LOW COST SAFETY IMPROVEMENTS
Introduction

Highway Traffic Fatalities Trend
Introduction

• U.S. Highway System
  – Fatality Rate has decreased or remained same (as Traffic is Increasing)
  – But over 42,000 Deaths & 2,920,000 Injuries per Year

• Lane Departure and Intersection Crashes
  – Engineering focus areas
  – Rural crashes (70% of fatalities)
Introduction

Rural Road Safety by The Numbers

- Fatality Rate is 2.5 times that for Urban Roads.
- 40% of Travel and 60% of Fatalities
Introduction

Safety — an absolute

“Safer”- a relative term
Is this road ‘safe’ or ‘unsafe’?

- Lighting
- Advance Warning Signs
- Delineators
- Chevrons
- Shoulder Rumble Strip

Which of these low cost measures are required (i.e., nominal requirement)?
Substantive and Nominal Safety

- **Nominal Safety** is examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures.

- **Substantive Safety** is the actual crash frequency and severity for highways or roadways.
Nominal Safety – Advance Warning Sign + Advisory Speed Plaque
Nominal Safety

1st Step

- Speed limit = 45 mph
- Traffic Volume = 2,000
- Expect 2 crashes per year at this traffic volume

Nominal Safety – Advance Warning Sign + Advisory Speed Plaque
Nominal and Substantive Safety

1st Step
Nominal Safety – Advance Warning Sign + Advisory Speed Plaque

2nd Step
Advance Warning Sign + Advisory Speed + Chevrons = “Safer” = Substantive Safety
AASHTO Strategic Safety Plan
Guidebooks

VOLUME 5
NCHRP REPORT 500
NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan

Volume 5: A Guide for Addressing Signalized Intersection Collisions

TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMY
## Typical Benefit/Cost Ratios

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* From MN DOT Traffic Safety Fundamentals Handbook
LOW COST SAFETY IMPROVEMENTS

The Tools – Roadside Hazards
Roadside Hazards

Scope of the Roadside Problem

About one in three of all highway fatalities is the result of a single vehicle run-off-the-road Crash.
Roadside Hazards

Drivers May Leave the Roadway As A Result Of:

- Driver Error
- Collision Avoidance
- Roadway Condition
- Vehicle Component Failure
Roadside Hazards

Driver Limitations

- Perceive 2 or more events per second
- Make 1 to 3 decisions per second
- Take 30 to 120 actions per minute
- Commit at least one error every 2 minutes
- Are Involved in a hazardous situation every 2 hours
- Have 1 or 2 near collisions per month
- Average 1 crash every 6 years
Roadside Hazards

- Trees
- Utility Poles
- Light Poles
- Sign Posts
- Mail Boxes
- Steep Ditches
- Edge Drop Off’s
Countermeasures for Roadside Hazards:

1. Trees – removal & restriction of species
2. Utility Poles - relocation
3. Sign Supports – breakaway and shielding
4. Mail Boxes – crashworthy
5. Single-Vehicle Run-Off-the-Road - Rumble Strips and Rumble Stripes
Countermeasures for Roadside Hazards:

6. Slopes and Ditches
7. Rumble Strips
8. Rumble Stripes
9. “Safety Edge”
Countermeasures for Trees

Proven

CRF = 22% to 71%

*NCHRP 500, Volume 3- Guide for Addressing Collisions with Trees in Hazardous Locations
Countermeasures for Relocation of Utility Poles

Relocate Utility Pole away from edge of pavement
Reduction in Utility Pole Crashes for Pole Relocation

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Crashworthy Sign Supports

Small sign Supports – less than 50 Sq Foot

Two 1 ½” Holes in a 4” x 6” wood post
Countermeasures for Street Light Poles

Non-Breakaway steel light pole

Light Pole within 1 foot of back of curb

*NCHRP 500, Volume 6, Strategy 15.1 C1 – Improve Roadside Hardware (Light Poles and Sign Posts)
Countermeasures for Mailboxes

8” hardened steel gas pipe

*NCHRP 500, Volume 6, Strategy 15.1 B2 – Remove/Relocate Objects in Hazardous Locations
Update/Replace Roadside Hardware

Replace Antiquated Guardrail and Terminals

NCHRP 500, Volume 6, Strategy 15.1 C1 – Improve Roadside Hardware
Update/Replace Roadside Hardware

NCHRP 350 compliant end terminal
Countermeasures for Slopes

Drop-Off

Non-recoverable slope

Power pole in toe of ditch

*NCHRP 500, Volume 6, Strategy 15.1 B1 – Design Safer Slopes and Ditches
Countermeasures for Slopes

“After Condition”

Ditch Filled In

Traversable Slope

NCHRP 500, Volume 6, Strategy 15.1 B1 – Design Safer Slopes and Ditches
Countermeasures for Run-Off-the-Road Crashes

Rumble strips are intended to supplement pavement markings

- Adds sound and vibration to the visual benefits of painted markings
- Provide a drowsy, inattentive, or distracted driver with a clear warning that the vehicle has left travel lane…
- Provides some reaction time before the vehicle leaves the road
Countermeasures for Run-Off-the-Road Crashes – Edgeline Rumble Strips

CRF = 20 to 49% for 2 Lane

Tried

NCHRP 500, Volume 6, Strategy 15.1 A1 – Install Shoulder Rumble Strips
Countermeasures for Run-Off-the-Road Crashes – Centerline Rumble Strips

Two-Lane Hwy

Undivided 4-Lane Hwy
Rumble Stripes

NCHRP 500, Volume 6, Strategy 15.1 A2 – Install Edge line “Profile marking”
Rumble Stripes

Rumble Stripes on MS 589

Mississippi

NCHRP 500, Volume 6, Strategy 15.1 A2 – Install Edge line “Profile Marking”
Rumble Stripes

- Michigan initiative with edge line painted over shoulder rumble strip

NCHRP 500, Volume 6, Strategy 15.1 A2 – Install Edge line “Profile Marking”
Rumble Stripes

- Michigan initiative with edge line painted over shoulder rumble strip.

Michigan I-75 - After 1st Winter
Reducing Edge Drop Off Crashes

Example of Edge Drop-Off Crash

County Road recently resurfaced – Edge drop-off resulted in 3 Fatalities
Reducing Edge Drop-Off Crashes

Edge Drop-off
Reducing Edge Drop-Off Crashes

Pavement Edge Rutting and Drop-Offs:
- Edge rutting occurs on all sections of roads
- Usually a small percentage of road length
- Caused by errant vehicles in conjunction with erosion
- Common in curves and near turning movements
- Mailboxes
Reducing Edge Drop-Off Crashes

“Safety Edge”

NCHRP 500, Volume 6, Strategy 15.1 A8 – Apply Shoulder Treatment
The Safety Edge

- Helps errant vehicles to maintain stability particularly on roadway re-entry
- Effective up to 5 inches of pavement depth
- Beneficial in reducing Tort Liability during construction & after project completion

NCHRP 500, Volume 6, Strategy 15.1 A8 – Apply Shoulder Treatment
The Safety Edge

Demonstration Project in Georgia

“Shoe” Installed in Screed
The Safety Edge

Demonstration Project in Georgia

The “Safety Edge”
Countermeasures for Roadside Hazards

“Delineate Hazards”

*NCHRP 500, Volume 6, Strategy 15.1 B3 – Delineate Trees or Utility Poles with Markers or Retroreflective Tape
LOW COST SAFETY IMPROVEMENTS

The Tools – Signing & Markings & Lighting
Signing & Markings & Lighting

Discussion

**Signs:**
- Warning Signs
- Unexpected Hazards
- Curves
- Right of Way Control
- Regulatory Signs

**Markings:**
- Centerline
- Edgeline
- Markers
- StopBars
Signing Countermeasures

- Traffic Signs have the 2nd Highest rank in terms of benefit to cost of all safety countermeasures

  39% Fatalities
  15% Injuries
**Warning Signing**

**Purpose:** ...to call attention to unexpected conditions and to situations that might not be readily apparent to road users.
Warning Signing for Curves

25% of all Highway Fatalities occur on Horizontal Curves

NCHRP 500
Strategy 15.2
Horizontal Curves
Case Study: Warning Signs for a Curve

Sweeping Horizontal Curve with alignment “hidden” by vertical crest
Warning Signing for Curves

**Case Study:** Warning Signs for a Curve

**Tried**

CRF = 18%

CRF = 22% with Advisory Speed
Right-of-Way Regulatory Signing
Right-of-Way Regulatory Signing

Install YIELD or STOP Control

CRF = 45%

2-Way STOP CRF = 35%

*Missouri HAL Manual
Right-of-Way Regulatory Signing

Change 2-Way STOP to All-Way STOP

CRF = 53% for all crashes
CRF = 84% for Right Angle Crashes

*NCHRP 500, Objective 17.1 F2 – Provide All-Way Stop Control at Appropriate Intersections
Visibility of Right-of-Way Regulatory Signing

(Supplemental Stop Sign in Island)

*NCHRP 500, Strategy 17.1 E3 – Install Splitter Islands on Minor Road Approaches
Visibility of Right-of-Way Regulatory Signing

(Stop Sign in Island)

NCHRP 500, Strategy 17.1 E3 – Install Splitter Islands on Minor Road Approaches

CRF = 11% All Crashes
CRF = 36% Right Angle Crashes
Observation
Typical layout of intersection guide signs intercepts sight lines from the stop signs.

Suggestion
Develop/adopt a revised typical layout that relocates all of the signs away from the intersection.
Some intersections also contain “Adopt A Highway” signs mixed with intersection guide signs.
Signing

Revised Typical Layout of Trunk Highway Guide Signs

Relocate all “Adopt A Highway” signs that are mixed in with the sequence of guide signs on the approach to intersections.
2. Markings

   A. Centerline and Edge line Warrants
   B. Delineation
   C. Stop Bar Placements
   D. Safety Pylons
Centerline and Edgeline Markings

Centerline with No-Passing Zones

+ 36%

Tried

Edge lines (alone)  8%
Delineation

15% Fatalities
6% Injuries
25% - 58% Run-Off-Road
Delineation

Traffic Pylons

Close off Area to Channelize Traffic
Lighting Countermeasures

- Lighting has the highest benefit to cost ratio of any of the traffic safety countermeasures.

Proven

CRF = 18% - 70% for spot locations and intersections

Typical Benefit / Cost (B/C) Ratios for Various Improvements (1974 - 1993)

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1-64
Lighting Countermeasures

- Lighting of rural intersections reduced crashes by 25 to 50% - MN study
Lighting Countermeasures

Illumination of Rural Curves

Route 376 near Poughkeepsie, NY
Lighting Countermeasures

Illumination of Rural Curves

Cayuga Heights Road just north of Ithaca, NY
Low Cost Safety Solutions

Examples of Efficient Low Cost Projects:

District 3
  County Road & Trunk Hwy intersections
  Road Safety Audits
  Intersection improvements

District 6
  Multi-County horizontal curve project
  Install chevrons at horizontal curves
Low Cost Safety Solutions

SUMMARY

• Data-driven approach
• Lane Departure
• Intersections
• Rural safety problem (70% fatalities)
• Random location of crashes
• Proactive Systematic projects
Thank You....

Dave Kopacz, P.E.
Safety Engineer
FHWA – Minnesota Division

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