Traffic Sign Life Expectancy
Investigation LAB943

Project Tap Meeting #1
02/19/2013

Project Team
Matt Lebens, MnDOT PI
Howard Preston Co-PI
Jim McGraw, MnDOT
Maureen Jensen, MnDOT
Agenda

- Introductions
- Project review
- Literature review on other state studies
- Survey of local agencies & states
- MnROAD test decks – vertical and 45 degree rack
  - Select sign material types, colors, sample size, direction, ages
  - Color evaluation
- Next Steps
Project Goals and Objectives

- Develop Sign Life Expectancies
  - Improve Sign Management
  - Enable adoption of sign replacement policy
  - Provide an acceptable management method per federal requirements
  - Understand what drives sign replacements
  - Reduce costs for managing and replacing signs
Task 1: Survey of Practice

- Survey local agencies, other states
  - Types, colors and fabrication method of sheeting
  - Known, quantifiable drivers of sign replacements
  - Agencies with sign management data that could be used
  - All information that can be used from state studies, evaluations and databases
  - List of sign replacement projects scheduled that can provide signs for test deck
  - Potential set of in-field control signs for ongoing measurements

Jan 1, 2013 – April 30, 2013
Task 2: Test Deck & Data Collection Plan

- Identify in-service signs that will be measured
  - Single point
  - Continuing Control Sign
- Select or Develop Spreadsheet Database
- Develop how-to video
- Determine need for additional equipment
- Develop test deck plan for MnROAD
  - Types, colors, number of samples

May 1, 2013 – June 30, 2013
Task 3: MnROAD Data Collection

- Construct vertical and $45^\circ$ accelerated decks
- Populate with sign materials
- Collect retroreflectivity and color annually
- Share Data on Website

July 1, 2013 – Nov, 2016

Anticipate continuation by MnDOT
Task 4: System Data Collection

- Provide Training at MnDOT Lab
- Coordinate shared retroreflectometers
- Provide stickers for field control signs
- Annually calibrate purchased equipment
- Review data, collate into database, prepare results, summarize on webpage

May 1, 2013 – Dec 30, 2013
Task 5: Data Analysis, Recommendations, Report

- Synthesize all information
- Form Expert Panel: TAP + Legal
- Recommend Expected Life for Sign Materials
- Develop Technical Memorandum
  - Document analysis, decision process, results, data,
  - Guideline for sign life, maintenance policies

Jan 1, 2014 – Mar 30, 2014
# Project Schedule

<table>
<thead>
<tr>
<th>Tasks</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J</td>
<td>F</td>
</tr>
<tr>
<td>1. Survey of Practice</td>
<td>T</td>
<td>*</td>
</tr>
<tr>
<td>2. Develop test deck &amp; data collection plan</td>
<td>T</td>
<td>*</td>
</tr>
<tr>
<td>3. MnROAD test deck</td>
<td>T</td>
<td>*</td>
</tr>
<tr>
<td>4. System Data Collection</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>5. Data Analysis and Recommendations</td>
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<td></td>
</tr>
</tbody>
</table>

* Task Complete
E Expert Panel Meeting
T TAP Meeting
Literature Review of Sign Retroreflectivity Studies
FHWA (1991)

- Type 1 and III (Engineering Grade, HI)
- 5,700 signs across the U.S.

Findings:
- Sign orientation, solar radiation not strong predictors
- Signs 1-2 years old have high variability in retroreflectivity
- Developed predictive equations

• 1,341 Type III red, white, yellow signs, 10-11 years old
• Findings:
  – No significant correlation between retro and orientation
  – south facing red signs had increased variability
  – 4% failure
• 2010 – 211 signs, 72 north, 72 south, 15 were over 16 years
  – All green passed, 4% white, 4% red, 12% yellow failed
  – Using 18 year expected life Type III
  – Moving to Type IV
Utah State U/UDOT

- Collected data on 1716 signs in 2011 (age unknown)
- Developed a custom mobile application that incorporates GPS, pictures and data
- 93% passed retro but, 23% of the passing were damaged
  - Elevation: higher=more damage (plow spray)
  - Temperature swing: greater=more damage (more remote)
  - Geography: remote=more damage (more shot)
- Solution: install a target below the sign
North Carolina State U (2005-6)

- 1,047 Type I and III white, yellow, red, green
- 192 of the original signs were replace in ‘06
- Included analysis of national data
- Findings
  - Typically replacement is 6% :
    - About half from low retro/natural damage
    - Half from vandalism
  - Linear regression fits best
Vermont (2008)

- 398 Type III
- 220 Type IX fluorescent yellow and yellow-green
- Type IX signs in service for 6 years max
- Findings:
  - No significant correlation to orientation or offset
    - North facing higher retro than south
    - Avery outperformed 3M (but small Avery sample, may be skewed)
  - Linear deterioration curve for Type III, Non-Linear for Type IX (but only 6 years of data)
  - Study recommended 15 for red, 15-20 for rest
  - Use 15 year expected life for small signs, control for large?
Texas TTI (2009)

- 859 Type III white yellow and red across Texas:
  - 99% retroreflectivity compliance:
    - 2% failure rate for signs 10-12
    - 8% for signs 12-15
  - No strong correlation between orientation and retro

- Accelerated weathering for all types (10 years= 20 years)
  - Color fading is a significant issue
    - Maintenance crews report direction does impact life, but is it retro or color?
Penn DOT (2012)

- 1,007 Type III and IV, 10+ years old, yellow, white, green, red, black and white
- Findings:
  - No regional differences
  - 28 signs below minimum (2.8%) at an average age of 14
  - Expected sign life value of 15 for Type III yellow, white, green and red signs
Retroreflectivity of Existing Signs in Pennsylvania

Figure 2: Age versus Retroreflectivity for Yellow Signs (all counties combined)

Yellow Signs - Age vs. Retroreflectivity

\[ y = -20.24x + 523.53 \quad R^2 = 0.2533 \]

23.5 years
Figure 3: Age versus Retroreflectivity for Red Signs (Red) (all counties combined)

Red Signs - Age vs. Red Retroreflectivity

\[ y = 4.0818x + 94.055 \quad R^2 = 0.1537 \]
Survey of Minnesota Agencies

(Minnesota survey will close this week, a survey of other state DOTs is planned)

We asked Minnesota Agencies;
(preliminary results as of 02/19/2013)

- Who collects retro data & how is retro maintained/verified?
- Possible participants for this study?
- Who has an inventory? & what is tracked?
- What sheeting types are installed? & what types are currently specified?
Survey of Minnesota Agencies
(a survey of other states is planned)
Minnesota Agencies – preliminary results as of 02/19/2013

1. Please enter the information about yourself.

<table>
<thead>
<tr>
<th></th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation Agency:</td>
<td>100.0%</td>
<td>60</td>
</tr>
<tr>
<td>Person(s) replying to questionnaire:</td>
<td>100.0%</td>
<td>60</td>
</tr>
<tr>
<td>Contact phone number:</td>
<td>98.3%</td>
<td>59</td>
</tr>
<tr>
<td>Contact e-mail:</td>
<td>96.7%</td>
<td>58</td>
</tr>
</tbody>
</table>

answered question 60
skipped question 3
## Survey of Minnesota Agencies

**Minnesota Agencies – preliminary results as of 02/19/2013**

### 2. What method does your agency use for maintaining minimum retroreflectivity of traffic signs? (select all that apply)

<table>
<thead>
<tr>
<th>Method</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nighttime Visual Inspection</td>
<td>34.5%</td>
<td>19</td>
</tr>
<tr>
<td>Measured Sign Retroreflectivity</td>
<td>7.3%</td>
<td>4</td>
</tr>
<tr>
<td>Expected Sign Life</td>
<td>54.5%</td>
<td>30</td>
</tr>
<tr>
<td>Blanket Replacement</td>
<td>30.9%</td>
<td>17</td>
</tr>
<tr>
<td>Control Signs</td>
<td>5.5%</td>
<td>3</td>
</tr>
<tr>
<td>Combination of Methods</td>
<td>36.4%</td>
<td>20</td>
</tr>
<tr>
<td>Agency established sign service life</td>
<td>5.5%</td>
<td>3</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>answered question</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>skipped question</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>
Survey of Minnesota Agencies
Minnesota Agencies – preliminary results as of 02/19/2013

3. Would you be interested in collecting retroreflectivity data on some of your signs if the equipment and training was provided?

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>65.5%</td>
<td>36</td>
</tr>
<tr>
<td>No</td>
<td>34.5%</td>
<td>19</td>
</tr>
</tbody>
</table>

answered question 55
skipped question 8
## Survey of Minnesota Agencies

**Minnesota Agencies – preliminary results as of 02/19/2013**

### 4. Do you have a sign inventory that tracks:

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Rating Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign Age</td>
<td>87.0% (47)</td>
<td>13.0% (7)</td>
<td>54</td>
</tr>
<tr>
<td>Sheeting material type</td>
<td>88.7% (47)</td>
<td>11.3% (6)</td>
<td>53</td>
</tr>
<tr>
<td>Sheeting material manufacturer</td>
<td>32.7% (16)</td>
<td>67.3% (33)</td>
<td>49</td>
</tr>
<tr>
<td>Fabrication method</td>
<td>12.2% (6)</td>
<td>89.8% (44)</td>
<td>49</td>
</tr>
<tr>
<td>Measured Retroreflectivity</td>
<td>18.0% (9)</td>
<td>84.0% (42)</td>
<td>50</td>
</tr>
<tr>
<td>Cause of replacement (accident,</td>
<td>70.4% (38)</td>
<td>29.6% (16)</td>
<td>54</td>
</tr>
<tr>
<td>damage, color/retro,etc)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**answered question** 54

**skipped question** 9
5. What sign sheeting materials are now in place on your existing traffic signs? Please type in approximate percentage of each.

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM Type I - Engineering grade?</td>
<td>75.0%</td>
<td>39</td>
</tr>
<tr>
<td>ASTM Type III-High Intensity?</td>
<td>73.1%</td>
<td>38</td>
</tr>
<tr>
<td>ASTM Type IV-High intensity Prismatic?</td>
<td>71.2%</td>
<td>37</td>
</tr>
<tr>
<td>ASTM Type IX-VIP prismatic?</td>
<td>55.8%</td>
<td>29</td>
</tr>
<tr>
<td>ASTM Type XI-DG3 prismatic?</td>
<td>73.1%</td>
<td>38</td>
</tr>
</tbody>
</table>

Answered question: 52
Skipped question: 11
## Survey of Minnesota Agencies

### Minnesota Agencies – preliminary results as of 02/19/2013

6. What sign sheeting materials do you currently specify for new traffic signs? Choose one or more by checking box(s)

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM Type I - Engineering grade?</td>
<td>7.4%</td>
<td>4</td>
</tr>
<tr>
<td>ASTM Type III-High intensity?</td>
<td>16.7%</td>
<td>9</td>
</tr>
<tr>
<td>ASTM Type IV-High intensity Prismatic?</td>
<td>38.9%</td>
<td>21</td>
</tr>
<tr>
<td>ASTM Type IX -VIP prismatic?</td>
<td>11.1%</td>
<td>6</td>
</tr>
<tr>
<td>ASTM Type XI-DG3 prismatic?</td>
<td>57.4%</td>
<td>31</td>
</tr>
</tbody>
</table>

Other (please specify) 1

answered question 54

skipped question 9
MnROAD Sign Test Deck
Proposed Location and Configuration (for Task 2)
Sign Test Deck Proposed Location at MnROAD
Proposed Sign Structure Locations

- 25+ Structures, Approximately 20 feet Apart.
- 45 degree deck at south end in the middle
Questions for MnROAD Test Deck

Discussion/Input

- Salvage Vs. New Panels?
- Colors? (planning only those requiring retro – and will test for color)
- Face directions? (planning for NC type “box” formation of all 4 directions)
- Fabrication Methods? (any method and fabricator)
- Sheeting Materials Manufacture? (3M or others too?)
- Sheeting Materials Type(s)?
# New MUTCD Table 2A.3
## Minimum Maintained Retroreflectivity Levels

<table>
<thead>
<tr>
<th>Sign Color</th>
<th>Sheet Type</th>
<th>Beaded Sheeting</th>
<th>Prismatic Sheeting</th>
<th>Additional Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>White on Green</td>
<td>Beaded Sheeting</td>
<td>I: $W \geq 7$ $G \geq 15$ II: $W \geq 25$</td>
<td>III: $W \geq 250$ $G \geq 25$</td>
<td>Overhead</td>
</tr>
<tr>
<td>Black on Yellow or Orange</td>
<td>Beaded Sheeting</td>
<td>Y*: $Y \geq 50$ O*: $O \geq 50$</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Black on Orange</td>
<td>Beaded Sheeting</td>
<td>Y*: $Y \geq 75$ O*: $O \geq 75$</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>White on Red</td>
<td></td>
<td></td>
<td>W: $W \geq 35$ R: $R \geq 7$</td>
<td>4</td>
</tr>
<tr>
<td>Black on White</td>
<td></td>
<td></td>
<td>W: $W \geq 50$</td>
<td></td>
</tr>
</tbody>
</table>

1. The minimum maintained retroreflectivity levels shown in this table are in units of cd/lx/m² measured at an observation angle of 0.2° and an entrance angle of -4.0°.
2. For text and fine symbol signs measuring at least 1200 mm (48 in) and for all sizes of bold symbol signs.
3. For text and fine symbol signs measuring less than 1200 mm (48 in).
5. * This sheeting type should not be used for this color for this application.
NTPEP Outdoor Weathering Fence
Maplewood Lab
Portable Retro
Light Tunnel
AASHTO-NTPEP Sign Sheeting Testing
MnDOT Location

- Retroreflection
  - Lab and Field
- Color
  - Lab and Field
  - Color coordinates, x,y
- Visual Evaluation
  - Shrinkage, blistering etc.
- Frequency
  - Initial, 1,2 and 3 years
3M DG3 Stop Sign Evaluation
Fabrication Method

Initial Retro Readings

- Red EC film signs - 168.
- Screened signs - 64.

Initial Color Reading
Next Steps

- Retro measurement ‘how-to’ video
- Data collection on in-service signs
- TAP meeting in late April to cover Tasks 2 and 3
Questions?

Thank You