Data-Driven Safety Analysis

Integrating Safety Performance into All Highway Investment Decisions

Jeffrey Shaw
FHWA Office of Safety

Efficiency through technology and collaboration
FHWA - Every Day Counts

• Launched in 2010, then again in Fall 2012 for EDC 2

• Encourages the rapid deployment of existing, proven technologies to:
  • Shorten project delivery
  • Enhance highway safety
  • Protect the environment
  • Reduce Congestion
How EDC Initiatives Are Chosen

Questions
What areas need work? What solutions already being used successfully could be applied nationally?

Highway Construction Other
Agencies Industry Stakeholders
“IDEAS”

SIX KEY AREAS

Shortening Project Delivery
Innovative Contracting
Environment
Reducing Construction Time
Safety
Mobility

FHWA uses a collaborative process to select the initiatives featured in Every Day Counts.
# The DDSA Team

<table>
<thead>
<tr>
<th>Position</th>
<th>Team Member(s)</th>
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<tbody>
<tr>
<td>Team Lead</td>
<td>Jerry Roche, Office of Safety</td>
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<td></td>
<td>John McFadden, RC Safety &amp; Design</td>
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<tr>
<td>Co-Team Lead</td>
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<tr>
<td>FHWA Subject Matter Experts</td>
<td>Ray Krammes, Office of Safety</td>
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<td></td>
<td>Karen Scurry, Office of Safety</td>
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<td></td>
<td>Clayton Chen, Safety Research &amp; Development</td>
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<td></td>
<td>Mick Matzke, Office of Infrastructure</td>
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<td></td>
<td>Gene Amparano, RC Safety &amp; Design</td>
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<td></td>
<td>Dave Engstrom, RC Safety &amp; Design</td>
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<tr>
<td></td>
<td>Hillary Isebrands, RC Safety &amp; Design</td>
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<tr>
<td>State DOT Representatives</td>
<td>Tim Harmon, New Hampshire DOT</td>
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<td></td>
<td>John Miller, Missouri DOT</td>
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<td></td>
<td>Stephen Read, Virginia DOT</td>
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<td></td>
<td>Derek Troyer, Ohio DOT</td>
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<td></td>
<td>Jeremey Vortherms, Iowa DOT</td>
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<tr>
<td>FHWA Division Representatives</td>
<td>Linda Guin, Alabama Division</td>
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<td></td>
<td>Don Petersen, Washington Division</td>
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<td></td>
<td>Will Stein, Minnesota Division</td>
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<td></td>
<td>Betsey Tramonte, Louisiana Division</td>
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<tr>
<td>Marketing</td>
<td>Judith Johnson, FHWA Office of Technical Services</td>
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<tr>
<td>Coordination with AASHTO/TRB</td>
<td>Kelly Hardy, AASHTO</td>
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<tr>
<td></td>
<td>John Milton, Washington State DOT</td>
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<tr>
<td></td>
<td>Priscilla Tobias, Illinois DOT</td>
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<tr>
<td>Local Agency Representatives</td>
<td>Matt Enders, Washington State LTAP</td>
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<tr>
<td></td>
<td>Earl “Rusty” Lee, Delaware LTAP, University of Delaware</td>
</tr>
<tr>
<td></td>
<td>Kevin Murphy, Delaware Valley Regional Planning Commission</td>
</tr>
<tr>
<td></td>
<td>Mark Vizecky, Minnesota DOT</td>
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<tr>
<td>FLH, Parks and Tribal Outreach</td>
<td>Victoria Brinkly, Western Federal Lands</td>
</tr>
</tbody>
</table>
What is the Data-Driven Safety Analysis Initiative?

- The application of **two science-based analysis approaches**...

<table>
<thead>
<tr>
<th>Approaches</th>
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<tr>
<td>Systemic</td>
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<tr>
<td>Predictive</td>
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</table>
Systemic Analysis

• Implements a **system-wide screening** of a roadway network based on the presence of **high-risk roadway features** correlated with **particular severe crash types**, rather than high crash locations.

Source: FHWA Systemic Safety Project Selection Tool
Predictive Analysis

- Uses crash, roadway, and traffic volume data
- Provides reliable estimates of an existing or proposed roadway’s expected safety performance.
- Helps agencies quantify the safety impacts of transportation decisions, similar to the way agencies quantify:
  - traffic growth
  - environmental impacts
  - traffic operations
  - pavement life
  - construction costs
What is the Data-Driven Safety Analysis Initiative?

- The application of two science-based analysis approaches...into two common transportation processes
Comparing Predictive and Systemic Analysis

- Both use crash, roadway, and traffic data
- Predictive approaches provide crash frequency estimates as a function of roadway and traffic characteristics
- Systemic approaches focus on the presence of risk factors associated with higher crash frequencies of particular crash types
- Ultimately, both provide answers that can be used to make informed decisions and improve safety performance
Why the Data-Driven Safety Analysis Initiative?

- from FHWA State Data Capabilities Assessment:
  - Use of data analysis varies from state-to-state
  - All states want to improve their data capability
  - States are excited about implementing the HSM and upgrading their existing analysis practices
  - Many states noted that the introduction of the HSM was a major advance for the transportation safety profession
Transportation Processes

Safety Management

Systemic

1. Problem Identification
2. Countermeasure Selection
3. Project Prioritization
4. Project List
5. Implementation
6. Evaluation
7. Predictive

Project Development

Predictive

1. Project Planning
2. Alternatives Identification
3. Alternatives Evaluation
4. Preliminary Design
5. Final Design

Predictive

SAFe

ISATe, Spreadsheets

usRAP

Highway Safety Manual

AASHTO
What is the Key Message regarding Data-Driven Safety Analysis?

- More Informed Decision Making
- Better Targeted Investments
- Fewer Fatalities & Serious Injuries
Our EDC Vision and Mission

VISION:

• Safety Performance is integrated into all highway investment decisions.

MISSION:

• To broaden implementation of quantitative safety analysis, so that it becomes an integral component of safety management and project development decision making, resulting in fewer fatal and serious injury crashes on our Nation’s roadways.
What effect can Quantitative Analysis have on Safety?

• **Colorado** – “outperformed the rest of the country in reduction of fatal crashes.”

• **Illinois** – “has improved the sophistication of safety analyses, resulting in better decisions to allocate limited safety resources.”

• **Ohio** – “these higher identification rates indicate much more accurate identification of problem locations.”

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What DDSA Opportunities Exist in Your State?

• **Safety Management**
  – Systemic Approaches (systemic)
  – Network Screening (predictive)

• **Project Development**
  – Design Exceptions on expanded NHS
  – Alternatives Analysis as part of NEPA
  – Interstate Access Requests (Policy Point #3)
  – Performance-Based Practical Design
A systemic illustration...

- You could select cable median barrier locations on fatal crash data alone... but considering other roadway characteristics would likely lead to a better risk-based solution.
## Case Study - New York State DOT

- **Intersection and Lane Departure Crashes by System**

<table>
<thead>
<tr>
<th></th>
<th>Local</th>
<th>County</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersection Crashes</td>
<td>64% (18,270)</td>
<td>30% (1,957)</td>
<td>25% (5,033)</td>
</tr>
<tr>
<td>Lane Departures</td>
<td>18% (5,128)</td>
<td>44% (2,892)</td>
<td>30% (5,985)</td>
</tr>
<tr>
<td>Other</td>
<td>18% (5,199)</td>
<td>26% (1,723)</td>
<td>45% (8801)</td>
</tr>
</tbody>
</table>

*Source: New York State DOT*
Case Study - New York State DOT

• AADT
  – Crashes over represented when AADT between 3,000-5,999
  – 36.3% of crashes occur on 27.8% of the mileage
Benefits of Systemic Safety Planning

- Proactive program to address fatalities and serious injuries that seemingly occurred at “random” locations
- Greater knowledge regarding severe crashes, including contributing factors and location characteristics
  - Improve planning, design, and maintenance practices
  - Risk management for tort liability
A Predictive Illustration...

All three of these meet design standards...

but predictive analysis tells us they would perform very differently from a safety perspective.

Source: CH2M HILL
Case Study - Arizona DOT

Use Predictive Method for Alternatives

Alternative Improvements Included:
- Widening to 5 ft shoulders
- Widening to 8 ft shoulders
- Improve superelevation
- CL & Shoulder rumble strips
- Flattening side slopes
- Install guardrail

PROJECT LOCATION
SR 264 (MP 441 to 466)
- Rural Minor Arterial
- Navajo County, Arizona
- Undivided Two-Lane, Two-Way Road
- 12-foot travel lanes
- 0-1-foot shoulders
- Intermittent right and left turn lanes
- Intermittent passing lanes

Source: Arizona DOT
# Case Study – Arizona DOT

## Parameters for Existing & Proposed Conditions:

- Used IHSDM to perform safety analysis

<table>
<thead>
<tr>
<th>ROADWAY ELEMENT</th>
<th>HSM Base Condition</th>
<th>Existing SR 264 (1-Foot Shoulders)</th>
<th>Alternative A (5-Foot Shoulders)</th>
<th>Alternative B (8-Foot Shoulders)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane width</td>
<td>12-Foot</td>
<td>12-Foot</td>
<td>12-Foot</td>
<td>12-Foot</td>
</tr>
<tr>
<td>Shoulder width</td>
<td>6-Foot</td>
<td>1-Foot</td>
<td>5-Foot</td>
<td>8-Foot</td>
</tr>
<tr>
<td>Shoulder type</td>
<td>Paved</td>
<td>Paved</td>
<td>Paved</td>
<td>Paved</td>
</tr>
<tr>
<td>Roadside hazard rating</td>
<td>3</td>
<td>Varies (6 or 7 most frequent)</td>
<td>Varies (1 or 2 most frequent)</td>
<td>Varies (1 or 2 most frequent)</td>
</tr>
<tr>
<td>Driveway density</td>
<td>≤ 5 per mile</td>
<td>Per survey &amp; Holbrook District turnout database</td>
<td>Per survey &amp; Holbrook District turnout database</td>
<td>Per survey &amp; Holbrook District turnout database</td>
</tr>
<tr>
<td>Horizontal curves: length, radius, and presence or absence of spiral transitions</td>
<td>None</td>
<td>Per best fit alignment</td>
<td>Per best fit alignment (match existing)</td>
<td>Per best fit alignment (match existing)</td>
</tr>
<tr>
<td>Horizontal curves: Super-elevation</td>
<td>None</td>
<td>Per as-builts &amp; survey</td>
<td>Per as-builts &amp; survey (match existing)</td>
<td>Per as-builts &amp; survey (match existing)</td>
</tr>
<tr>
<td>Grades</td>
<td>≤ 3%</td>
<td>Per as-builts &amp; survey</td>
<td>Per as-builts &amp; survey (match existing)</td>
<td>Per as-builts &amp; survey (match existing)</td>
</tr>
<tr>
<td>Centerline rumble strips</td>
<td>None</td>
<td>None</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Passing lanes</td>
<td>None</td>
<td>Per survey</td>
<td>Per survey (match existing)</td>
<td>Per survey (match existing)</td>
</tr>
<tr>
<td>Two-way left-turn lanes</td>
<td>None</td>
<td>Per survey</td>
<td>Per survey (match existing)</td>
<td>Per survey (match existing)</td>
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<tr>
<td>Lighting</td>
<td>None</td>
<td>Present @ US 191 Intersection</td>
<td>Present @ US 191 Intersection (match existing)</td>
<td>Present @ US 191 Intersection (match existing)</td>
</tr>
<tr>
<td>Automated speed enforcement</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
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</table>

Source: Arizona DOT
Case Study – Arizona DOT

Plot of Geometric Features and Expected Crashes

**EXPECTED CRASH RESULTS**

- **Elevation**
- **Radius**
- **Expected Crash Rate (Crashes/Mile)**

Source: Arizona DOT
Case Study – Arizona DOT

Crash Prediction Results

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Total Crashes</th>
<th>Fatal and Injury Crashes</th>
<th>Property Damage Only Crashes</th>
<th>Reduction in Total Crashes over Existing Conditions</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Build</td>
<td>636.4</td>
<td>283.4</td>
<td>353.0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Alternative A</td>
<td>531.6</td>
<td>230.5</td>
<td>301.1</td>
<td>104.8</td>
<td>16.5</td>
</tr>
<tr>
<td>Alternative B</td>
<td>504.2</td>
<td>216.8</td>
<td>287.4</td>
<td>132.2</td>
<td>20.8</td>
</tr>
<tr>
<td>Only Superelevation Improvements</td>
<td>635.3</td>
<td>282.7</td>
<td>352.6</td>
<td>1.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

• **IHSDM Safety Analysis:**
  – Model was un-calibrated as used (not necessary for comparative alternatives analysis)
  – **Alternative B** (8-ft shoulders) **would reduce crashes by 4 percent more** than Alternative A (5-ft shoulders)
• **Economic analysis:**
  – Although Alternative B (8-ft shoulders) could provide the greater benefit in reduction in fatal and injury crashes, **Alternative A** (5-ft shoulders) would provide the **greater return on investment** and was selected as the preferred alternative.
Benefits of DDSA Implementation

- Ability to quantitatively evaluate safety impacts for various design alternatives
- Improved decision making
- Use of effective safety countermeasures
- Integrates safety elements in the most cost-effective manner in the project development process
Keys to Successful DDSA Implementation

- Identify a Champion and establish an Implementation Team
- Develop and execute an Implementation Plan
- Revise/develop agency policies and resources
- Examine risk management and legal issues
- Assess data, information technology, and analytical tools
- Develop budget and phased approach
- Identify technical assistance needs
- Consider organizational needs and issues
Key DDSA Lessons Learned

• Employ a Consistent Technical Approach
  – predictive methods, assumptions, CMFs, B/C calculations need to be uniform

• Encourage Gradual Changes
  – Policies, use of predictive methods, and training should not outpace the capability of the data and decision-support systems

• Anticipate and Champion Culture Change
  – Explain new concepts (substantive safety)

• Manage Training
  – Consider how HSM will be used and what level of understanding each person needs
Question: What is your state’s experience and interest in **PREDICTIVE/ SYSTEMIC** Safety Analysis as a part of the **Safety Management/ Project Development** process?

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<tbody>
<tr>
<td><strong>Opt-out:</strong> The State is not interested in pursuing [tool or technology]</td>
<td></td>
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</tr>
<tr>
<td><strong>Development Phase:</strong> Collect guidance and best practices, build support with partners and stakeholders, and develop a process necessary for implementation</td>
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</tr>
<tr>
<td><strong>Demonstration Phase:</strong> Testing/piloting [tool or technology]</td>
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<tr>
<td><strong>Assessment Phase:</strong> Assess performance and the process for carrying out [tool or technology]. Make adjustments to prepare for full deployment</td>
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</tr>
<tr>
<td><strong>Institutionalized:</strong> [Tool or technology] is adopted by the State’s highway construction industry and used regularly on projects</td>
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</tbody>
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What FHWA can offer

• **Technology Transfer**
  – Presentations
  – Training
  – Peer Exchange

• **FREE Technical Assistance for each state that opts-in**
  – Safety Management & Project Development
  – Predictive & Systemic Analyses
STIC Incentive Program

• Up to $100,000 available to each STIC per year
• Fund activities which will have a statewide impact on making an innovation a standard practice
• Example activities include: developing standards and specifications, preparing SOPs or technical guidance, developing/delivering training, etc.
HSM Lead/Support/Pooled-Fund States

25 States

- HSM Pooled Fund States (13)
- HSM Lead States (16)
- HSM Supporting States (5)
States Implementing Systemic Safety Improvements through the HSIP

Source: 2013 HSIP Reports
Systemic Safety Implementation Peer Exchanges

- **Sep. 17-18, Salt Lake City, UT**
- **Nov. 18-19, Columbus, OH**
- **Potential Future Peer Exchange States**
Thank You!

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More
Informed Decision Making

Better
Targeted Investment

Fewer Fatalities & Serious Injuries