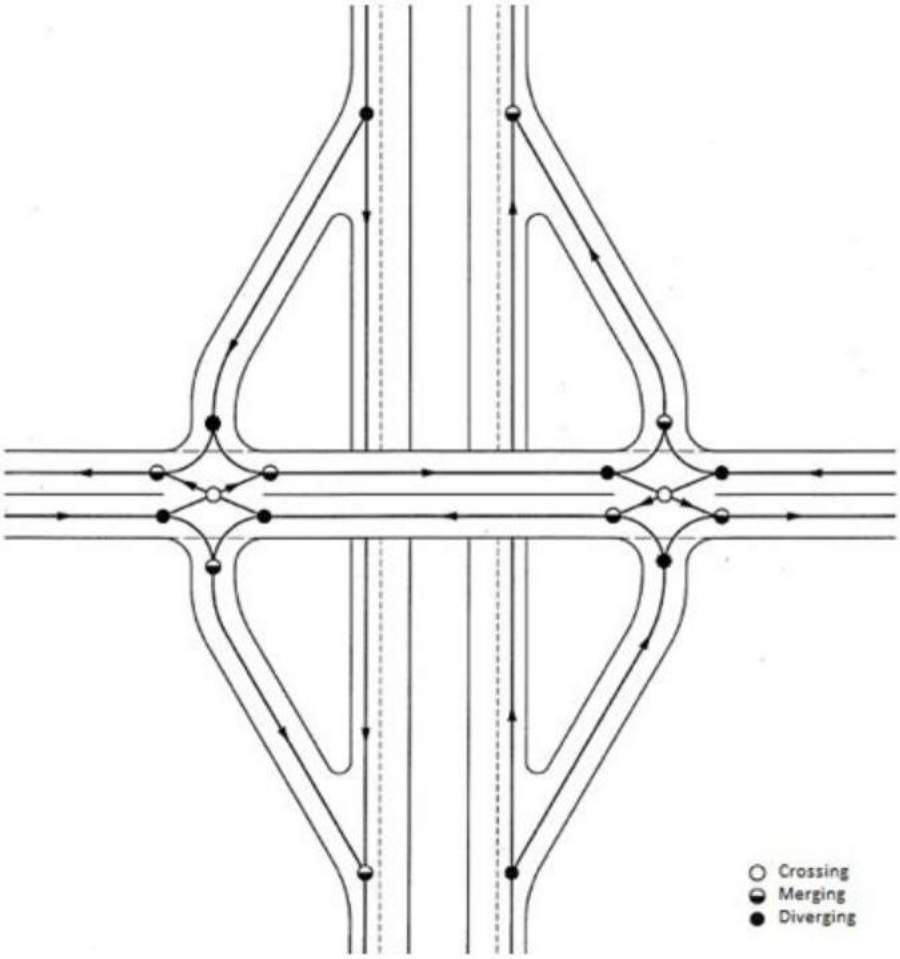
Answers

a. Talk about what users would be looking out for, signal color, stop signs, crossing vehicles, pedestrian crosswalks, etc. (This discussion can lead into the next talking points really well based on answers.)
b. Intersection can be signalized, all-way stop control, side street stop control, side street yield, or uncontrolled based on the road levels
c. Pros

- Fewer crossing conflict points
- Increased Left Turn capacity onto and off of highway

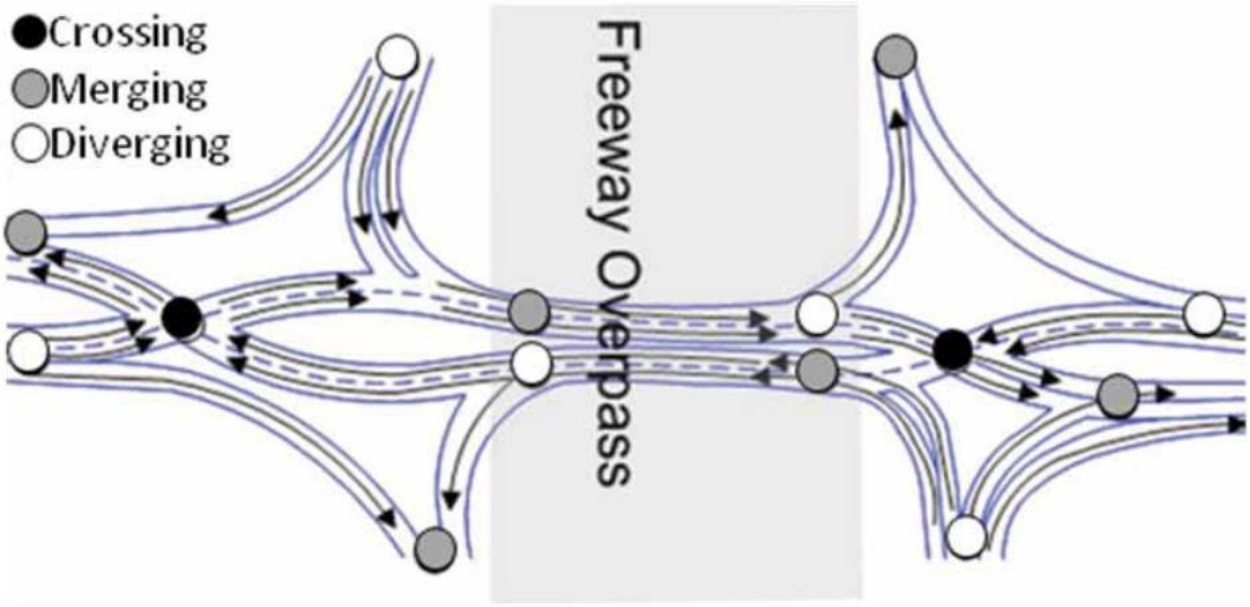
d. Cons
   - Can be difficult for pedestrians since traffic in middle is on the opposite side

e. Conflict points (see diagram below for locations)
   - 2 Crossing Point Conflict Points
   - 6 Diverging Conflict Points
   - 6 Merging Conflict Points
   - 8 Pedestrian Conflict Points

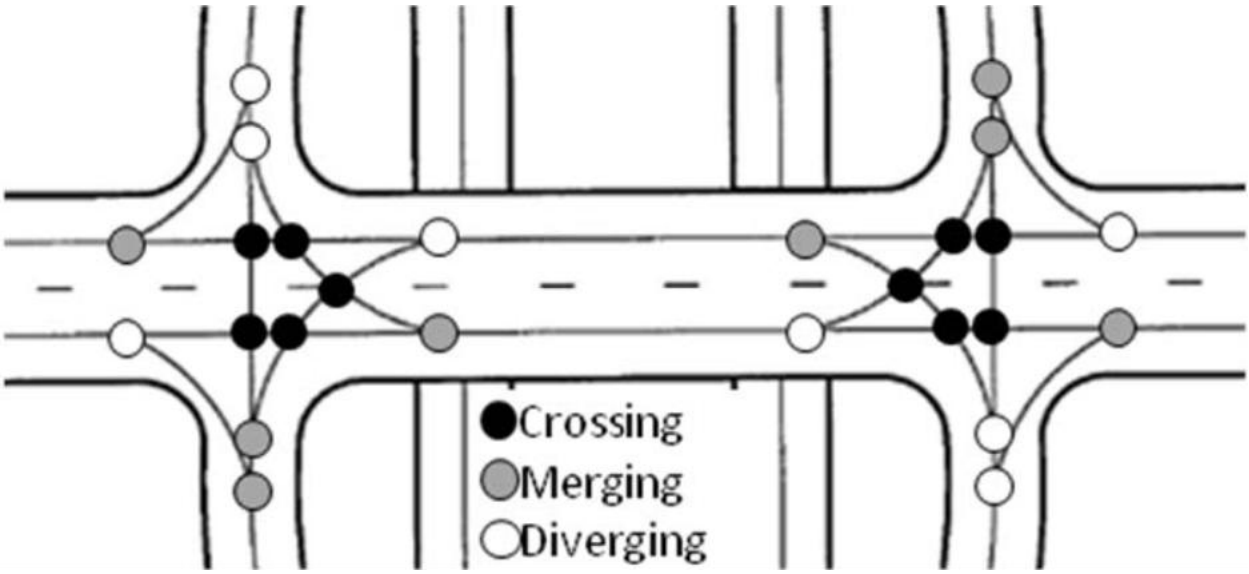


https://epg.modot.org/index.php/234.6_Diverging_Diamond_Interchanges

Diverging Diamond



Conventional Diamond



https://www.fhwa.dot.gov/publications/research/safety/09060/007.cfm