Data-Driven Safety Analysis (DDSA)
Implementing Safety Innovations
Every Day Counts 3
DDSA Presentation Overview

• Systemic Approach Overview
• Predictive Approach Overview
• Systemic vs. Predictive
• DDSA Initiative
• Resources
DDSA Presentation Overview

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What is Data-Driven Safety Analysis?

- The application of two science-based analysis approaches into two common transportation processes.
Systemic Approach

• Supplements the traditional site analysis (i.e. “hot-spot”) approach

• Particularly applicable when a significant number of severe crashes happen over a wide area:
  – Rural Roadways
  – Local Roadways
  – May focus on specific crash types
    • Cross-median
    • Pedestrian
    • Curve

May include treating locations that haven’t experienced many crashes
Limitations to the Site Analysis Approach

Crashes on rural roads often account for a high percentage of severe crashes, but the density of crashes on rural roadways is typically low and may not lead to identifying crash concerns within the “traditional” site-based analysis process.

About 57% of fatal crashes are on rural roads.

A further challenge is that crashes on the local system might not have robust data to assist with identifying locations of concern.
Evidence indicates that severe crashes are widely distributed across state and local highway systems, and very few individual locations in rural areas and on local systems experience a high number or sustained occurrence of severe crashes.
An Urban Issue Also

The “low-density” crash challenge is not just a rural issue, but similar situations exist in urban areas, such as crashes involving motorized vehicles and vulnerable road users (e.g., pedestrians, bicyclists, and motorcyclists).
## Fatal crash types

<table>
<thead>
<tr>
<th>Year</th>
<th>2. Type of Collision</th>
<th>Number</th>
<th>Percent</th>
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<tr>
<td>2005</td>
<td>A: Head-On</td>
<td>424</td>
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<td></td>
<td>B: Sideswipe</td>
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<tr>
<td></td>
<td>C: Rear End</td>
<td>305</td>
<td>8%</td>
</tr>
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<td></td>
<td>D: Broadside</td>
<td>720</td>
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</tr>
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<td></td>
<td>E: Hit Object</td>
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<td></td>
<td>F: Overturned</td>
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<td></td>
<td>G: Vehicle/Pedestrian</td>
<td>656</td>
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</tr>
<tr>
<td></td>
<td>H: Other</td>
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<tr>
<td></td>
<td>UN: Unknown</td>
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<td>Others</td>
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<tr>
<td></td>
<td>C: Rear End</td>
<td>325</td>
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<td></td>
<td>D: Broadside</td>
<td>695</td>
<td>18%</td>
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<td>G: Vehicle/Pedestrian</td>
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<td>390</td>
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<td>D: Broadside</td>
<td>608</td>
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<td>E: Hit Object</td>
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<td>G: Vehicle/Pedestrian</td>
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<td>2%</td>
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<td>0%</td>
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<table>
<thead>
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<td></td>
<td>Others</td>
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<tr>
<td>TOTAL</td>
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</table>
Systemic Analysis

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

Source: FHWA Systemic Safety Project Selection Tool
Systemic Problem Identification

- System-wide crash analysis
- Crash characteristics at the system level

Select focus crash type(s) → Select focus facilities → Identify common characteristics

Systemic improvements are widely implemented based on high-risk roadway features correlated with particular severe crash types
NYSDOT chose curve radii as a potential risk factor for rural, undivided, two-lane roadways.

For this facility type, segments with curve radii between 100-300 feet are overrepresented in crash proportion.

NYSDOT selected a curve radius less than 300 feet as a risk factor because the data show that 12 percent of severe crashes occurred in curves with radii less than 300 feet, while only 7 percent of all reviewed curves have radii less than 300 feet.
Based on this descriptive statistics analysis, Thurston County chose Rural Major Collector functional classification as a risk factor.

**Example Application**

Thurston County, WA examined severe curve-related roadway departure crashes on various functional classifications to the proportions represented of the entire County roadway system. The data showed the focus crash type occurs in greater proportion on Rural Major Collectors.

**Evaluation of Roadway Functional Class as a Potential Risk Factor**

![Chart showing the proportion of severe crashes by functional classification.]

- **Rural Minor Arterial**: 1% (Injury), 3% (Fatal/Serious)
- **Rural Major Collector**: 76% (Injury), 76% (Fatal/Serious)
- **Urban Minor Arterial**: 11% (Injury), 9% (Fatal/Serious)
- **Urban Principal Arterial**: 1% (Injury), 2% (Fatal/Serious)
- **Urban Major Collector**: 2% (Injury), 4% (Fatal/Serious)

**Source:** Thurston County, Washington, Department of Public Works
Identifying Systemic Countermeasures

• Initial list of strategies
  – Low cost
  – Significant crash reduction

• Evaluation
  – Effectiveness
  – Implementation costs
  – Policies/practices/experiences
# Systemic Countermeasure Selection

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Countermeasures</th>
<th>Relative Cost to Implement and Operate</th>
<th>Effectiveness</th>
<th>Typical Timeframe for Implementation</th>
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<tr>
<td>15.1 A:</td>
<td>Keep vehicles from encroaching on the roadside</td>
<td>Low</td>
<td>Tired</td>
<td>Short</td>
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<tr>
<td>15.1 A1:</td>
<td>Install shoulder rumble strips</td>
<td>Low</td>
<td>Tired</td>
<td>Short</td>
</tr>
<tr>
<td>15.1 A2:</td>
<td>Install edgelines “profile marking”, edgeline rumble strips or modified</td>
<td>Low</td>
<td>Experimental</td>
<td>Short</td>
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<tr>
<td></td>
<td>shoulder rumble strips on section with narrow or no paved shoulders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.1 A3:</td>
<td>Install midlane rumble strips</td>
<td>Low</td>
<td>Experimental</td>
<td>Short</td>
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<td>15.1 A4:</td>
<td>Provide enhanced shoulder or delineation and marking for sharp curves</td>
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<td>Tired/Proven/Experimental</td>
<td>Short</td>
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<tr>
<td>15.1 A5:</td>
<td>Provide improved highway geometry for horizontal curves</td>
<td>High</td>
<td>Proven</td>
<td>Long</td>
</tr>
<tr>
<td>15.1 A6:</td>
<td>Provide enhanced pavement markings</td>
<td>Low</td>
<td>Tired</td>
<td>Short</td>
</tr>
<tr>
<td>15.1 A7:</td>
<td>Provide skid-resistance pavement surfaces</td>
<td>Moderate</td>
<td>Proven</td>
<td>Medium</td>
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<tr>
<td>15.1 A8:</td>
<td>Apply shoulder treatments</td>
<td>Low</td>
<td>Experimental/Proven</td>
<td>Medium</td>
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<tr>
<td></td>
<td>— Eliminate shoulder drop-offs</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>— Shoulder edge</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>— Widens and/or pave shoulders</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Minnesota Department of Transportation Case Study**
The systemic approach to safety is a data-driven process that involves analytical techniques to identify safety investments not typically identified through the traditional site analysis approach.

The intent of this complementary approach is to supplement traditional site analysis and provide a more comprehensive and proactive approach to preventing the most severe crashes, especially on rural and local roadways.
Systemic Safety Project Selection Tool

- Step-by-step process to conduct systemic safety analysis and planning
- Method for balancing systemic safety improvements and spot safety improvements
- Mechanism to quantify benefits of systemic safety improvements

http://safety.fhwa.dot.gov/systemic/fhwasa13019/
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Predictive Approaches
What is Data-Driven Safety Analysis?

- The application of **two** science-based analysis approaches into **two** common transportation processes
Predictive Analysis - Definition

- Uses crash, roadway, and traffic volume data to provide 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:
  - environmental impacts
  - traffic operations
  - pavement life
  - construction costs
“What gets measured gets done”
“Road safety management is in transition. The transition is from action based on experience, intuition, judgment, and tradition, to action based on empirical evidence, science, and technology...”
HSM Philosophy

- There is no such thing as “absolute safety”
  - There is safety “risk” in all highway facilities
  - Safety risk is also due to environmental conditions and user behavior
- Agencies try to operate and improve roads to the highest level that funding limitations allow

Design choices can reduce the risk of crashes and their severity
Integrating Safety into Decision Processes

“It would cost my agency about $80,000 to construct turn lanes at this two-lane rural road intersection – how can I quantify the expected safety benefits in order to convince my leadership that this is a wise public investment?”
HSM Applications

Decisions requiring quantitative safety estimates

- Identifying crash patterns that differ from “expected”
- Evaluating crash reduction benefits of treatments
- Evaluating design exceptions for safety risk
- Conducting economic appraisals of projects

Estimating the effects of design decisions on crash frequency and severity
HSM Applications

Where does the HSM fit in the Project Development Process?

System Planning
- Long Range Transportation Plans
- Strategic Highway Safety Plans
- Corridor Study

Project Planning
- Corridor study
- Alternatives evaluation
- Designing new network connections

Preliminary Design
- Final Design
- Construction
- Designing a new facility
- Widening an existing roadway
- System upgrades

Operations and Maintenance
- Signal timing/phasing modifications
- Intersection modifications
- Parking management plans
- Traffic impact study
HSM Applications in Project Delivery – Louisiana Case Study

• Seven stages of LDOTD project development
  – Stage 0, Feasibility
  – Stage 1, Planning and Environment
  – Stage 2, Funding Project Prioritization
  – Stage 3, Final Design
  – Stage 4, Letting
  – Stage 5, Construction
  – Stage 6, Operation
HSM Applications in Project Delivery

- **Stage 0, Feasibility**
  - Use CMFs and predictive method to evaluate safety of various design elements or alternatives
HSM Applications in Project Delivery

• Stage 1, Planning and Environment
  – Use CMFs and predictive method to evaluate safety impacts of various design alternatives
  – I-12 to Bush, LA project (IHSDM)
HSM Applications in Project Delivery

• I-12 to Bush Case Study

  – Four alternatives were considered to replace a two-lane, un-divided roadway with a four-lane, divided roadway with controlled access

  – All four alignments predicted a reduction in crashes from the No Build alternative
HSM Applications in Project Delivery

• I-12 to Bush Case Study Overall Comparison

<table>
<thead>
<tr>
<th>Rank</th>
<th>Alternative</th>
<th>Total Crashes</th>
<th>Crashes Reduced</th>
<th>Total Cost of Crashes</th>
<th>Potential Reduction</th>
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<tr>
<td>1</td>
<td>P</td>
<td>820.8</td>
<td>87.3</td>
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<td>2</td>
<td>J</td>
<td>828.2</td>
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<td>3</td>
<td>Q</td>
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<td>4</td>
<td>B/O</td>
<td>902.9</td>
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<td>5</td>
<td>No Build</td>
<td>908.1</td>
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<td>$24,405,965</td>
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</tbody>
</table>

[Image: Diagram of a highway with trees and cars]
HSM Applications in Project Delivery

• Benefits from use of IHSDM
  – Quantify safety costs and benefits
  – Safety given equal weight in comparative analysis

• Corps of Engineers selected Alternative Q, which had a predicted crash reduction of 6% and a $1.5M cost savings to society
HSM Applications in Project Delivery

• Stage 3, Final Design
  – Use CMFs in Design Exceptions to determine safety impacts
  – Use CMFs in Transportation Management Plans to analyze safety impacts of temporary traffic control
HSM Resources

• Provides examples of integrating HSM into project development process

• Discusses application of safety analysis tools such as the Interactive Highway Safety Design Model (IHSDM), SafetyAnalyst, the CMF Clearinghouse, and spreadsheet tools.
HSM Resources

• Integrating the HSM into the project development process
• Examples with step-by-step procedures for HSM application
• Frequently asked questions

Suite of software analysis tools for quantitative evaluation of safety and operational effects of geometric design decisions during the highway design process.

The Crash Prediction Module can evaluate rural two-lane highways, rural multilane highways, urban/suburban arterials, freeway segments, and freeway ramps/interchanges (including ramps, collector-distributor (C-D) roads and ramp terminals).

The current release of IHSDM software may be downloaded free of charge through the IHSDM Public Software Web site, http://www.ihsdm.org.
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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
Predictive and Systemic Approaches

Can be applied in Transportation Management

System Planning
- Long Range Transportation Plans
- Strategic Highway Safety Plans
- Corridor Study

Project Planning
- Corridor Study
- Alternatives Evaluation
- Designing new network connections

Preliminary Design
- Designing a new facility
- Widening an existing roadway
- System upgrades

Final Design

Construction

Operations & Maintenance
- Signal Timing/Phasing Modifications
- Intersection Modifications
- Parking Management Plans
- Traffic Impact Study
Transportation Processes

Safety Management

Systemic
- Problem Identification
  - Countermeasure Selection
    - Project Prioritization
      - Project List
        - Implementation
          - Evaluation

Predictive
- Countermeasure Selection
  - Problem Identification

Project Development

Systemic
- Project Planning
  - Alternatives Identification
    - Alternatives Evaluation
      - Preliminary Design
        - Final Design

Predictive
- Alternatives Identification
  - Project Planning

Systemic
- SaA Safety Analyst

usRAP
- Systemic

ISATe, Spreadsheets
Our ultimate performance measure
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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 for DDSA

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.
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
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What does FHWA offer?

- **Technology Transfer**
  - Presentations
  - Training
  - Peer Exchange

- **FREE Technical Assistance**
  - Safety Management & Project Development
  - Systemic and Predictive Analyses

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More Informed Decision Making
Better Targeted Investments
Fewer Fatalities & Serious Injuries

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