Lessons Learned from the Minnesota County Road Safety Plans

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CH2M HILL

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Overview of the MN CRSP: Why Prepare Safety Plans for Local Systems?

- **MAP-21**: Requires states to address ALL roads as part of their statewide safety planning process.
- **2012 FARS**: Indicates that around the country, 44% of fatalities occur on local systems.
- **State Strategic Highway Safety Plans**: Identify short and long term crash reduction goals. Are these stretch goals achievable if all safety investments are directed to the state system?
  - Toward Zero Deaths was adopted as a long term vision in 2003.
  - In 2009, MnDOT changed the distribution of Highway Safety Improvement Program funds – from virtually all on State highways to a distribution proportional to the number of severe crashes – basically 50% state and 50% local systems.
Q: How do you analyze the highway system and prepare safety plans for 87 counties?

Issue: Statewide, the rural, paved county road system exceeds 20,000 miles, with thousands of intersections and horizontal curves.
A: Phased Approach

- Four Phases
  - Each Phase included two ATPs
  - Began with ATP 3 and ATP 6
    - Greatest frequency of severe crashes on the local system
- Have a process that can be used for each phase
Q: How will you gather the data needed for the analysis?

Issue: Data systems for the county highways are not as complete as the information systems maintained for the trunk highways.
A: Make Use of a Variety of Resources

- DPS Crash Records to access driver behavior information
- MnCMAT for location specific (segment, intersection, curve) crash records
- Video Log and On-line Aerial or cross-section and geometric data
- MnDOT Traffic Counts Maps
Q: What is the best safety analysis method for screening the county highway system?

Issue: Most safety analysis methods are based on crash frequencies and/or rates to find areas needing safety improvements. However, the severe crashes are widely spread across the county system.
A: Look Towards a New and Evolving Method.

- Systematic Safety
  - South Carolina...wide spread use of cable median barrier
  - Missouri...applied lane edge treatments during large resurfacing bond
  - Illinois...used SPFs to prioritize based on risk (i.e., predicted crashes)
  - Only applied to state highways (high-volume)

- Systemic Safety
  - Evolved due to the MN CRSP
  - FHWA Guide Book
    - Process similar to MN CRSP but with some variations
Q: How does the systemic process analyze the data to make informed decisions that are consistent from phase to phase?

Issue: Safety summaries should be easy to understand but help identify the focus for the program.
### Greater Minnesota and Metro Emphasis Areas

<table>
<thead>
<tr>
<th>Emphasis Area</th>
<th>Statewide Percentage</th>
<th>Greater Minnesota</th>
<th>Metropolitan</th>
<th>City, Townshp &amp; Other</th>
<th>Interstate, US &amp; TH</th>
<th>CSAH &amp; CR</th>
<th>City, Townshp &amp; Other</th>
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<td>CSAH &amp; CR</td>
<td>City, Townshp &amp; Other</td>
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<td>Pedestrians crashes</td>
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<td>16% (825)</td>
<td>11% (247)</td>
<td>9% (191)</td>
<td>6% (172)</td>
<td>6% (122)</td>
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<tr>
<td>Crashes</td>
<td>16%</td>
<td>15% (745)</td>
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<td>17% (379)</td>
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<td>6% (127)</td>
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<td>More effective processes</td>
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</table>
Greater Minnesota Crash Data Overview

5 Year Crashes
156,182
4,902

State System
70,808 – 45%
2,000 – 41%

CSAH/CR
36,716 – 24%
1,963 – 40%

Urban
14,086 – 38%
337 – 17%

Rural
22,630 – 62%
1,626 – 83%

Run off Road
7,891 – 67%
675 – 65%

On Curve
3,222 – 40%
339 – 50%

Animal
4,009 – 18%
60 – 4%

Right Angle
849 (34%), 122 (56%)

Other/Unknown
1,881 – 26%
43 – 30%

Other
1,268 (47%), 37 (86%)

Head On
100 (4%), 4 (13%)

Left Turn
375 (16%), 5 (16%)

Run Off Road
999 (38%), 95 (42%)

Right Angle
268 (10%), 39 (17%)

“Other” – 303 (12%), 29 (13%)

Head On – 112 (4%), 21 (9%)

All Way Stop
209 – 4%
4 – 1%

Signalized
2,511 – 46%
216 – 47%

Thru-Stop
2,511 – 46%
216 – 47%

On Curve
247 – 33%
46 – 35%

Run off Road
7,891 – 67%
675 – 65%

On Curve
3,222 – 40%
339 – 50%

Run Off Road – 1,268 (47%), 37 (86%)

“Other” – 252 (9%), 9 (21%)

Left Turn – 268 (10%), 4 (9%)

Rear End – 333 (12%), 3 (7%)

Unknown/Other
1,577 – 11%
17 – 5%

Unknown/Other
11,849 – 64%
1,042 – 66%

Not Inters-Related
5,177 – 37%
175 – 52%

Inter-Related
7,332 – 52%
145 – 43%

City, Twnshp, Other
48,658 – 31%
939 – 19%

Example
All – %
Severe – %

Source: MnCMAT Crash Data, 2006-2010
Severe is fatal and serious injury crashes (K+A).
Q: How does a systemic process prioritize a low-volume, low-crash frequency system?

Issue: If risk is historically based on crash frequency, few [if any] county systems will be a priority, even though it accounts for approximately half of severe crashes in MN. Severe crashes occur randomly and sporadically across local roads.
A: Risk Factors to Estimate Future Crash Potential

**Segments:**
- Density of Road Departure
- Traffic Volume
- Critical Curve Radius Density
- Access Density
- Edge Risk Assessment

**Curves:**
- ADT Range
- Radius Range
- Severe Crash on curve
- Intersection on curve
- Visual Trap on curve

**Intersections:**
- Skewed approaches
- On/near curve
- Volume
- Proximity to railroad crossing
- Proximity to last STOP sign
- Intersection related crashes
- Commercial Development in quadrant
Risk Factors

- Originally known as “surrogates”
  - Changed to risk factors in the FHWA guide

- Selection based on:
  - Highway Safety Manual ➔ Edge Risk Assessment
  - Other Research ➔ Development at Rural Intersections
  - Professional Judgment ➔ Visual Trap

- Descriptive statistics used to verify risk factors are appropriate measures of future crash potential
  - See examples
Example Segment Risk Evaluation – Access Density

- 21,700 miles of paved roads evaluated
  - 1,056 severe road departure crashes
  - 0.009 severe crashes/mile/year

![Graph showing Minnesota County Road Access Density](image-url)

Length (17966 miles)  | Crash Rate (Avg=0.9)  | Severe Crash Density (Avg=0.14)(SevCr/yr/10mi)
Example Curve Risk Evaluation – Radius

- 19,730 curves evaluated
- 482 severe curve crashes
  - 95% of curves had NO severe crashes
  - 2% of curves had ONE severe crashes
  - No Dead Man’s Curve – no curve averaged one severe crash per year
  - 0.005 severe crashes/curve/year
Q: How many risk factors need to be present for a segment/curve/intersection to be a high priority?

Issue: Risk factors may provide an estimate of future crash potential, but how is that used to prioritize locations for improvement.
A: Typically Determined 3 Risk Factors Appropriate

### Rural Intersection Prioritization

<table>
<thead>
<tr>
<th>Rank</th>
<th>Int #</th>
<th>Sys #</th>
<th>Intersection Description</th>
<th>Skew</th>
<th>On/Near Curve</th>
<th>Development</th>
<th>RR Xing</th>
<th>Previous STOP (&gt;5 mi)</th>
<th>Total Crashes (Min/Maj)</th>
<th>Priority</th>
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### Risk Factors

- **Skew**: if intersection is skewed at an angle of 15 degrees or greater.
- **On/Near Curve**: if intersection is on or within 1,000 feet of curve.
- **Development**: if intersection aerial shows a commercial development with access near intersection.
- **RR Xing**: if intersection has a railroad crossing on any approach within 500 feet.
- **Previous STOP (>5 mi)**: if vehicles approaching the stop control have not had a previous stop control along the roadway within 5 miles.
- **Total Crashes**: if intersection has at least 1 crash.
- **Ratio (Min/Maj)**: if intersection has an ADT ratio in the range of 0.4 to 0.8.

### Prioritization

- **Total Stars**:
  - 46
  - 88
  - 8
  - 8
  - 140
  - 114
  - 79

- **Percentage That Gets Star**:
  - 19%
  - 36%
  - 3%
  - 3%
  - 57%
  - 47%
  - 32%

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Are all Risk Factors Equally Important?
Q: What type of projects will be the program’s focus?

Issue: With limited resources, there is insufficient funds to improve the highest priority locations with moderate or high cost strategies.
A: Proven Effective

Typical Run-Off Road Strategies

Lane Departure Crashes

Key Objectives:
Keep Vehicles in Their Lane

Key Strategies:
- Improved curve delineation
- Improved lane markings

Key Objectives:
Improve Shoulders

Key Strategies:
- Safety edge
- Paved shoulders
- Shoulder rumble strips

Rumble Strip
Without Safety Edge
With Safety Edge
A: Typically Low-Cost
Typical Signalized Intersection Strategies

- Countdown Timers and Advanced Pedestrian Intervals
- Confirmation Red-Light Running Lights
- Curb Extensions and Medians
A: Range of Options (higher cost where needed)
Typical Rural Intersection Strategies

### Change Intersection Type

**3/4 Access**

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<th>Benefit</th>
<th>Cost</th>
<th>Total</th>
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**Full Access**

- Enhanced Signing and Delineation
- Dynamic Warning Signs
- Street Lighting

**Indirect Turns**

- Add can delineators to Stop sign
- 360° reserve area
- Intersections with documented deficiency
- Where there are RR gates:
  - Crossing on the CH approach
  - Distance between Stop Ahead and Stop
  - Distance between Stop Ahead and Junction sign
  - 45° (min.) to 75° (max), larger than Stop up to 45°
Q: How are project assignments made to provide a consistent answer in each county?

Issue: With multiple analysts working across counties, the project type selected may vary from county to county.
A: Employ a Project Decision Tree

1. Road Surface?
   - Paved
     - ADT > 200?
       - YES
         - Noise Sensitive Receiver
           - NO
             - Paved Shoulder?
               - YES
                 - PROJECT: Rumble Strip
               - NO
                 - PROJECT: Lane Width?
                   - >= 12 feet
                     - PROJECT: Rumble Strip E
                   - < 12 feet
                     - PROJECT: 2 ft. shoulder paving* (up to 6 miles/year**)
               PROJECT: 6" Wet Reflective in longitudinal groove
     - NO
       - PROJECT: 6" Latex Edgeline
   - Gravel
     - Segment received Stars for SVROR Crash Density & Critical Radius Curve Density
       - NO
         - NO PROJECT
       - YES
         - PROJECT: Chevrons in Critical Radius Curves

Note: All projects also include Chevrons and Paving 2" inside shoulder in Critical Radius curves, except Gravel Roads
* Where regrading not required
** After 6 miles/year of paving, wet reflective longitudinal groove provided
Q: Well, did the systemic process work?

Issue: The process needs to successfully identify enough projects to meeting funding goals, but at the right locations.
A: Yes – Over $230M in suggested projects

### RURAL PROJECTS

#### Segment Project Summary (measured in miles)

<table>
<thead>
<tr>
<th>2' Shoulder Pave+RS+Safety Wedge</th>
<th>Rumble Strip</th>
<th>Rumble StripE</th>
<th>6-inch Edge Lines</th>
<th>Ground In Wet-Reflective Markings</th>
<th>4' Buffer</th>
<th>12' Painted Median</th>
<th>Total Project Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,135</td>
<td>1,514</td>
<td>3,816</td>
<td>1,645</td>
<td>2,163</td>
<td>39</td>
<td>23</td>
<td>$101,553,800</td>
</tr>
</tbody>
</table>

#### Curve Project Summary (number of curves)

<table>
<thead>
<tr>
<th>Total</th>
<th>Currently Installed Chevrons</th>
<th>Proximity</th>
<th>HP Seg + Crit Rad</th>
<th>Total Project Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>19,829</td>
<td>3,238</td>
<td>3,505</td>
<td>4,068</td>
<td>$78,174,000</td>
</tr>
</tbody>
</table>

#### Intersection Project Summary (number of intersections)

<table>
<thead>
<tr>
<th>Roundabout</th>
<th>All-Way STOP</th>
<th>Directional Median</th>
<th>Dynamic Warning Sign</th>
<th>Street Lights</th>
<th>Upgraded Signs &amp;/or Markings</th>
<th>Review Signs &amp; CST</th>
<th>Total Project Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>55</td>
<td>189</td>
<td>1,692</td>
<td>3,287</td>
<td>258</td>
<td>$38,108,000</td>
</tr>
</tbody>
</table>

### URBAN PROJECTS

#### Intersection

<table>
<thead>
<tr>
<th>Pedestrian/Bike Advanced Walk</th>
<th>Pedestrian/Bike Countdown Timers</th>
<th>Pedestrian/Bike Curb Extensions</th>
<th>Pedestrian/Bike Medians</th>
<th>Right Angle Confirmation Lights</th>
<th>Segment Rear End 3/5 Lane Conversions (miles)</th>
<th>Total Project Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>413</td>
<td>223</td>
<td>80</td>
<td>64</td>
<td>583</td>
<td>146</td>
<td>$13,809,000</td>
</tr>
</tbody>
</table>
A: Yes – Presence of Risk Factors Linked with Presence of Severe Crashes

Greater Minnesota Curve Star Summary

- 17% Curves
- 38% Curves

Greater Minnesota Segment Star Summary

- 15% Miles
- 27% Miles
- 28% Miles
- 18% Miles
- 9% Miles
- 3% Miles

- 0.011 Severe Crash Density
- 0.009 Severe Crash Density
- 0.075 Severe Crash Density
- 0.011 Severe Crash Density
- 0.019 Severe Crash Density
- 0.042 Severe Crash Density

- 0.006 Severe Lane Departure Crash Density
- 0.009 Severe Lane Departure Crash Density
- 0.007 Severe Lane Departure Crash Density
- 0.006 Severe Lane Departure Crash Density
- 0.010 Severe Lane Departure Crash Density
- 0.015 Severe Lane Departure Crash Density
Q: Now that the plans are completed, how do we increase county participation?

Issue: Simply preparing a plan will not reduce crashes and save lives; it takes implementation to make a real difference.
A: Provide Funding with a Streamlined Process

- Approximately half of safety funds identified for local systems
- Encourage multi-county project submittals
  - Minimize county effort
  - Improve construction prices
- Project Form
  - Simplify application process for safety funds