Today’s Presentation

- Introduction and housekeeping
- Audio issues?
  Dial into the phone line instead of using “mic & speakers”
- PBIC Trainings and Webinars
  www.pedbikeinfo.org/training
- Registration and Archives at
  pedbikeinfo.org/webinars
- PBIC News and updates on Facebook
  www.facebook.com/pedbike
- Questions at the end
Countermeasure Strategies for Pedestrian Safety Webinar Series

Upcoming Webinars

Transit and Pedestrian Safety
Wednesday, January 20 (1:00 – 2:30 PM Eastern Time)

To view the full series and register for the webinars, visit
www.pedbikeinfo.org/training/webinars_PSAP_countermeasurestrategies.cfm
WHY WELL DESIGNED ROUNDBOOUTS WORK FOR PEDESTRIANS

- Slow speed entry = yield
- Slow speed exit
- Truck apron
- Deflection = slow speeds throughout
- Slow speed entry = yield
- Separated sidewalks direct peds to crosswalks
- Crosswalk ~1 car length back
- Splitter island
PEDESTRIAN ROUNDBAOUT EXPERIENCE

- Low speeds (15-25mph)
- Fewer conflict points (16 to 8 ped-veh)
- Shorter crossing distances
- Cross only one direction of travel at a time

Vehicle traveling at 20 MPH
9 out of 10 pedestrians survive.

Vehicle traveling at 30 MPH
5 out of 10 pedestrians survive.

Vehicle traveling at 40 MPH
1 out of 10 pedestrians survive.

Source of Images: Seattle DOT

Photo credits: Butzek
PEDESTRIAN SAFETY

- Belgium study*
  - Converting an unsignalized intersection to a roundabout associated with 27% decrease in pedestrian crashes

- US experience
  - No existing comprehensive “before” and “after” crash data analyses
  - Surrogate safety metrics such as vehicle speed and yielding compliance can also be used
  - Multilane crossings still present a multiple threat challenge for pedestrians
  - Audible cues needed to assess gaps and judge vehicle yielding behavior are different as compared to orthogonal intersections

SIGHT DISTANCE
SPLITTER ISLAND
CROSSWALKS
STOPPING SIGHT DISTANCE

STOPPING SIGHT DISTANCE

\[ d = (1.468)(t)(V) + 1.087 \frac{V^2}{a} \]

where

- \( d \) = stopping sight distance, ft;
- \( t \) = perception–brake reaction time, assumed to be 2.5 s;
- \( V \) = initial speed, mph; and
- \( a \) = driver deceleration, assumed to be 11.2 ft/s\(^2\).

<table>
<thead>
<tr>
<th>Speed (mph)</th>
<th>Computed Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>46.4</td>
</tr>
<tr>
<td>15</td>
<td>77.0</td>
</tr>
<tr>
<td>20</td>
<td>112.4</td>
</tr>
<tr>
<td>25</td>
<td>152.7</td>
</tr>
<tr>
<td>30</td>
<td>197.8</td>
</tr>
<tr>
<td>35</td>
<td>247.8</td>
</tr>
<tr>
<td>40</td>
<td>302.7</td>
</tr>
<tr>
<td>45</td>
<td>362.5</td>
</tr>
<tr>
<td>50</td>
<td>427.2</td>
</tr>
<tr>
<td>55</td>
<td>496.7</td>
</tr>
</tbody>
</table>
SPEEDS AT CROSSWALK

Entry Curvature
Slow entry R1

Slow circulating
R2

Average vehicular speeds at ped crossing
dictated by geometry acceleration rate of
4-7 ft/sec*sec and dist to crossings ....18
mph

Source: MTJ Engineering
Landscape consideration: **DO NOT** block sight line

Typically raised

Width – minimum* of 6 ft at the crosswalk

Typical crosswalk setback of 20 ft
  - Approx one vehicle length behind yield line
  - Lengths may vary between entrance and exit

* Minimum if a two-stage crossing

## PEDESTRIAN DESIGN DIMENSIONS

### Table 9-31 Key Design Dimensions to Accommodate Nonmotorized Users

<table>
<thead>
<tr>
<th>User</th>
<th>Characteristic</th>
<th>Dimension</th>
<th>Affected Roundabout Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicyclist</td>
<td>Length</td>
<td>1.8 m [6.0 ft]</td>
<td>Splitter island width at crosswalk</td>
</tr>
<tr>
<td></td>
<td>Minimum operating width</td>
<td>1.2 m [4.0 ft]</td>
<td>Bike lane width on approach roadways; shared use path width</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>Width</td>
<td>0.5 m [1.6 ft]</td>
<td>Sidewalk width, crosswalk width</td>
</tr>
<tr>
<td>Wheelchair user</td>
<td>Minimum width</td>
<td>0.75 m [2.5 ft]</td>
<td>Sidewalk width, crosswalk width</td>
</tr>
<tr>
<td></td>
<td>Operating width</td>
<td>0.9 m [3.0 ft]</td>
<td>Sidewalk width; crosswalk width</td>
</tr>
<tr>
<td>Person pushing stroller</td>
<td>Length</td>
<td>1.7 m [5.6 ft]</td>
<td>Splitter island width at crosswalk</td>
</tr>
<tr>
<td>Skaters</td>
<td>Typical operating width</td>
<td>1.8 m [6.0 ft]</td>
<td>Sidewalk width</td>
</tr>
</tbody>
</table>

*Source: 2011 AASHTO Green Book*
CROSSWALK OPTIONS
CROSSWALK OPTIONS
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CROSSWALK OPTIONS
ACCESSIBILITY AT ROUNDABOUTS IN THE UNITED STATES
EAGLE COUNTY, CO
Blind pedestrians must master four principal tasks for crossing a street:

1. *Finding the crosswalk & identifying the intended crossing location*
2. *Aligning to cross*
3. *Deciding when to cross*
4. *Maintaining alignment while crossing multiple lanes until the far side is reached*
RAISED CROSSWALK IN GOLDEN, CO

Photo Source: City of Golden, CO
PEDESTRIAN HYBRID BEACONS IN GOLDEN, CO

Photo Source: Isebrands
PEDESTRIAN HYBRID BEACON
PECOS/I-70 RAMP, DENVER, CO

Photo Source: Isebrands
The objective of this effort was to conduct field studies at multilane roundabouts with the goal of defining the region of feasibility for RRFBs at multilane roundabouts to provide guidance and data for practitioners(1) and the U.S. Access Board(2).
Percent Intervention
Pedestrian Delay
Free Flow Speed at Crosswalk
Driver Yielding Rate at Crosswalk

Conceptual relationship between interventions and other factors
Based on this research, RRFB installations should

- be installed as a two-stage crossing with separate devices for crosswalks on the roundabout’s entry and exit legs
- be installed on both ends of the crosswalk; both at the curb and at the splitter island
- be installed to be as visible as possible to drivers, and the design should consider the brightness and orientation of the devices
- need to be outfitted with audible devices with both a pushbutton locator tone and a speech message indicating when the yellow lights are flashing
SIGNING & MARKING
Proper signing is important
- YIELD
- Pedestrian Warning
- Lane Use

High visibility crosswalks are preferred
PEDESTRIAN SIGNS SHOULD STAND OUT
LANDSCAPING
Wherever possible, sidewalks should be set back from the edge of the circulatory roadway with a landscape strip
- Discourages pedestrians from crossing to the central island or cutting across the circulatory roadway of the roundabout
- Helps guide pedestrians with vision impairments to the designated crosswalks

Landscape strips provide
- Increased offset from traffic
- Room for signs, street furniture and snow storage
- Buffer to allow for the overhang of large vehicles as they navigate the roundabout
SIDEWALK BUFFERS
Avoid landscaping in the line of sight of crosswalks

- Within critical visibility areas, limit height to 2 ft
Hardscape treatments, patterned concrete or paver surface, may be used on splitter islands in lieu of landscaping.
PERIMETER LIGHTING

- Pedestrians illuminated
- Signs illuminated

Study Source: Hasson and Lutkevich
## PERIMETER ILLUMINATION

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Illumination can be strongest around critical bicycle and pedestrian areas.</td>
<td>- Illumination is weakest in central island, which may limit visibility of roundabout from a distance.</td>
</tr>
<tr>
<td>- Continuity of poles and luminaires is maintained for the illumination of the lanes, as well as good visual guidance on the circulatory roadway.</td>
<td>- More poles are required to achieve the same illumination level.</td>
</tr>
<tr>
<td>- Approach signs typically appear in positive contrast and thus are clearly visible.</td>
<td>- Poles may need to be located in critical conflict areas to achieve illumination levels and uniformity.</td>
</tr>
<tr>
<td>- Maintenance of luminaires is easier due to curbside location.</td>
<td></td>
</tr>
</tbody>
</table>

CENTRAL ILLUMINATION

- Pedestrians visible only as silhouettes
- Signs not visible

Study Source: Hasson and Lutkevich
Figure 21. Lighting elements that are used in the final lighting system.

Figure 22. Isometric view of the roundabout showing the lighting on the crosswalks, the landscape.
## IESNA LIGHTING LEVELS

### Table 1. Illuminance Levels at Roundabouts and Other Intersections

<table>
<thead>
<tr>
<th>Roadway Classification (Street A/Street B)</th>
<th>Recommended Illuminance for Intersections</th>
<th>Uniformity Ratio ($E_{avg}/E_{min}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Maintained Illuminance at Pavement$^1$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pedestrian/Area Classification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High lux (fc)</td>
<td>Medium lux (fc)</td>
</tr>
<tr>
<td>Major/Major</td>
<td>34.0 (3.2)</td>
<td>26.0 (2.4)</td>
</tr>
<tr>
<td>Major/Collector</td>
<td>29.0 (2.7)</td>
<td>22.0 (2.1)</td>
</tr>
<tr>
<td>Major/Local</td>
<td>26.0 (2.4)</td>
<td>20.0 (1.9)</td>
</tr>
<tr>
<td>Collector/Collector</td>
<td>24.0 (2.2)</td>
<td>18.0 (1.7)</td>
</tr>
<tr>
<td>Collector/Local</td>
<td>21.0 (2.0)</td>
<td>16.0 (1.5)</td>
</tr>
<tr>
<td>Local/Local</td>
<td>18.0 (1.7)</td>
<td>14.0 (1.3)</td>
</tr>
</tbody>
</table>

$^1$ fc = foot candles (conversion factor from lux to foot candles is 10.67.)  
fc has been rounded to the nearest tenth  
$^2$ $E_{avg}$ = Horizontal Illuminance, $E_{min}$ = Vertical Illuminance  
Source: ANSI / IESNA RP-8-00 Table 9
INFORMATIONAL REPORT ON LIGHTING DESIGN FOR MIDBLOCK CROSSWALKS

- FHWA-HRT-08-053
  - April 2008
Fig 11. Traditional midblock crosswalk lighting layout

Fig 12. New design for midblock crosswalk lighting layout

Recommended lighting level: 20 lux at 5’ above pavement
CASE STUDY
CASE STUDY: ROUNDABOUTS (GREAT NECK PLAZA, NY)

Problem/Background

- Small, dense, suburban community on Long Island
- High pedestrian activity & older population
  - Busy central business district
  - High-use train station
- Excessive vehicle speeds
CASE STUDY: ROUNDBOUTS (GREAT NECK PLAZA, NY)

Solution

- City received traffic calming grant from state DOT
  - Goal: calm traffic, enhance visibility of pedestrians, & improve crosswalk safety
- 4-way STOP replaced by roundabout
  - Contrasting pavement color, curb extensions, fencing, and islands used to direct traffic
- Other locations: illuminated pedestrian crossings and speed awareness devices installed
- Cost: $365,000 for the roundabout, $275,000 for the other improvements
Results

- Pedestrian collisions reduced near the roundabout after installation
- Users indicate a safer pedestrian environment
- Vehicle flow improved
- Effect of pedestrian crossing signs & speed warning devices not as good
- Officials and residents consider project a success

Speed awareness device installed at same time as roundabout
BICYCLISTS
BICYCLIST ROUNDABOUT EXPERIENCE

- Low speeds (15-25mph)
- Fewer conflict points
- Bicyclists can take the lane OR use bike ramp to exit to multi-use path and cross with pedestrians
BICYCLISTS AT ROUNDABOUTS

Photo credits: Isebrands
BIKE & PED PATH RINGS IN NETHERLANDS

https://bicycledutch.wordpress.com/2013/05/09/a-modern-amsterdam-roundabout/
SUMMARY & QUESTIONS
SUMMARY

- Low speeds (15-25mph)
- Fewer conflict points (16 to 8 ped-veh)
- Shorter crossing distances
- Cross only one direction of travel at a time

Source of Images: Seattle DOT
Thank You!

- Archive at www.pedbikeinfo.org/webinars
  - Downloadable/streaming recording and presentation slides
- Questions?
  webinars@hsrcc.unc.edu