Session 76
Pedestrians and Intersections

Moderator: Meg Storrow, RLA
Storrow Kinsella Associates

Andrew Gast-Bray, PhD, AICP
Storrow Kinsella Associates (former)

Michael Koslow, PE
Storrow Kinsella Associates

Nathan Sheets
City of Indianapolis Traffic Engineering
Case Study
North Meridian Street area, Indianapolis

The Midtown District is:

• a destination
• the geographic area between the White River, Fall Creek/Michigan Road, and the Monon Trail
• a valuable economic and cultural asset to the City of Indianapolis
• serves as home to approx. 40,000 residents
• has many of the City’s most venerable institutions of culture and learning
Project Purpose

- Pedestrian Connectivity and Safety

- Traffic Calming, while maintaining traffic flow

- Neighborhood District Identity

Case Study
North Meridian Street area, Indianapolis
Pedestrian Connectivity and Safety

- Connect the neighborhood to the Canal Towpath and Greenway System
- Connect the neighborhood to the local business nodes
- Connectivity within the neighborhood
- Maintain and enhance pedestrian safety
Primary Walkable Route
determining factors

• Check for Plans in Place:
  – Safe Routes to School
  – Multimodal Plans
  – Complete Street Plans
  – Pedestrian Plans
  – Bicycle Plans
  – Transit Plans

• Pedestrian Counts

• Adjacent pedestrian destinations

• Field Check

Outcome:
*Determine if your intersection is a primary walkable route.*
Primary Walkable Route
determining factor: Safe Routes to School Plan

IMMACULATE HEART OF MARY AND CENTER FOR INQUIRY (IPS SCHOOL 84)
SAFE ROUTES TO SCHOOL PLAN
TIERED ROUTES

smaller circle - 1/2 mile radius
larger circle - 1 mile radius

LEGEND
- IHM Family
- CFI Family
- Tier 1, 20+ Families
- Tier 2, 10-19 Families
- Tier 3, 5-9 Families
- Tier 4, < 5 Families
56th Street Selected Route

- Fits with Safe Routes to School recommendations
- Connects to Greenway system
- Connects to business nodes
- Is most direct route
- Unsafe pedestrian crossing at 56th and Central
Intersection Context
56th and Central

Central Ave.:
- 2010 ADT = ~4,080 vpd
- posted/design speed = 35 mph
- on-street parking, 1 NB lane, 1 SB lane
- crosswalk length = 44 ft
- ped crossing volume = 7 peds / 15 min

56th Street:
- 2010 ADT = ~1,800 vpd
- design speed = 30 mph
- on-street parking, 1 EB lane, 1 WB lane
- crosswalk length = 30 ft

- ped walking speed = 3 mph
## Intersection Context
56th and Central

## Vehicular Warrant for 4-way Stop
56th Street and Central Avenue

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Major Street Volume</th>
<th>Minor Street Volume</th>
<th>Meets Warrant?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total of Both Approaches</td>
<td>Total of Both Approaches</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(vehicles/hour)</td>
<td>(vehicles/hour)</td>
<td></td>
</tr>
<tr>
<td>5-6 pm¹</td>
<td>Actual</td>
<td>Required</td>
<td>Actual</td>
</tr>
<tr>
<td></td>
<td>408³</td>
<td>300</td>
<td>180</td>
</tr>
<tr>
<td>8th Hour²</td>
<td>266</td>
<td>300</td>
<td>117</td>
</tr>
</tbody>
</table>

¹ Volumes for hour from 5 - 6 pm estimated to be 4 times the 5:00 - 5:15 pm volume
² 8th highest hour estimated to be 65% of the 5 - 6pm volume
³ Both major and minor street volumes must be > required for this warrant
### Intersection Context
56th and Central

<table>
<thead>
<tr>
<th>$V_{major}$ (mph)</th>
<th>Passenger Car</th>
<th>Single-Unit Truck</th>
<th>Combination Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Local Road</td>
<td>Collector or Arterial</td>
<td>$t_d$ (s)</td>
</tr>
<tr>
<td>15</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>20</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>25</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>30</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>35</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>40</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>45</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
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<tr>
<td>50</td>
<td>7.5</td>
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<td>8.5</td>
</tr>
<tr>
<td>55</td>
<td>7.5</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>60</td>
<td>7.5</td>
<td>9.5</td>
<td>9.5</td>
</tr>
<tr>
<td>65</td>
<td>7.5</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>70</td>
<td>7.5</td>
<td>10.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

**Vehicular Intersection Sight Stopping Distance**
Stop-Controlled Intersection (IDM Figure 46-10G)
### Intersection Context
56th and Central

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Brake Reaction Time (s)</th>
<th>Brake Reaction Dist. (ft)</th>
<th>Braking Distance (ft)</th>
<th>Minimum Calculated SSD (ft)</th>
<th>Rounded SSD for Design (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2.5</td>
<td>55.1</td>
<td>21.6</td>
<td>76.7</td>
<td>80</td>
</tr>
<tr>
<td>20</td>
<td>2.5</td>
<td>73.5</td>
<td>38.4</td>
<td>111.9</td>
<td>115</td>
</tr>
<tr>
<td>25</td>
<td>2.5</td>
<td>91.9</td>
<td>60.0</td>
<td>151.9</td>
<td>155</td>
</tr>
<tr>
<td>30</td>
<td>2.5</td>
<td>110.3</td>
<td>86.4</td>
<td>196.7</td>
<td>200</td>
</tr>
<tr>
<td>35</td>
<td>2.5</td>
<td>128.6</td>
<td>117.6</td>
<td>246.2</td>
<td><strong>250</strong></td>
</tr>
<tr>
<td>40</td>
<td>2.5</td>
<td>147.0</td>
<td>153.6</td>
<td>300.6</td>
<td>305</td>
</tr>
<tr>
<td>45</td>
<td>2.5</td>
<td>165.4</td>
<td>194.4</td>
<td>359.8</td>
<td>360</td>
</tr>
<tr>
<td>50</td>
<td>2.5</td>
<td>183.8</td>
<td>240.0</td>
<td>423.8</td>
<td>425</td>
</tr>
<tr>
<td>55</td>
<td>2.5</td>
<td>202.1</td>
<td>290.3</td>
<td>492.4</td>
<td>495</td>
</tr>
<tr>
<td>60</td>
<td>2.5</td>
<td>220.5</td>
<td>345.5</td>
<td>566.0</td>
<td>570</td>
</tr>
<tr>
<td>65</td>
<td>2.5</td>
<td>238.9</td>
<td>405.5</td>
<td>644.4</td>
<td>645</td>
</tr>
<tr>
<td>70</td>
<td>2.5</td>
<td>257.3</td>
<td>470.3</td>
<td>727.6</td>
<td>730</td>
</tr>
</tbody>
</table>

**Vehicular Stopping Sight Distance**
(IDM Figure 42-1A)
Vehicular Warrant for 4-way Stop
56th Street and Central Avenue

• Traffic Volume Warrants not met
• Stopping Sight Distance Criteria* “borderline”
  • Existing sight distance = 400 feet from north
  • STOP warranted if 390 feet or less

*Sight distance criteria from Indiana Design Manual, Indiana Department of Transportation
56th Street Sidewalks
City funded project: Illinois to Washington

• Construction to begin in 2011
• Sidewalks on south side of the street from Illinois Street to Washington Boulevard
• Sidewalk to be constructed in parking lane – no impact to historic walls and landscaping
• Sidewalk project increases pedestrian traffic because sidewalk infill provides four blocks of new sidewalk on 56th Street
• Intersection at 56th and Central not addressed
Pedestrian Challenge:

- Crest curve on Central Ave. just north of 56th Street
56th and Central
Field Check

Verify Pedestrian Demand on Field Check
Pedestrian crossing time vs. Vehicular Intersection Sight Distance

<table>
<thead>
<tr>
<th>Distance</th>
<th>$t_g$(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>4.54</td>
</tr>
<tr>
<td>30</td>
<td>6.81</td>
</tr>
<tr>
<td>40</td>
<td>9.09</td>
</tr>
<tr>
<td>50</td>
<td>11.36</td>
</tr>
<tr>
<td>60</td>
<td>13.64</td>
</tr>
<tr>
<td>70</td>
<td>15.91</td>
</tr>
<tr>
<td>80</td>
<td>18.18</td>
</tr>
<tr>
<td>90</td>
<td>20.45</td>
</tr>
<tr>
<td>100</td>
<td>22.73</td>
</tr>
</tbody>
</table>

**Pedestrian Crossing time gap**
- Intersection has a 44ft crossing distance
- Pedestrian crossing time of ~10 seconds.

This time gap would suggest that the proper ISD should be as follows using the calculations

$$ISD = 1.47 V_{major} t_g$$

Yields ISD of 520 ft.

Where:
- $t_g$ is the time gap,
- $V_{major}$ the speed (mph) of the major road, and
- ISD (ft), the intersection sight distance (the value to determine).

*from the Manual 46-10, For other conditions, the time gap should be adjusted and the required ISD recalculated using this formula*
The Challenge:

define PEDESTRIAN intersection sight distance as a concept
56th and Central
Pedestrian Sight Distance

390 ft from crosswalk

• Car is not visible
300 ft from crosswalk

- Car is beginning to be visible through the windshield of the legally parked car.
56th and Central
Pedestrian Sight Distance

200 ft from crosswalk

- Car is visible
56th and Central
Real Time (video)

2nd vehicle is test – travelling at 35 mph
Pedestrian Intersection Sight Distance for a Time Gap of 10 seconds (44 foot crossing)

<table>
<thead>
<tr>
<th>V\text{major} (mph)</th>
<th>t\text{g} (s)</th>
<th>ISD (ft)</th>
<th>ISD (rounded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>10</td>
<td>221</td>
<td>230</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>294</td>
<td>300</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>368</td>
<td>370</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
<td>441</td>
<td>450</td>
</tr>
<tr>
<td>35 \textbf{10}</td>
<td>515</td>
<td>520</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>10</td>
<td>588</td>
<td>590</td>
</tr>
<tr>
<td>45</td>
<td>10</td>
<td>662</td>
<td>670</td>
</tr>
<tr>
<td>50</td>
<td>10</td>
<td>735</td>
<td>740</td>
</tr>
<tr>
<td>55</td>
<td>10</td>
<td>809</td>
<td>810</td>
</tr>
<tr>
<td>60</td>
<td>10</td>
<td>882</td>
<td>890</td>
</tr>
<tr>
<td>65</td>
<td>10</td>
<td>956</td>
<td>960</td>
</tr>
<tr>
<td>70</td>
<td>10</td>
<td>1029</td>
<td>1030</td>
</tr>
</tbody>
</table>
Protected Pedestrian Crossing Warrant
Where High Pedestrian Traffic Demand Exists

- At peak hour: 408 vehicles traveling at 35 mph on Central Ave
- All way stop at previous intersection spreads south-bound traffic evenly, rather than platooning traffic
- 8 second average window for pedestrians to cross – 10 seconds would be required
Intersection limitations would require either:

- major re-grading on Central Avenue to correct the crest vertical curve.
- bumpouts at the intersection (would shorten the walking distance permitting easier unobstructed ISD and require only 5.5 second - ISD of 290’)
- altering the speed limit to 20mph on Central Ave., or
- making the intersection an all-way stop.
Preferred Choice: the all-way stop.

Four-way stop at Central Avenue and 56th Street in conjunction with improved sidewalks.
Implementation Strategy
Stop Sign included with IHM / CFI II SRTS plan
Design Solution Options
High Pedestrian Demand Crossings

- Foot Actuated Lighted Crosswalks
- Solar Powered Flashing Beacon Assembly
- Rectangular Rapid Flashing Beacon
- HAWK Signal
Design Solution Options
High Pedestrian Demand Crossings

Foot Actuated Lighted Crosswalks – San Francisco, CA
Design Solution Options
High Pedestrian Demand Crossings

Solar Powered Flashing Beacon Assembly – CR 300N, Hendricks County, IN
Design Solution Options
High Pedestrian Demand Crossings

Rectangular Rapid Flashing Beacon – Orlando, FL
Design Solution Options
High Pedestrian Demand Crossings

HAWK Signal – Tucson, AZ
“The Indiana Design Manual (IDM) was developed to provide design guidance regarding Indiana Department of Transportation design practices and policies for the benefit of highway designers and other interested parties.

Although the IDM design guidance generally parallels the design guidance presented in American Association of State Highway and Transportation Officials (AASHTO) and Federal Highway Administration (FHWA), etc. publications, **it is essential for designers to exercise good engineering judgment** also.

**Context sensitive issues should also be included in the collective project design considerations** in order to provide an efficient, effective and economical highway design that meets highway user and community expectations and needs”

*John Wright, Roadway Services Manager, INDOT
February 21, 2011*
Thanks for Participating!

Andrew Gast-Bray, PhD, AICP
Storrow Kinsella Associates (former)
agast-bray@gmail.com
317-834-3138

Michael Koslow, PE
Storrow Kinsella Associates
koslow@storrowkinsella.com
317-639-3420

Nathan Sheets
City of Indianapolis Traffic Engineering
nsheets@indy.gov
317-327-8481

Questions and Answers