Interactive Highway Safety Design Model (IHSDM)

Traffic Records Forum
Biloxi, MS
October 28, 2012
Agenda

• Welcome and Introductions
• IHSDM – A Quantitative Approach to Evaluating Highway Safety
• IHSDM Workflow
• IHSDM 2012 Demonstration
• Hands-on Exercise
• Questions / Discussion
IHSDM: A Quantitative Approach to Evaluating Safety
What is IHSDM?

• A product of FHWA’s Safety Research and Development Program

• A suite of software tools that support project-level geometric design decisions by providing quantitative information on the expected safety and operational performance
What Benefits does IHSDM Provide?

- IHSDM results help project developers make design decisions that improve the expected safety performance of designs.

- IHSDM helps project planners, designers, and reviewers justify and defend geometric design decisions.
How do you or your agency currently evaluate highway safety?
Nominal vs. Substantive Safety

Nominal Safety
• (Compliance)

Substantive Safety
(Performance)
May be **nominally** safe, but could **exhibit poor substantive safety performance.**
## Safety Matrix

<table>
<thead>
<tr>
<th>Nominal Safety</th>
<th>Meets</th>
<th>Does Not Meet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substantive Safety</strong></td>
<td></td>
<td></td>
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<tr>
<td>“Meets”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Does Not Meet”</td>
<td></td>
<td></td>
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**IHSDM**

U.S. Department of Transportation
eral Highway Administration
IHSDM

- Enables more informed decision-making
- Helps explain decisions to stakeholders
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<tr>
<th>IHSDM Evaluation Module</th>
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<td>Intersection Review</td>
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<td>Driver/Vehicle</td>
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What Highway Types can the 2012 Release Evaluate?

• Facility types:
  – Two-lane rural highways (All Modules)
  – Multilane rural highways (Crash Prediction)
  – Urban & suburban arterials (Crash Prediction)
  – Freeways (Crash Prediction)

• Existing and proposed alternative highway geometric designs
Data Needs

- Vary by IHSDM evaluation module (and by highway type in CPM)
- All modules require at least horizontal and vertical alignment data
- Highway Segment Data (all modules)
- Intersection Data (CPM, IRM)
- Crash Data (CPM – optional)
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Crash Prediction Module

Scope

- Estimates expected crash frequency (i.e., Substantive Safety) based upon roadway geometry and traffic volumes
Crash Prediction Module (CPM)

Typical Uses

- Predicts crash frequency for highway segments and intersections
- Evaluates the safety impact of highway improvements/treatments
- Compares relative safety performance of design alternatives
- Assesses safety cost effectiveness of design decisions
Relationship between IHSDM CPM and the HSM

A. Introduction and Fundamentals
B. Roadway Safety Management Process
C. Predictive Method (IHSDM CPM)
   Chapter 10: Rural, Two–Lane Roads
   Chapter 11: Rural, Multilane Highways
   Chapter 12: Urban & Suburban Arterials
   Chapter 18 (draft): Freeways (Beta version)
   Chapter 19 (draft): Ramps (future)
D. Crash Modification Factors
## Crash Prediction Models

<table>
<thead>
<tr>
<th>Highway Segments</th>
<th>2R</th>
<th>MR</th>
<th>U/SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-lane undivided (2U)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-lane divided (2D)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-lane w/TWLTL (3T)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-lane undivided (4U)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4-lane divided (4D)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5-lane arterial w/TWLTL (5T)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
## Crash Prediction Models

<table>
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<th>Intersections</th>
<th>2R</th>
<th>MR</th>
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<tr>
<td>3-leg STOP-control on minor</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3-leg Signalized</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4-leg STOP-control on minor</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4-leg Signalized</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
## Crash Prediction Models

<table>
<thead>
<tr>
<th>Freeway Segments and Speed Change Lanes</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>4–Lanes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6–Lanes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8–Lanes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10–Lanes</td>
<td></td>
<td>X</td>
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</tbody>
</table>
Estimating Expected Crashes

- Model components for crash prediction:
  - Safety Performance Functions (SPFs) (i.e., “base models”)
  - Crash Modification Factors (CMFs)
  - Calibration Factors
  - Site–specific crash history (Empirical–Bayes process)
Calibration

- HSM Appendix to Part C: The purpose of the calibration procedure “is to adjust the predictive models which were developed with data from one jurisdiction for application in another jurisdiction.”
CPM Calibration Utility

- Assists agencies in implementing the calibration procedures described in the Appendix to HSM Part C
  - Organizes Required and Desired Data
  - Calculates Calibration Factors
- Allows agencies to enter their own SPF s and to modify default crash distributions
Summary: IHSDM CPM Capabilities

- Fully implements HSM Part C Predictive Methods
- Can evaluate many highway segments/intersections over a number of years
- Automatically segments the highway into homogeneous segments as per HSM Part C
- Can handle complex (and simple) alignments
- Seamlessly evaluates a highway that changes facility type (e.g., rural 2-lane to rural multilane)
- Full implementation of Empirical-Bayes procedure
- Incorporates Calibration Factors from IHSDM Calibration Utility
Looking Ahead…

• The latest CPM enhancements represent the first phase towards full implementation in IHSDM of future HSM Chapter 18 (Prediction Methods for Freeways) and Chapter 19 (Prediction Method for Ramps).
Looking Ahead...

- **Crash Prediction Module:**
  - Freeways:
    - Calibration – add “calculate using site data”
  - Ramps/Interchanges:
    - Faithfully implement methods described in draft HSM Chapter 19 (Predictive Method for Ramps) for:
      - Ramps
      - Collector–Distributor (C–D) Roads
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Policy Review Module

Scope

- Checks roadway segment geometry against relevant design policy and “flags” variations
Policy Review Module
Policy Check Categories

- Cross-Section (7 checks)
- Horizontal Alignment (4 checks)
- Vertical Alignment (2 checks)
- Sight Distance (3 checks)
Policy Review Module
Stopping Sight Distance Graphs
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• Estimates 85th percentile speed profile along alignment to evaluate operating speed consistency
Design Speed vs. Design Consistency

• Will this driver anticipate...this curve?
Traffic Analysis Module

Scope

- Traffic simulation model
- Estimates traffic quality of service measures (mean speeds; % following)
- Helps evaluate climbing and passing lane alternatives, volume, and capacity
Traffic Analysis Module
Mean Speed and % Following
Intersection Review Module

Scope

• Expert system that applies rules of good practice in a comprehensive diagnostic review of a single intersection

• Identifies possible safety concerns and typical treatments
<table>
<thead>
<tr>
<th>Scope</th>
<th>Status</th>
<th>Concern</th>
<th>Category</th>
<th>Road</th>
<th>Threshold</th>
<th>Comment</th>
<th>Design Improvements</th>
<th>Mitigation Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersection</td>
<td>Level 2</td>
<td>Large intersection pavement area</td>
<td>Skewed</td>
<td>52.9530 (deg)</td>
<td>60.0000 (deg)</td>
<td>Skewed intersection, large vehicle turn path</td>
<td>1. Realign one or more legs.</td>
<td>1. Move stop bar</td>
</tr>
<tr>
<td>Leg #1 - SE</td>
<td>Level 1</td>
<td>Loss of control potential due to frequent braking</td>
<td>Safety</td>
<td>5 (mph)</td>
<td>6 (mph)</td>
<td>Horizontal curve, Simple Curve 12+861.286 to 13+855.184 direction=left radius=820.21 ft</td>
<td>1. Relocate intersection.</td>
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<tr>
<td>ihsdm pike</td>
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<td>2. Increase curve radius.</td>
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<td>3. Provide left-turn lane.</td>
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<td>4. Provide right-turn lane.</td>
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<td>5. Increase superelevation.</td>
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<td>6. Improve drainage.</td>
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<td>1. Provide more skid resistant pavement.</td>
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<td>2. Post advisory speed.</td>
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<td>3. Reduce speed limit.</td>
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<td>4. Install warning sign.</td>
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<td></td>
<td>5. Increase signal clearance on all-red time.</td>
<td></td>
</tr>
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Driver/Vehicle Module

Scope

- Simulates driving behavior and vehicle dynamics on a two-lane highway

- Provides profiles of predicted speed and other response variables, via a simulation of a single driver/vehicle combination
Driver Vehicle Module
IHSDM Workflow

Establish project goals

1. Create a project
2. Establish highways & intersections/ input data
3. Run evaluation module(s)
4. View results (output)

Synthesize IHSDM Output
IHSDM User Interface

- **Menu Bar**
- **Navigation Tree**
- **Operations Panel**
- **Message Box**

**Desktop**
Data Input Options

Add data via the IHSDM Highway Editor

Export data from design software into LandXML format -- then import into IHSDM

Copy and paste data from a spreadsheet
Data Requirements – Highway Editor

**Tip:** The highway data editor has several new features to help facilitate manual data entry. For more information, click here.
Data Requirements – Highway Editor

Data that has been input

Data not input, but non-essential

Required data that are missing
IHSDM Demonstration

- IHSDM 2012 Release (version 8.0.0; September 27, 2012)
• Download: http://www.ihsdm.org

• Technical support:
  – IHSDM.Support@dot.gov
  – (202)-493-3407

• Training:
  – On-Site: FHWA–NHI–380071
  – Web-based: FHWA–NHI–380100
  – See NHI catalog at http:// nhi.fhwa.dot.gov
Hands-On Exercise

- Using IHSDM 2012 Release (version 8.0.0; September 27, 2012):
  - Evaluate a Rural 2–Lane Highway
  - Evaluate an Urban 6–Lane Freeway
Who Uses IHSDM?

- Those involved in the highway design process (Designers, Planners, Reviewers)
- State/Local DOTs and their consultants
- FHWA Federal Lands Highway Divisions
- Transportation Researchers
- Universities (Research and Academic Use)
- International users
Typical IHSDM Applications

• Evaluate relative safety impacts of alternative designs for EIS
• Evaluate expected safety impacts of recently completed improvements
• Safety analysis of preliminary construction plans
• Evaluate operational impacts of passing/climbing lanes
• In conjunction with Road Safety Audits
Typical IHSDM Applications

- Quantify relative safety/operational performance of alternatives and compare against other (e.g., environmental, cost) impacts
- Refine alternatives to optimize safety and operational performance
- Evaluate / prioritize 3R safety improvements
- Verify design exception areas
Mike Dimaiuta
ihsdm.support@dot.gov; (202)-493-3407