6-inch Edge Lines
10 years ago...

- Agencies “liked” the looks of wider edge lines but did not have evidence to support broad implementation.
- Implemented mostly on Interstate and similar highways
- Limited operations-based research results were inconsistent
  - Speed, lateral position
- Human factors studies were simulator-based studies not transferable
- Safety impacts were not well understood
  - Until now, no significant results
  - Naïve before-after crash studies
  - Insufficient data and lack of experimental control
Wide Pavement Markings (2006)

Mostly Interstate Highways

White = no response, Grey = implemented, Grid = not implemented
Fresh Insights

• A compilation of new data since 2006 provides evidence that wider edge lines increase safety
• FHWA has completed a 5 year study that included a safety evaluation of wide edge line markings
• Follow up research was also conducted to fill in the gaps
• Confirmation through case study
Wider Lines v. Brighter Lines

- Wider edge lines provide more benefit than very high retro levels
- “wider edge lines provide a more comfortable driving environment for drivers”
- “wider edge lines provide more time for drivers to focus on critical driving tasks”
- FHWA/TX-10/5862-1
Detection Distances

Mean Predicted Detection Distance Dry Conditions (feet)

<table>
<thead>
<tr>
<th>Pair</th>
<th>4-inch Detection Distances</th>
<th>6-inch Detection Distances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>330</td>
<td>310</td>
</tr>
<tr>
<td>Pair 2</td>
<td>320</td>
<td>300</td>
</tr>
<tr>
<td>Pair 3</td>
<td>310</td>
<td>290</td>
</tr>
<tr>
<td>Pair 4</td>
<td>280</td>
<td>260</td>
</tr>
<tr>
<td>Pair 5</td>
<td>270</td>
<td>250</td>
</tr>
</tbody>
</table>

4-inch, 6-inch Pairs

FHWA/TX-07/5008-2
Statewide Retrospective Crash Analysis of Wider Edge Lines

• Nationwide survey
  – Do you use wider edge lines?
  – Where?
  – When?
  – Available crash data?

• Michigan, Illinois, Kansas
Summary of Safety Effects

• For Two-Lane Rural Highways

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>15.0 – 30.1</td>
</tr>
<tr>
<td>Fatal and Injury</td>
<td>15.4 – 37.7</td>
</tr>
<tr>
<td>Day</td>
<td>12.0 – 29.1</td>
</tr>
<tr>
<td>Night</td>
<td>-2.4 – 30.7</td>
</tr>
</tbody>
</table>

• Based on data from 3 states:
  – Kansas from 2001-2007, 1300 miles
  – Michigan from 2001-2009, 788 miles
  – Illinois from 2001-2006, 287 miles

• References:
  – Full: FHWA-HRT-12-048
  – Summary: AAP 2012
FHWA CMF Clearinghouse

Install Wider Edge Lines (4 to 6 inches)

<table>
<thead>
<tr>
<th>CMF</th>
<th>CRF(%)</th>
<th>Quality</th>
<th>Crash Type</th>
<th>Crash Severity</th>
<th>Area Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.635</td>
<td>36.5</td>
<td>🌟🌟🌟🌟</td>
<td>All</td>
<td>Fatal,Serious injury,Minor injury</td>
<td>Rural</td>
</tr>
<tr>
<td>0.585</td>
<td>41.5</td>
<td>🌟🌟🌟🌟</td>
<td>Day time</td>
<td>Fatal,Serious injury,Minor injury</td>
<td>Rural</td>
</tr>
<tr>
<td>0.873</td>
<td>12.7</td>
<td>🌟🌟🌟🌟</td>
<td>Nighttime</td>
<td>Fatal,Serious injury,Minor injury</td>
<td>Rural</td>
</tr>
</tbody>
</table>
Comparative B/C Analysis

- Crash data from Kansas DOT
  - fatal and injury crash data
- Crash cost data from NHTSA’s *Economical & Societal Impact of Motor Vehicle Crashes*
  - Fatal = $9,145,998
  - Injury = $1,573,306
  - PDO = $3,862
- Pavement markings
  - waterborne paint
  - $0.15 per foot for 6-in markings
  - 2 year service life
## Comparative B/C Findings
*(Two-Lane Highways)*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>B/C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wider Edge Lines</td>
<td>$33 - $55 per $1</td>
</tr>
<tr>
<td>Rumble Strips</td>
<td>$37 - $46 per $1</td>
</tr>
<tr>
<td>Chevrons</td>
<td>$9 - $46 per $1</td>
</tr>
<tr>
<td>RRPMs</td>
<td>$13 per $1</td>
</tr>
</tbody>
</table>

- **Reference:** [AGBMA 2012](#)
A Message from FHWA Associate Administrator for Safety, Tony Furst

I’d like to take this opportunity to remind the safety community of the incredible research potential that will be provided by the Strategic Highway Research Program’s (SHRP2) efforts to compile the largest, most comprehensive naturalistic driving study (NDS) ever.

Initiated several years back, the SHRP2 NDS collects data on trips taken by over 3,000 volunteers whose vehicles are instrumented to record vehicle location, forward radar, video of the forward roadway, and the driver’s face and hands. This information will be coupled with data provided by the vehicle itself, such as braking, speed, acceleration rate, brake, gear position, seat belt use, and airbag deployment. When the data collection is complete at the end of 2013, the database will include information on more than 5 million trips, 30 million travel miles, and 1 million driving hours.

This database will be linked by GIS to a Roadway Information Database

In This Issue:

- New Study Finds Overall Reduction in Crashes Due to Improvements Implemented From RSAs
- Missouri Implements Systematic Lane Departure Countermeasures to Combat Fatalities on State Roads
- ConnDOT Overhauls Crash Data Program, Partners with UConn to Establish Transportation Safety Research Center
- Report Proves Rural Two-Lane Highways See Safety Benefits from Wider Edge Lines
- New Jersey LTAP Conducts Engineering Symposium to Promote Safety in Pedestrian Design

Reference: FHWA Safety 2013
Summary

• Eye-Tracking: wide edge lines provide “safer” driver conditions (more time for driver to focus on other critical tasks)
• Speeds: Negligible
• Lane position: Negligible
• Safety: 4 star CMFs ranging from 0.585 to 0.873
• Cost: 15% more
• Cost effectiveness: $1 spent → $33 to $55 benefits
• Automated vehicles: easier detection and tracking for lane departure warning (LDW) and lane keeping assistance (LKA)
Case Study: Missouri DOT

• Smooth Roads Initiative (2005-2006)
  – 2,300 miles of roadways were improved
  – Focus: Rideability and Visibility
  – Visibility ➔ Striping & Delineation
    • Wider markings
    • Rumble strips with wider markings
    • Barrier delineators
    • Reference markers on Interstates
Analysis

• Empirical Bayes (EB) method employed using 3 years before (2002-2004) and 3 years after (2007-2009)
• Effectiveness of Striping & Delineation programs:
  – 16% reduction in fatal and disabling injury crashes
  – 11% reduction in fatal and all injury crashes

• Report: Benefit/Cost Evaluation of MoDOT’s Total Striping and Delineation Program: Phase II, MRIGlobal, June 2011
Missouri B/C Findings

• Wider markings (6-inch)
  – urban multilane divided highways (B/C = 29)
  – rural freeways (B/C = 24)
  – urban multilane undivided highways (B/C = 22)

• Wider markings (6-inch) w/ resurfacing
  – rural multilane undivided highways (B/C = 146)
  – urban two-lane highways (B/C = 118)
  – Center line and edge line rumble strips on rural two-lane highways (B/C = 36)
Reference Materials

• Evaluation of Potential Benefits of Wider and Brighter Edge Line Pavement Markings, FHWA/TX-10/5862-1, July 2010
• Benefit/Cost Evaluation of MoDOT’s Total Striping and Delineation Program: Phase II, MRIGlobal, Report CM 12-002, June 2011
• Safety Effects of Wider Edge Lines on Rural Two-Lane Highways, Accident & Analysis Prevention, January 2012.
• An Evaluation of the Effectiveness of Wider Edge Pavement Markings, American Glass Bead Association, February 2012.
• FHWA Safety Newsletter, 2013, Volume 7, Issue 1
Status of Wide Markings

• Since 2016
  – Statewide: Arkansas, West Virginia, California
  – Partial: Louisiana, Nevada
  – Considering: Colorado, New Hampshire
  – Under Study: North Carolina