Local Project Prioritization using the Highway Safety Manual
Outline of Presentation

- Introduction
- Background
- The Highway Safety Manual (HSM)
- Wisconsin Network Screening
What was the problem?

ME! ME! ME! ME! ME! ME! ME! ME! ME! ME! ME! ME! ME! ME! ME! ME! ME!

SO HOW DO WE DECIDE WHERE WE SHOULD DO A STUDY?

WELL, WE DON'T HAVE THE STAFF OR TIME TO DO EVERYONE'S...

LET'S LET THE DATA LEAD THE WAY!

SO WHO REALLY NEEDS A STUDY?
What was the problem?

- Geographically disparate areas to review
- Limited window to review sites for concerns
- Limited funding for both safety reviews and
- Need to make objective, data-driven decisions

...how to identify projects with
limited staff,
limited time,
and limited resources
How do we decide?

...but I averaged the most over the past three years!

I had more crashes last year

What about serious crashes?

We have more traffic... doesn’t that count?

OK...
Summary of Alternatives

- Observed Crash Frequency
- High Crash Rate Locations
- Weighted Severity Factors
- Highway Safety Manual Methodology
  - Predicted
  - Expected
- usRAP
Observed Crash Frequency

- Most rudimentary screening option
- Assesses segments & intersections based solely on the raw number of observed crashes

Requirements
- Intersection & segment locations
- Location specific crash counts

Source: safety.fhwa.dot.gov
High Crash Rate Locations

- Builds on High Crash Locations method
- Considers observed crash counts and relative exposure

\[
\text{ObservedCrashRate}_{\text{int}} = \frac{(\text{Crashes / year}) \times 1,000,000}{\text{AADT} \times 365}
\]

\[
\text{ObservedCrashRate}_{\text{segment}} = \frac{(\text{Crashes / year}) \times 1,000,000}{\text{AADT} \times 365 \times L}
\]

- Requirements
  - Intersection and segment locations
  - Location specific crash counts
  - Traffic volumes for segments and intersection entering volumes
Weighted Severity Factors/Equivalent Property Damage Only

- Applies weighting factors to severity levels, e.g.
  - Fatality x 100
  - Incapacitating Injury x 50
  - Non-Incapacitating Injury x 30
  - Possible Injury x 10
  - Property Damage Only x 1

- Expresses crashes in terms of property damage only collisions

- Requirements
  - Segment and intersection locations
  - Location specific crash data
  - Weighting factors
Highway Safety Manual Methodology (HSM) – Predictive Method

• Considers geometric characteristics and exposure rates
• Employs tested statistical methods to predict safety performance
  – Safety Performance Functions
  – Crash Modification Factors
  – Local Calibration Factor
• Results in a predicted crash frequency based on a long term average
• Observed crashes not required
Highway Safety Manual Methodology (HSM) - Expected

- Considers geometric characteristics and exposure rates
- Compares expected and predicted crash frequencies
  - i.e. "Excess Expected Crashes"
usRAP

- Assigns risk ratings to network segments based on geometric and operational characteristics
- Distributes crashes across network based on assigned risk ratings and internal algorithms
- Results in predicted/estimated crash distributions
  - Proposed treatments are based on this analysis and existing geometries

Requirements
- Detailed geometric and operational info
- Network/Region wide fatal crash total
- Various economic data

- Geo-located crashes not required
Putting it together...

SURE!

? COULD YOU PLEASE SUM THAT UP FOR ME?
<table>
<thead>
<tr>
<th>Method</th>
<th>Observed Crash Frequency</th>
<th>High Crash Rate Locations</th>
<th>Weighted Severity Factors</th>
<th>HSM – Predictive</th>
<th>HSM – Expected</th>
<th>usRAP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benefits</strong></td>
<td>Simple, tested method</td>
<td>Relatively simple, tested method</td>
<td>Considers collision severity, i.e. higher severity = greater weight</td>
<td>Historic crashes aren’t required</td>
<td>Allows for treatment comparisons</td>
<td>Site specific historic crashes not required</td>
</tr>
<tr>
<td></td>
<td>Targets high raw crash locations</td>
<td>Considers exposure effects</td>
<td></td>
<td>Allows for treatment comparisons</td>
<td></td>
<td>Identifies high risk locations and provides treatment suggestions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Visual/Interactive display tool</td>
</tr>
<tr>
<td><strong>Limitations</strong></td>
<td>Omits exposure factors</td>
<td>Limited predictive or comparative capacity</td>
<td>Limited predictive or comparative capacity</td>
<td>Time intensive</td>
<td>Requires SPF, CMF, and Calibration factors for each site</td>
<td>Time intensive</td>
</tr>
<tr>
<td></td>
<td>No predictive or comparative capacity</td>
<td></td>
<td></td>
<td>Requires SPF, CMF, and Calibration factors for each site</td>
<td></td>
<td>Treatments require further scrutiny</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Requires software access/support</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Proprietary internal processes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Visual/public results</td>
</tr>
</tbody>
</table>
### Data Requirements \(\approx\) Level of Effort

<table>
<thead>
<tr>
<th>Observed Crash Frequency</th>
<th>High Crash Rate Locations</th>
<th>Weighted Severity Factors</th>
<th>HSM - Predictive</th>
<th>HSM - Expected</th>
<th>usRAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Specific Crashes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Calibration Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometric Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collision &amp; Countermeasure Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **No Predictive Analysis**
- **Predictive Analysis**

Increasing Data Requirements = Increasing Effort
And the winner is...?

So now that you’ve seen the options, what do you think we should use?

The Highway Safety Manual!
The Highway Safety Manual - Purposes

• Released in 2010
• Best factual information and proven analysis tools for crash frequency prediction
• Primary focus is to increase application of analytical tools for assessing safety impacts
The Highway Safety Manual - Uses

- Identify sites with the most potential for crash frequency or severity reduction.
- Identify factors contributing to crashes and associated potential countermeasures to address these issues.
- Evaluate the crash reduction benefits of implemented treatments.
- Conduct economic appraisals of improvements to prioritize projects.
- Calculate the effect of various design alternatives on crash frequency and severity.
- Estimate potential crash frequency and severity on highway networks, and the potential effects of transportation decisions on crashes.
The Highway Safety Manual—How it is applied

- Using Part C—Predictive Method
- Roadway segments and intersections
- Uses Safety Performance Functions (SPF)
  - Equations that estimate average crash frequency as a function of traffic volume and roadway characteristics.

<table>
<thead>
<tr>
<th>Table 1 Facility Types with Safety Performance Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSM Chapter</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>10 Rural Two-Lane, Two-Way Roads</td>
</tr>
<tr>
<td>11 Rural Multilane Highways</td>
</tr>
<tr>
<td>12 Urban and Suburban Arterials</td>
</tr>
</tbody>
</table>
The Highway Safety Manual – Data Requirements

- Site Characteristic Data
  - Aerial Maps and Google Street View
- Traffic Volume Data
  - WiSDOT traffic count maps
- Crash Data
  - TOPS Lab
Wisconsin Network Screening

- Applied to roads and intersections within Tribal areas
- Applied HSM methodology to rank sites
  - Greatest opportunity to reduce crashes given already low excess expected rates
- Created preliminary designs for improvements
- Completed funding applications
What did we cover?

- 635 segments
  - Lengths varied from 0.1 to 5.2 miles (0.7 mile average)
- 358 intersections
  - Both stop controlled and signalized
- Locations scattered across the state
  - 11 Federally recognized tribes
Top 25 Sites by Observed Crashes

1. Bad River Band of Lake Superior Chippewa Indians
2. Lac du Flambeau Band of Lake Superior Chippewa Indians
3. Stockbridge-Munsee Band of Mohican Indians
4. Oneida Nation of Wisconsin
Site Cluster - 3 (per segment)

Legend
(Observed Crashes per Year)
- >2.0
- 15 - 19
- 10 - 14
- 0.5 - 0.9
- 0.0 - 0.4

Stockbridge-Munsee Band of Mohican Indians
Site Cluster 3 – Individual Crashes

Legend
- O - Property Damage Only
- C
- B
- A
- K - Fatality

Stockbridge-Munsee Band of Mohican Indians
Site Cluster 3

- Seven of the top 30 ranked sites
  - 53 crashes from 2007-11
  - Crash severity ranges from PDO to Fatality

- Included 4 of the top 10 locations

- Had not previously been audited
Other Information

- Steering Committee includes WisDOT and Tribal representatives
- Agreed list of preliminary locations
  - Needed approval and agreement with the respective tribes
- Conducted Road Safety Audits of selected sites
  - Worked with Tribes, County Highway Agencies, Bureau of Indian Affairs (BIA)
RSA Definition

A formal safety performance examination of an existing or future road or intersection by an independent, multi-disciplinary RSA team.
Post RSA

• Prepared initial cost estimates and benefit/cost analyses
• Selected preferred alternatives for each location
• Developed conceptual designs and more detailed cost estimates
• Prepared HSTP/HRRR funding applications
  • Stockbridge-Munsee submitted application earlier this year
Key takeaways

- Desktop exercise reduced fieldwork
  - Improved Safety

- No travel time required
  - Computer and internet connection

- Reduced scheduling conflicts
  - Team could work when convenient and/or in short stints
  - Staff with greater experience could review findings rather than inputting data

- Data-driven analysis
  - Objective
  - Repeatable

- Basic inventory of geometry and assets
  - Reduces future analysis times
  - Provides basic inventory to asset owner
Thank you!

Contact Information:

Andrew Ceifetz, P.E., CAPM
Opus International Consultants
27333 Meadowbrook Rd, Suite 210
Novi, MI 48377

248-539-2222
248-956-1242

Andrew.Ceifetz@opusinternational.com