CRITICAL THINKING IN ENGINEERING DESIGN

ANDREW CIBOR, PE
MARCH 7, 2018 – PURDUE ROAD SCHOOL
TRANSPORTATION GOALS

• Increase Sustainability
• Improve Public Transit
• Improve the Bicycle and Pedestrian Network
• Prioritize Non-Automotive Modes
• Protect Neighborhood Streets
• Optimize Public Space for Parking
• Educate the Public
EXCITING TIMES IN TRANSPORTATION
RANKED IMPORTANCE FOR NEW HIRES

Soft Skills
1. Willingness to Learn
2. People Skills
3. Writing Skills
4. General Analytical Skills
5. Ethics
6. Enthusiasm
7. Understanding Practical Aspects of Transportation Engineering
8. Presentation/Speaking Skills

Hard Skills
9. Traffic Operation Analysis Procedures
10. Roadway Design Principles
11. Transportation Analysis Software
12. Transportation Planning Procedures
13. Safety Analysis Procedures
14. Theoretical Aspects of Transportation Engineering
15. Multimodal Practices
16. Financial/Budgeting Procedures

*June 2016 ITE Journal
WHOLE-BRAIN THINKING

- Analysis
- Logic
- Synthesis
- Left-brain
- Math
- Sequencing
- Computation

- Intuition
- Metaphorical thought
- Creative problem solving
- Right-brain
- Holistic thinking
- Visualization
“Good highway design involves balancing safety, mobility, and preservation of scenic, aesthetic, historic, cultural, and environmental resources. This policy is therefore not intended to be a detailed design manual that could supersede the need for the application of sound principles by the knowledgeable design professional. Sufficient flexibility is permitted to encourage independent designs tailored to particular situations... Engineering judgment is exercised by highway agencies to select appropriate design values.”
“The National Complete Streets Coalition identified that between 2003 and 2012, almost 68 percent of all pedestrian fatalities were on roadways funded in some part by federal money and designed in accordance with federal guidelines. Simply designing to guidelines does not make a facility safe. Applying the right tools and guidelines for the right “context” is critical, and good engineering judgement is a must. Until we humanize the experience of transportation system users, we can’t truly appreciate their needs and challenges; adding the human element will make us better planners and engineers.”

Improving Health Through Walking, Biking, and Transit (Sept. 2016 ITE Journal)
CONTROLLING CRITERIA

- High Speed Criteria
  1. Design Speed
  2. Lane Width
  3. Shoulder Width
  4. Horizontal Curve Radius
  5. Superelevation Rate
  6. Stopping Sight Distance
  7. Maximum Grade
  8. Cross Slope
  9. Vertical Clearance
  10. Design Loading Structural Capacity

- Low Speed Criteria
  1. Design Speed
  2. Design Loading Structural Capacity

“States may adopt policies that are more restrictive than the revised FHWA policy… FHWA encourages agencies to work together with stakeholders to develop context sensitive solutions that enhance communities and provide multiple transportation options… Fixing America’s Surface Transportation (FAST) Act of 2015 includes new provisions encouraging design flexibility. The FHWA also issued a memorandum in 2013 expressing support for taking a flexible approach to bicycle and pedestrian facility design.”
DESIGN STANDARDS

• “I'm not a big fan of written procedures or guidance that say if this, then that. In the Department where I am employed, we have intentionally been generalizing the guidance that we write down. I prefer broad guidance and then empower engineers to make engineering decisions based on context.”
  – Ryan Lancaster, ITD Standards Engineer, 2/3/2017 ITE Community

• “Design decisions should be driven by common sense, context awareness and sensitivity, and innovation. Over-reliance upon traditional design standards and approaches has a tendency to predetermine the outcome without adequate consideration for alternative, more practical solutions.”
WHAT IS GOOD DESIGN?
STANDARD BASED DESIGN VS PERFORMANCE BASED DESIGN
CASE STUDIES
SIGHT DISTANCE

- Driver eye location
  - Edge of ‘travel way’
  - Low-speed, low-volume
  - Driveway or alley
- Intersection vs. stopping
  - Urban perception reaction time
CORNER RADIUS
CROSSWALKS
INDIANA CROSSWALK

Indiana Code 9-13-2-40

- A part of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface. **Marked Crosswalk**

- That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs, or in the absence of curbs, from the edges of the traversable roadway. **Unmarked Crosswalk**
THANK YOU
ANDREW CIBOR
CIBORA@BLOOMINGTON.IN.GOV
CRITICAL THINKING IN ENGINEERING DESIGN
Critical Thinking in Engineering Design
(Changing Your Mind)

Neil Kopper, PE
March 07, 2018 - Road School
Lane Widths

- FHWA: “In a reduced-speed urban environment... The design objective is often how to best distribute limited cross-sectional width to maximize safety for a wide variety of roadway users. **Narrower lane widths may be chosen** to manage or reduce speed and shorten crossing distances for pedestrians. Lane widths may be adjusted to incorporate other cross-sectional elements, such as medians for access control, bike lanes, on-street parking, transit stops, and landscaping.”

- AASHTO:

<table>
<thead>
<tr>
<th>Type of Roadway</th>
<th>Rural US (feet)</th>
<th>Urban US (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Ramps (1-lane)</td>
<td>12-30</td>
<td>12-30</td>
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<tr>
<td>Arterial</td>
<td>11-12</td>
<td>10-12</td>
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<tr>
<td>Collector</td>
<td>10-12</td>
<td>10-12</td>
</tr>
<tr>
<td>Local</td>
<td>9-12</td>
<td>9-12</td>
</tr>
</tbody>
</table>

- Research: **No increased crash risk using 10’ lanes at speeds up to 45mph**
S Lamar Blvd

- Major arterial
- 5 lane cross section
- 40,000 ADT
- Bus and truck traffic
- 35mph posted speed

- Poor access management
- Curves and hills
- No alternate bicycle routes
- Crash history
Before
60' Wide with Two Lanes in Each Direction and Center Turn Lane
S Lamar Blvd (ish)
Before/After Data (Lamar and Burnet)

Crash Data

85th Percentile Speed
Lessons Learned

- Against a curb
- Use of gutter pan
- Against opposing traffic
- Number of lanes
- Speed reduction
SR 48/W 3rd – Bloomington (Before)

5' * 10.5' 10.5' 12' 10.5' 10.5' 5' *

* 5' bike lane includes gutter pan width
St Johns – Lane Conversion

Existing Conditions

Width = 40’ west side, 44’ east side. ADT 7-10k
Lane Conversion Discussions

40’ and 44’ wide lane conversions
## Lane Conversion Discussions

- Comparisons to existing streets
- Warrants based on volume
- Safety considerations (motor vehicle)
- Cyclist considerations

### Similar Existing Conditions: Exposition, Berkman, 12th Street, Springdale, etc.

<table>
<thead>
<tr>
<th>Street</th>
<th>Cross-Street</th>
<th>LT Volume</th>
<th>1 turn every X minutes</th>
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<tbody>
<tr>
<td>Exposition</td>
<td>Greenlee</td>
<td>0.60</td>
<td>1.7</td>
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<tr>
<td>St Johns</td>
<td>Meador</td>
<td>0.40</td>
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<tr>
<td>St Johns</td>
<td>Grand Canyon</td>
<td>0.40</td>
<td>2.5</td>
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<tr>
<td>Hancock</td>
<td>Strass</td>
<td>0.40</td>
<td>2.5</td>
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<td>Exposition</td>
<td>Greenlee</td>
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<td>3.0</td>
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<tr>
<td>Hancock</td>
<td>Francis</td>
<td>0.30</td>
<td>3.3</td>
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<tr>
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<td>Placid</td>
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<tr>
<td>St Johns</td>
<td>Carver</td>
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<td>5.0</td>
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<tr>
<td>St Johns</td>
<td>Bethune</td>
<td>0.20</td>
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<tr>
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<td>Meador</td>
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<td>10.0</td>
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<td>St Johns</td>
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<td>Eastcrest</td>
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### Opposing Volume

<table>
<thead>
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<th>Street</th>
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<th>Cars/minute</th>
<th>Av. No seconds between cars</th>
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<tbody>
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<td>St Johns</td>
<td>Carver</td>
<td>8.2</td>
<td>7.4</td>
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<tr>
<td>Berkman</td>
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<tr>
<td>12th St Average</td>
<td>I-35 to Airport</td>
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<td>7.7</td>
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<tr>
<td>Springdale</td>
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- Comparisons to existing streets
- **Warrants based on volume**
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- Cyclist considerations

![Diagram showing lane conversion guidelines based on volume]
Lane Conversion Discussions

- Comparisons to existing streets
- Warrants based on volume
- **Safety considerations (motor vehicle)**
- Cyclist considerations

“Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads.”
(FHWA-HRT-08-046)
Lane Conversion Discussions

- Comparisons to existing streets
- Warrants based on volume
- **Safety considerations (motor vehicle)**
- Cyclist considerations

<table>
<thead>
<tr>
<th>Disaggregate Group</th>
<th>Sites</th>
<th>Estimate of percent reduction (standard error)</th>
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<tbody>
<tr>
<td>Arkansas—rural</td>
<td>15</td>
<td>51.2 (7.1)</td>
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<td>North Carolina—rural</td>
<td>38</td>
<td>27.3 (5.5)</td>
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<tr>
<td>California—rural</td>
<td>21</td>
<td>50.8 (5.7)</td>
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<tr>
<td>Illinois—rural</td>
<td>5</td>
<td>16.7 (10.5)</td>
</tr>
</tbody>
</table>

Lane Conversion Discussions
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- Comparisons to existing streets
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Lane Conversion Discussions

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St Johns – Lane Conversion

Example – St Johns Avenue

Proposed Left Turn Lane Locations
St Johns – Lane Conversion

Example – St Johns Avenue

NCHRP 279 – Left Turn Lane Guidelines

TWLTL
No TWLTL
St Johns – Lane Conversion
Questions?

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