What is the **intent** of the safety analysis for a transportation improvement project?

To help make more informed project design decisions.
The safety analysis should help guide design decisions in effort to:

- Mitigate existing risk features that potentially contribute to increased number and severity of crashes
- Reduce future safety risks by making effective and efficient design choices
Good design is more than just looking up values “in the book”

It’s applying engineering knowledge of the relationship between design factors and the “safety performance” of the facility
IHSDM: A Quantitative Approach to Evaluating Highway Safety
What is IHSDM?

- 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.
Potential IHSDM Applications

- As a tool to identify facilities where the “safety performance” is worse than expected
- Assists in making decisions where to invest limited resources in ways that will clearly improve safety performance

“... evolution in safety analysis from descriptive methods to quantitative, predictive analysis”

AASHTO Highway Safety Manual – Chapter 1 Introduction and Overview
Potential IHSDM Applications

- As a tool to assess the safety “benefit” when conducting a B/C analysis
  - Predict crashes before and after reconstructing or improving a facility
Potential IHSDM Applications

• As a tool to assess design options:
  – Evaluate alternatives
  – Evaluate proposed design exceptions
  – Evaluate and refine preliminary geometry
IHSDM: A Quantitative Approach

- Enables more informed decision-making
- Helps explain decisions to stakeholders
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What Highway Types can IHSDM Evaluate?

- **Facility types:**
  - Two-lane rural highways *(All Modules)*
  - Multilane rural highways *(Crash Prediction & Policy Review)*
  - Urban & suburban arterials *(Crash Prediction)*
  - Freeway segments *(Crash Prediction)*
  - Freeway ramps/interchanges *(Crash Prediction)*

- **Existing and proposed alternative highway geometric designs**
Data Needs

• Vary by IHSDM evaluation module (and by highway type in CPM)

• Highway Segment Data (all modules)
• Intersection Data (CPM, IRM)
• Interchange Data (CPM)
• Crash Data (CPM – optional)
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Crash Prediction Module (CPM) Typical Uses

- Predicts crash frequency for highway segments, intersections and interchanges
- Evaluates the safety impact of highway improvements/treatments
- Compares relative safety performance of design alternatives
- Assesses safety cost effectiveness of design decisions
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: Freeways
   Chapter 19: Ramps
D. Crash Modification Factors
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)
Predictive Method for:
• Freeways
• Ramps
• Implements methods described in HSM 2014 Supplement, including the Calibration procedure
CPM for Freeways / Ramps

Capabilities

• Evaluation of freeway segments, including segments with speed change lanes

• Evaluation of freeway ramps / interchanges, including:
  – Ramps
  – Collector–Distributor (C–D) Roads
  – Ramp Terminals
CPM for Freeways/Ramps

Capabilities

- CPM automatically segments highways for evaluation (including freeway segments, ramps and C–D roads), following HSM Chapters 18/19

- Application of the Empirical–Bayes (EB) process to factor in historical crash data – for freeway segments, ramps, C–D roads and ramp terminals
CPM Data Needs

- Highway Segment Data
- Intersection Data
- Crash Data (optional)

CPM data needs vary by highway type:
- Rural 2-lane Highways (2R)
- Multilane Rural Highways (MR)
- Urban/Suburban Arterials (U/SA)
- Freeways (F)
For all HSM Part C chapters:

“The definitions of roadway segments and intersections... are the same as those used in the FHWA IHSDM.”

From HSM Ch. 10, p. 10–11:
Site–Specific Crash Data (Empirical–Bayes Process)

- Improves accuracy of estimates for a particular highway.
- Captures effects of many factors not in model or CMFs.
- Has a synergistic effect when combined with a model estimate of producing data that is more accurate than either component could produce alone.
CPM Output

- **Highway data**
- **Evaluation Report**
  - Crash frequency and rate
  - Crash type distribution
- **Graphs**

### Table 8: Expected Crash Rates and Frequencies

<table>
<thead>
<tr>
<th>Description</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Crashes</td>
<td>73.46</td>
</tr>
<tr>
<td>Fatal and Injury Crashes (32%)</td>
<td>23.47</td>
</tr>
<tr>
<td>Property-damage-only Crashes (68%)</td>
<td>49.98</td>
</tr>
<tr>
<td>Average Future Road ADT (vehicles/day)</td>
<td>7,000</td>
</tr>
<tr>
<td>Crash Rate per miles per year</td>
<td>4.5</td>
</tr>
<tr>
<td>Fatal and Injury Crash Rate per miles per year</td>
<td>1.4</td>
</tr>
<tr>
<td>Property-damage-only Crash Rate per miles per year</td>
<td>3.1</td>
</tr>
<tr>
<td>Total travel (million vehicle-miles)</td>
<td>41.47</td>
</tr>
<tr>
<td>Crash Rate per million vehicle-miles</td>
<td>1.8</td>
</tr>
<tr>
<td>Fatal and Injury Crash Rate per million vehicle-miles</td>
<td>0.6</td>
</tr>
<tr>
<td>Property-damage-only Crash Rate per million vehicle-miles</td>
<td>1.2</td>
</tr>
</tbody>
</table>
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 SPFs and to modify default crash distributions
Why use IHSDM to implement HSM Part C Methods?

- Can evaluate many highway segments, intersections and interchanges over a number of years
- “Station–Based” Data Input automatically segments the highway into homogeneous segments as per HSM Part C
- “Site–Based” Data Input – especially useful for projects where detailed, station–based geometry not available
Why use IHSDM to implement HSM Part C Methods?

- Can handle complex (and simple) alignments
- Seamlessly evaluates a highway that changes facility type (e.g., rural 2-lane to rural multilane)
- Implements the Empirical-Bayes procedure
Why use IHSDM to implement HSM Part C Methods?

- IHSDM “Navigation tree” helps users to organize projects, highways, evaluations, etc.
- Evaluation Reports and Graphs provide extensive documentation of results / output
- Highway Viewer provides graphical representation of design
Why use IHSDM to implement HSM Part C Methods?

• Extensive documentation in “Help Browser”
• Tutorial provides step-by-step “soup to nuts” guidance
• IHSDM Administration Tool includes a Calibration Utility to help agencies implement HSM Calibration Procedures
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Policy Review Module

Scope

- Checks roadway segment geometry against relevant design policy and “flags” variations
- Applies to rural 2-lane and rural multilane highways
Policy Review Module
Policy Check Categories

- Cross-Section
- Horizontal Alignment
- Vertical Alignment
- Sight Distance
Policy Review Module
Stopping Sight Distance Graphs
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Design Consistency Module

Scope

• Estimates 85th percentile speed profile along alignment to evaluate operating speed consistency
Design Consistency Module
Estimated Operating Speed Profile
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

Elevation (ft)

Radius (ft)

Following (%)

Speed (mph)

Station
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 Ihsdm pike</td>
<td>Level 1</td>
<td>Loss of control potential due to frequent braking</td>
<td>Safety margin</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. 2. Increase curve radius. 3. Provide left-turn lane. 4. Provide right-turn lane. 5. Increase superelevation. 6. Improve drainage.</td>
<td>1. Provide more skid resistant pavement. 2. Post advisory speed. 3. Reduce speed limit. 4. Install warning sign. 5. Increase signal clearance on all-red time.</td>
</tr>
</tbody>
</table>
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
Establish project goals

1. Create a project
2. Establish highways, intersections, and interchanges; 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, Intersection Editor or Ramp Terminal Editor; or via the IHSDM Site Set Editor

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

Copy and paste data from a spreadsheet
Typical IHSDM Applications

- Evaluate relative safety impacts of alternative designs for EIS (CPM+)
- Evaluate expected safety impacts of recently completed improvements (CPM+)
- Safety analysis of preliminary construction plans (CPM+)
- Evaluate operational impacts of passing/climbing lanes (TAM)
- In conjunction with Road Safety Audits (CPM, DCM, IRM, PRM)
Typical IHSDM Applications

- Quantify relative safety/operational performance of alternatives and compare against other (e.g., environmental, cost) impacts (CPM, TAM+)
- Refine alternatives to optimize safety and operational performance (All)
- Evaluate / prioritize 3R safety improvements (All)
- Verify design exception areas (PRM, CPM)
2015 Release

- Download: http://www.ihsdmm.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