The Highway Safety Manual and Related Initiatives in the United States

(or.. “When is Someone Going to Do Something about Highway Safety?”)

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Objectives for the Presentation

- Background
- Overview of the Highway Safety Manual
- Overview of other major safety initiatives
- Final Observations

The Problem -- Today

Highway deaths have remained relatively constant– 42,884 in 2003 and 42,636 in 2004…the number of people who fill this football stadium.

- The fatality rate is unacceptably high: **1.48 deaths per 100 million VMT**
- **Total economic cost of roadway crashes: $230 billion a year. (Yr 2000 $'s)**

American Association of State Highway and Transportation Officials (AASHTO) National Highway Safety Goal

- Reduce fatalities by 1,000 per year; thus saving a cumulative total of over 50,000 lives within the next decade
- Reduce fatalities by one-half over the next 20 years

So…. When is someone going to do something about the highway safety problem in the United States

That is, we need new approaches to an old problem

What do we mean by "Safety?"

- *Subjective*: How road-user feels
- *Nominal*: How safe we think a design is (based upon meeting design criteria)
- *Objective Measure of Safety*:
  - Expected Number of Crashes, by Type and Severity

Our decision-making is complex - we must make trade-offs & choices

MOBILITY

COST

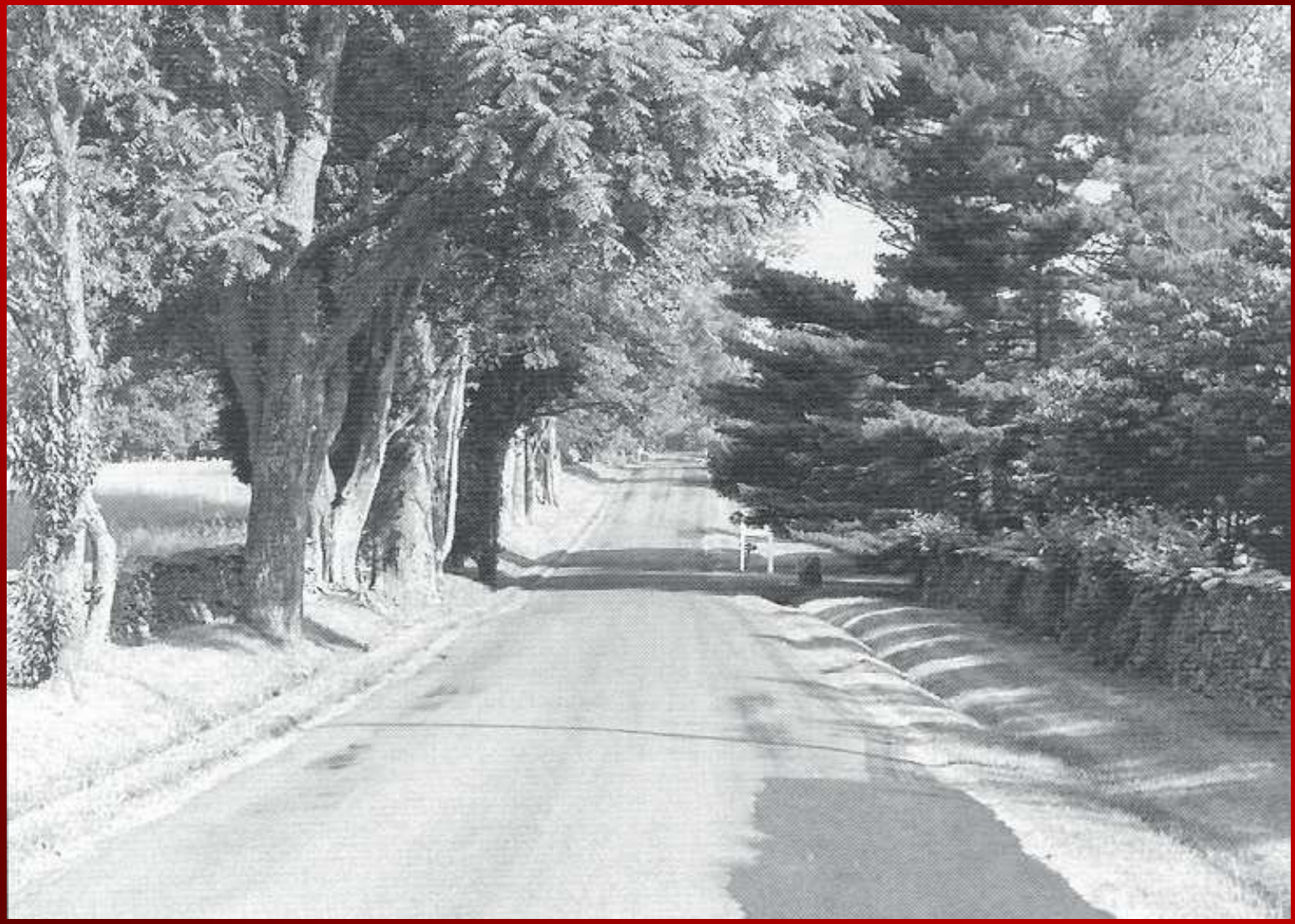
COMMUNITY VALUES

ENVIRONMENT

SAFETY

ACCESSIBILITY

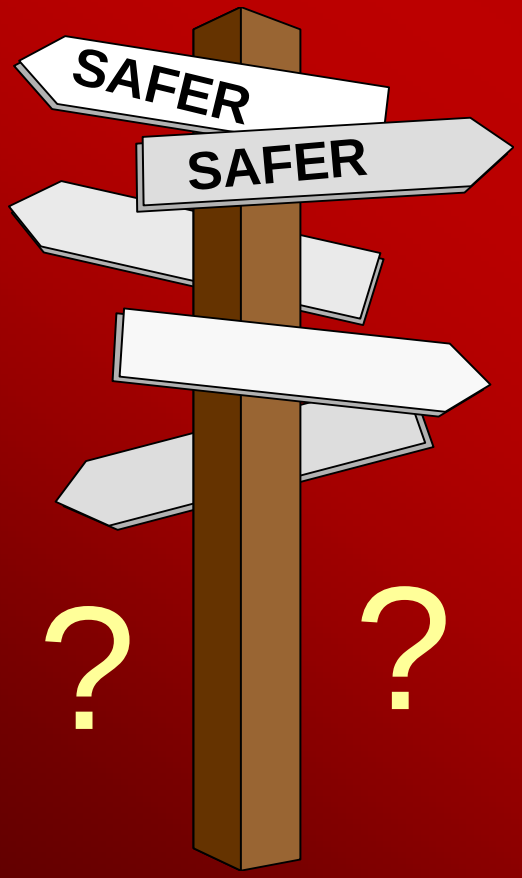
How Safe is This Road?



How do we evaluate choices such as these? What safety criteria do we apply?

The 'good news' (?) – There is a lot of information on substantive safety!

The ‘bad news’ is that many study results are problematic



- Poor study design & analysis
- Highly variable results
- Limited reproduction of results
- Most sources are regarding nominal safety

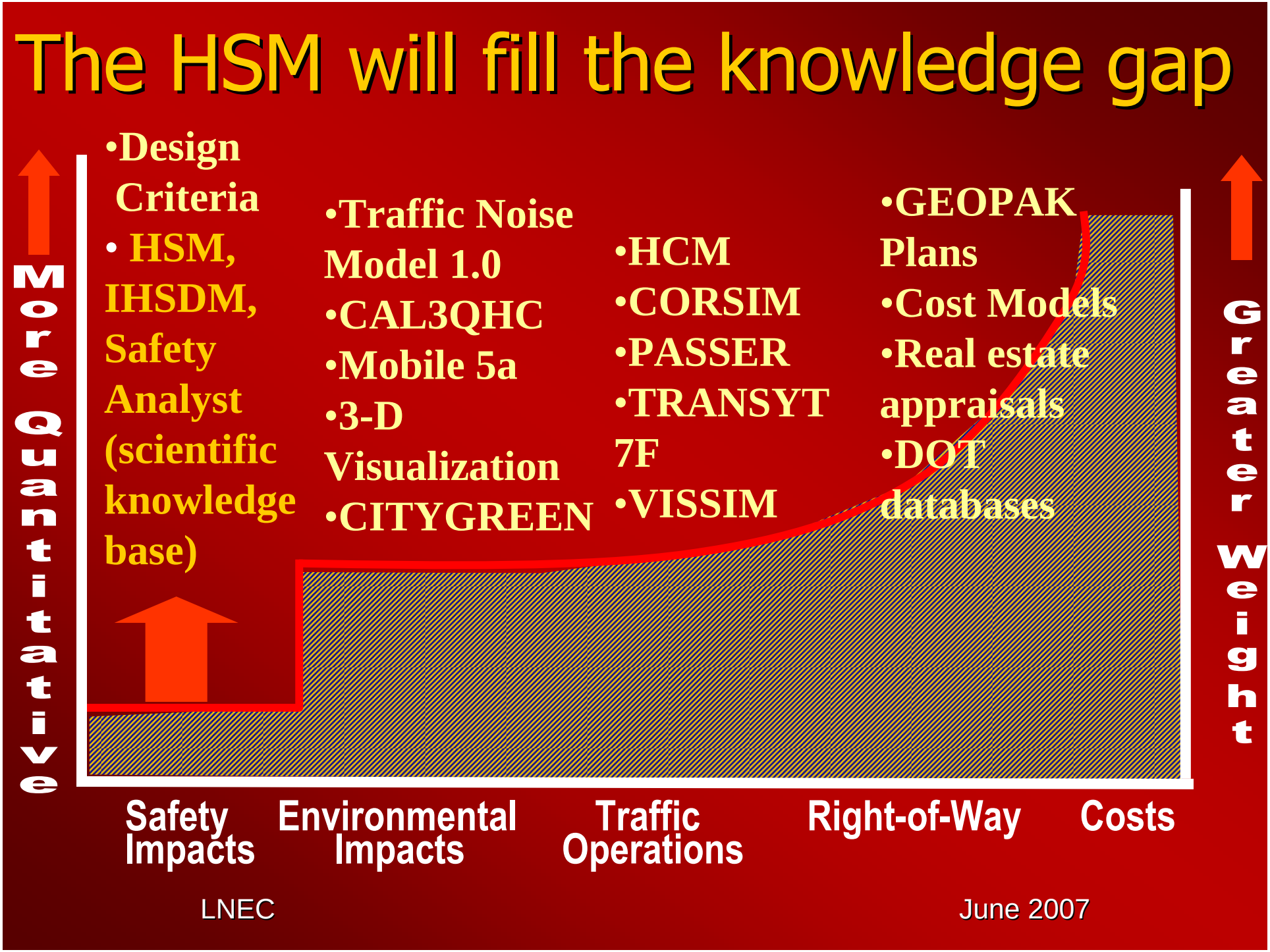
New Safety Analysis Initiative in US – A Highway Safety Manual

- Sponsor: The Transportation Research Board (TRB)
- Task Force to Develop a Highway Safety Manual (HSM)
- Funds from National Cooperative Highway Research Program (NCHRP)
- Some Federal Funds (FHWA)
- Published by AASHTO

The Highway Safety Manual (HSM)

- Help planners and designers answer the questions just raised
- To provide the *best factual information* and tools available, in a *useful* form, to facilitate roadway planning, design, operations, and maintenance decisions based upon *explicit consideration of their safety consequences*

The HSM will fill the knowledge gap



First Edition of the HSM

Part I – Introduction & Fundamentals

Part II – Knowledge

Part III – Predictive Methods

Part IV – Safety Management of a Roadway System

Part V – Safety Evaluation

Glossary

Chapters 1 & 2

- 1- Introduction & Overview
- 2- Fundamentals
  - What is Safety
  - How is Safety Measured
  - Effect of traffic volume and vehicle mix
  - Safety Performance Functions (SPF) & Accident Modification Factors (AMF)
  - Human Factors in Road Safety
  - Speed and Safety

Part II – Knowledge

- Focus of content is Accident Modification Factors (AMF)
- Expressed as multipliers

1.08 = 8% increase in expected crashes

0.89 = 11% decrease in expected crashes

- Plus other information on safety effects
- Provide best available safety-related knowledge

Example Format

Exhibit 3-38: Safety effects of installing continuous shoulder rumble strips on multi-lane highways (61)

Treatment	Setting Road type	Traffic Volume	Accident type Severity	AMF	Std. Error
Install continuous milled-in shoulder rumble strips	Rural Multi-lane divided	2,000 to 50,000 veh/day	All types All severities	**0.84**	**0.1**
			All types Injury	*0.83*	*0.2#*
			SV ROR All severities	*0.90**	*0.3#*
			SV ROR Injury	*0.78*	*0.3#*

NOTE: SV ROR = Single Vehicle Run-off-road accidents
Observed variability suggests less confidence than the AMF values in bold. See Chapter 1.
* Observed variability suggests that this treatment could result in a benefit or a disbenefit. See Chapter 1.

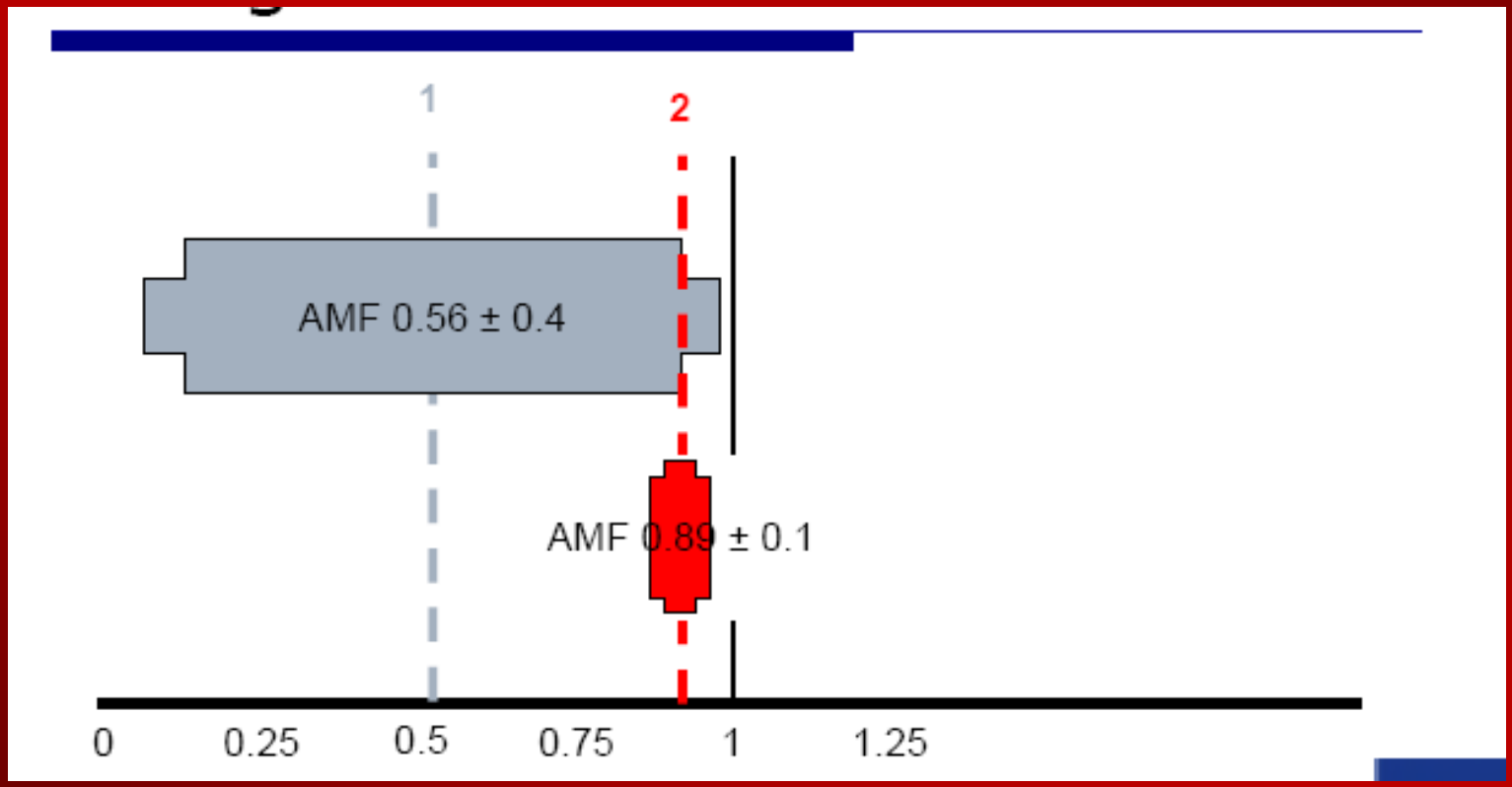
Rumble Strips
Rural Multi-lane Divided

Crash Type	Severity	AMF	Std. Error
All	All	0.84	0.1
All	Injury	0.83	0.2
SV ROR	All	0.90	0.3
SV ROR	Injury	0.78	0.3

Method Used for Knowledge Base

- Documented - over 600 publications
- Range of study types (cross-section, before-after, empirical Bayes, etc)
- Correction of AMFs made for known bias:
  - Method multipliers quantifying accuracy and reliability
  - Calculation & modification of standard error
  - Changes in traffic volume
  - Regression-to-the-mean

Differences in Precision: How do we treat this?



5 Levels of Knowledge Used in HSM

1. Safety effect is well established:
   std error ≤ 0.1
2. Safety effect appears to exist:
   0.1 < std error ≤ 0.3
3. Safety effect not reliably quantified:
   std error > 0.3
4. Information insufficient to determine safety effect
5. No information available (yet)

Method Used for Knowledge Base

- HSM AMFs pass a rigorous threshold before being included
- Accuracy shown by standard error
- In conclusion: an AMF, for a given treatment, included in the HSM, is of sufficient certainty that its value is unlikely to change significantly with new evaluations

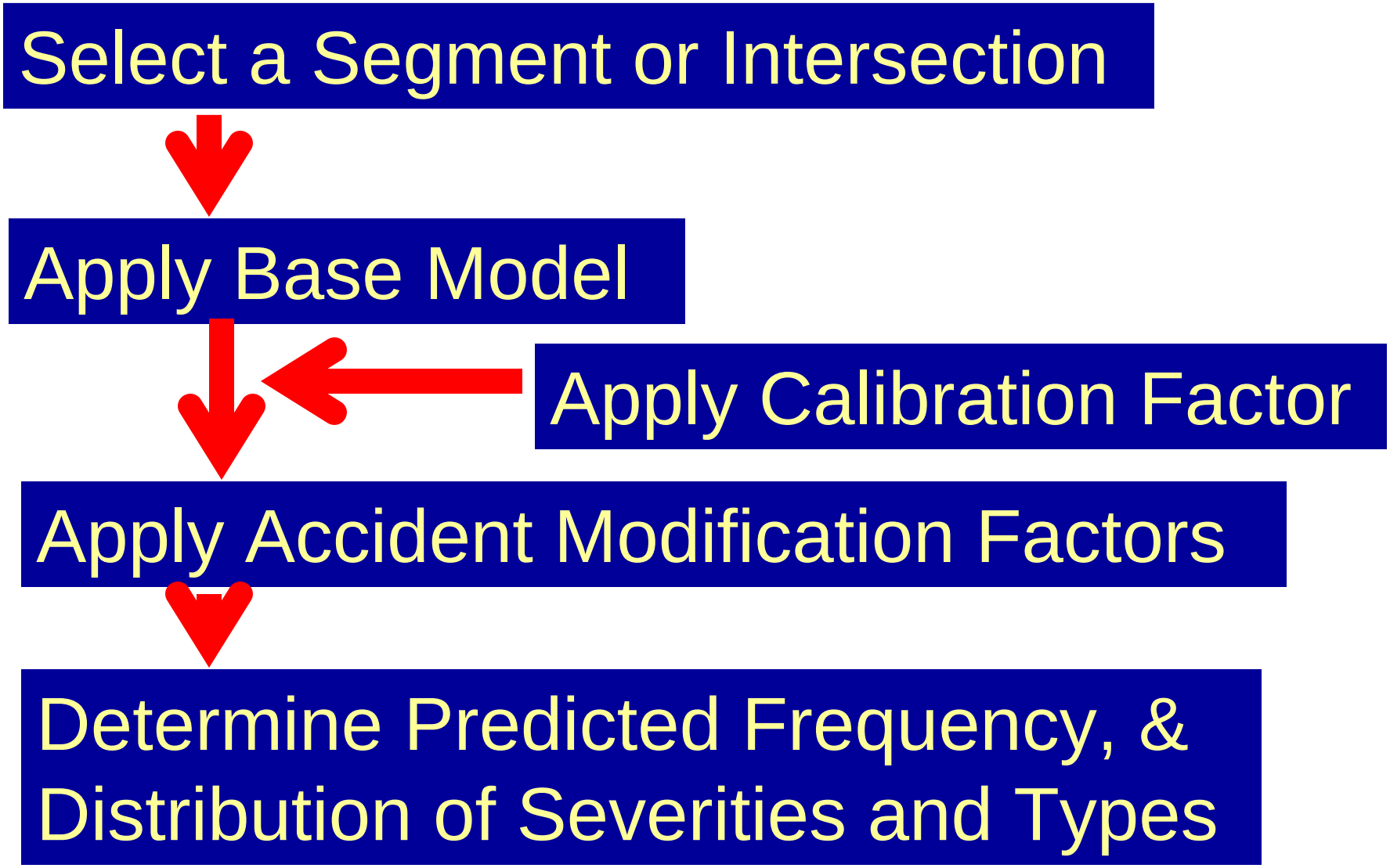
Part II – Knowledge Divided into Five Chapters

- Roadway Segments
- Intersections
- Interchanges
- Special Facilities and Geometric Situations
- Road Networks

Part III – Predictive Methods (Initial Version)

- Rural Two-Lane Highways
- Urban/Suburban Highways
- Rural Multi-lane Highways
- Applicable for Existing Facilities & Planned Improvements

Proposed Prediction Method



Base Models are Derived from General Prediction Models

- Relates Objective Measure to Key Geometric and Operational Features
- Usually Use Regression Analyses
- Used Data from States in a Federal Data Base (HSIS)
- Base Condition Defined and Applied to Regression Equation
- Result is Base Model

Regression Model – Example for Two-Lane Rural Road Segment

- Nbr = EXPOSURE exp (A)(B)
- A= (0.6409 + 0.1388STATE – 0.0846LW – 0.0688RHR + 0.0084DD)
- B=(∏WHiexp(0.0450DEGi))(∏WViexp(0.4652Kj))(∏WGiexp(0.1048GRi))
- WXi are weighting factors for sections along the segment being analyzed

Base Conditions (Not "Ideal")

Variable	Base
Lane width (LW)	12 ft
Shoulder width (SW)	6 ft
Roadside hazard rating (RHR)	3
Driveway density (DD)	5/mi
Horizontal curvature (*DEGi)*	None
Vertical curvature (*Kj)*	None
Grade (*GRi)*	Level

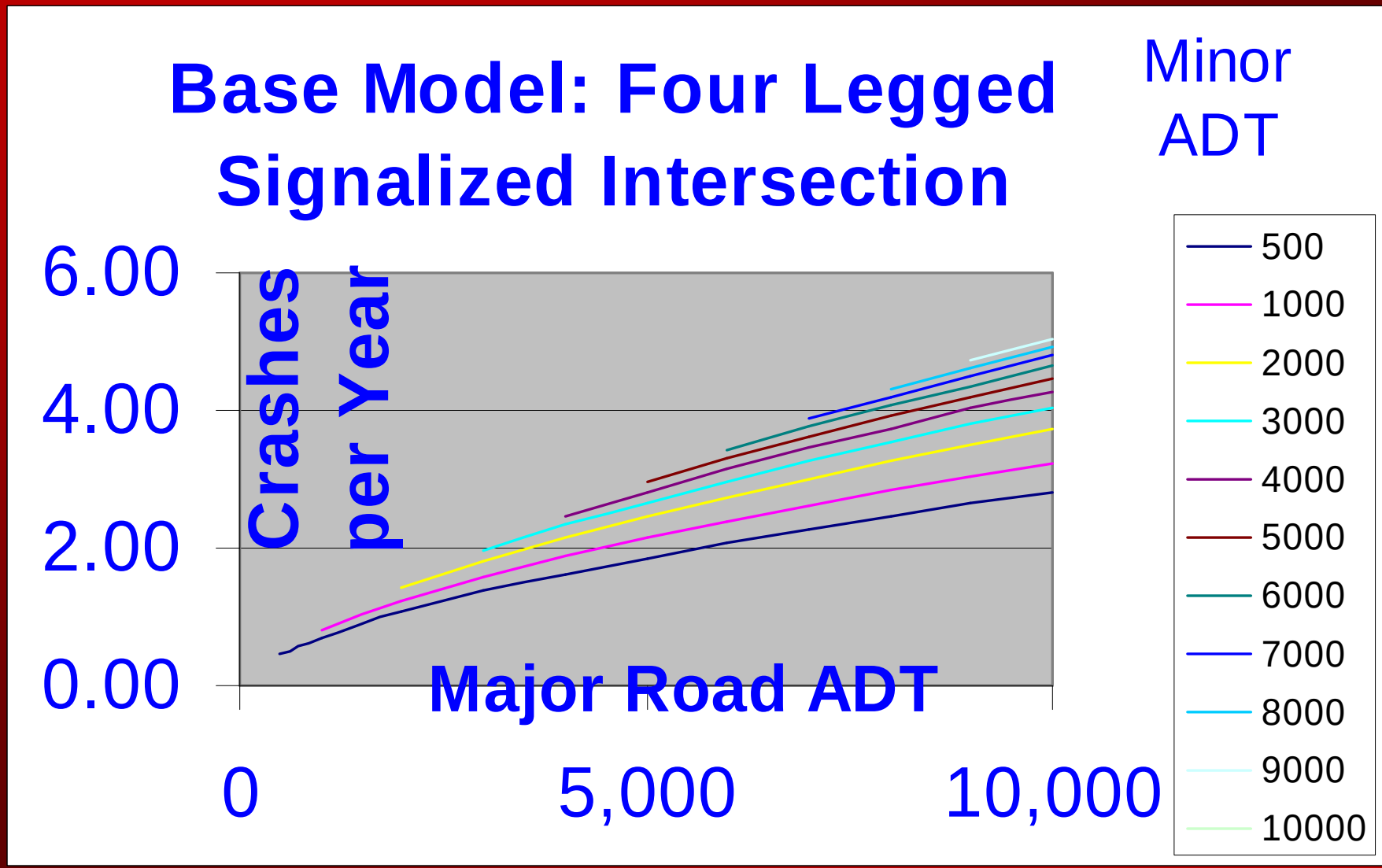
Base Model (Base Conditions) Rural Two-Lane Highways (SPF)

- $Nbr = (ADT)(L)(365)(10^{-6})\ exp(-0.4865)$

Reduced From

- Nbr = EXPO exp (A)(B) , where:
- A= (0.6409 + 0.1388STATE – 0.0846LW – 0.0688RHR + 0.0084DD)
- B=(∏WHiexp(0.0450DEGi))(∏WViexp(0.4652Kj)) (∏WGiexp(0.1048GRi))

Example Base Model - Signalized



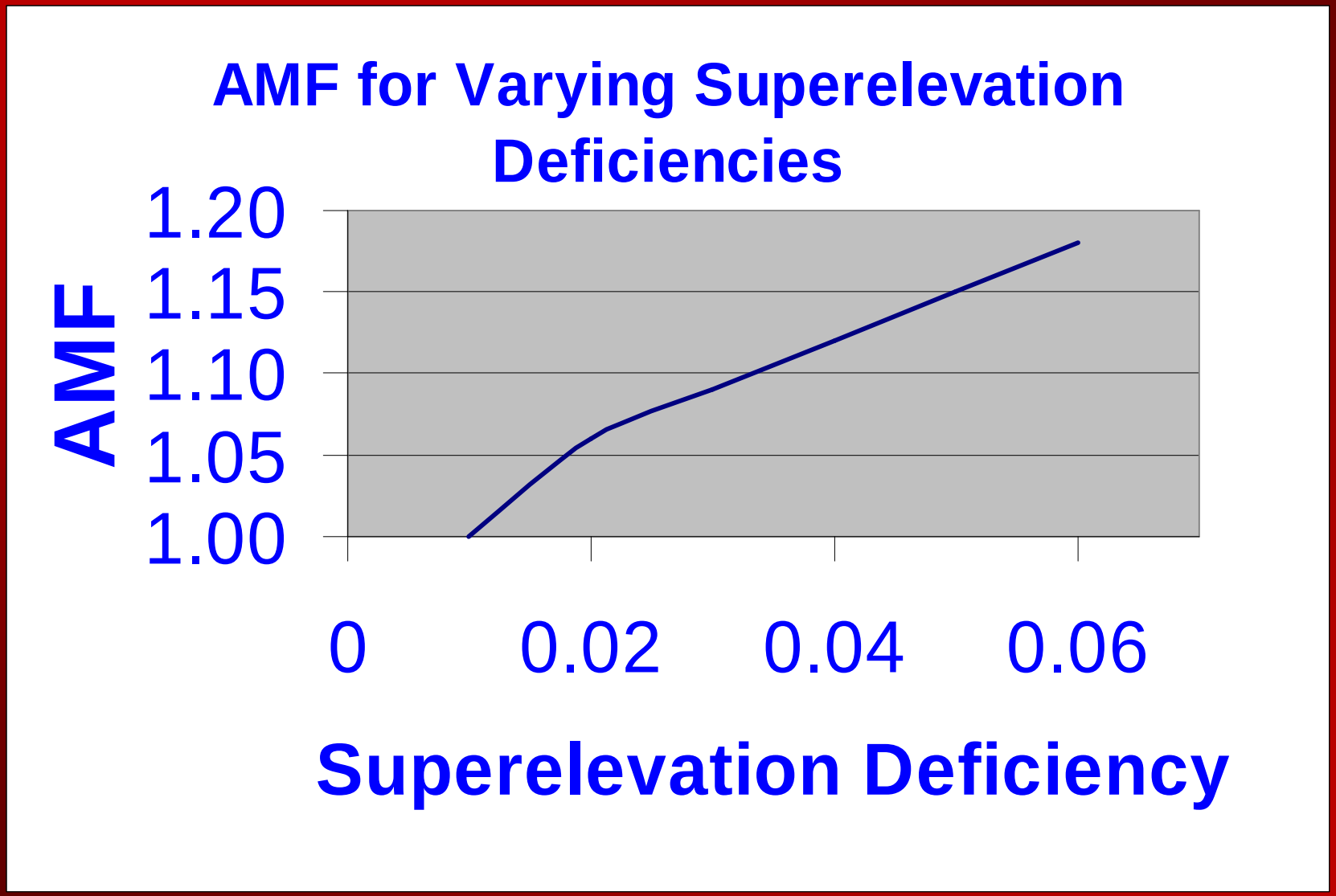
SPF - Method for Application of AMFs

- *Nrs = Nbr Cr (AMF1r, AMF2r, …AMFnr)*
- Where:
  - *Nrs* = predicted number of total roadway segment accidents per year
  - *Nbr* = predicted number for base conditions;
  - *Cr* = calibration factor for use for a particular geographical area.
  - *AMF1r, … AMFnr* = accident modification factors for each key geometric and operational feature

How Were Proposed AMFs Determined?

- Collective judgment of an expert panel
- Based upon comprehensive literature review by the expert panel.
- Different from AMFs in Part II (?)

Example AMF – Two Lane Segment



Existing Facilities (History Available) Use Bayesian Approach

- *Estimate of the Expected Accidents for a segment or intersection*

$$A_E = W*A_{ES} + (1-W)A_C$$

Where:

W = Weight ($0 \leq Weight \leq 1$)

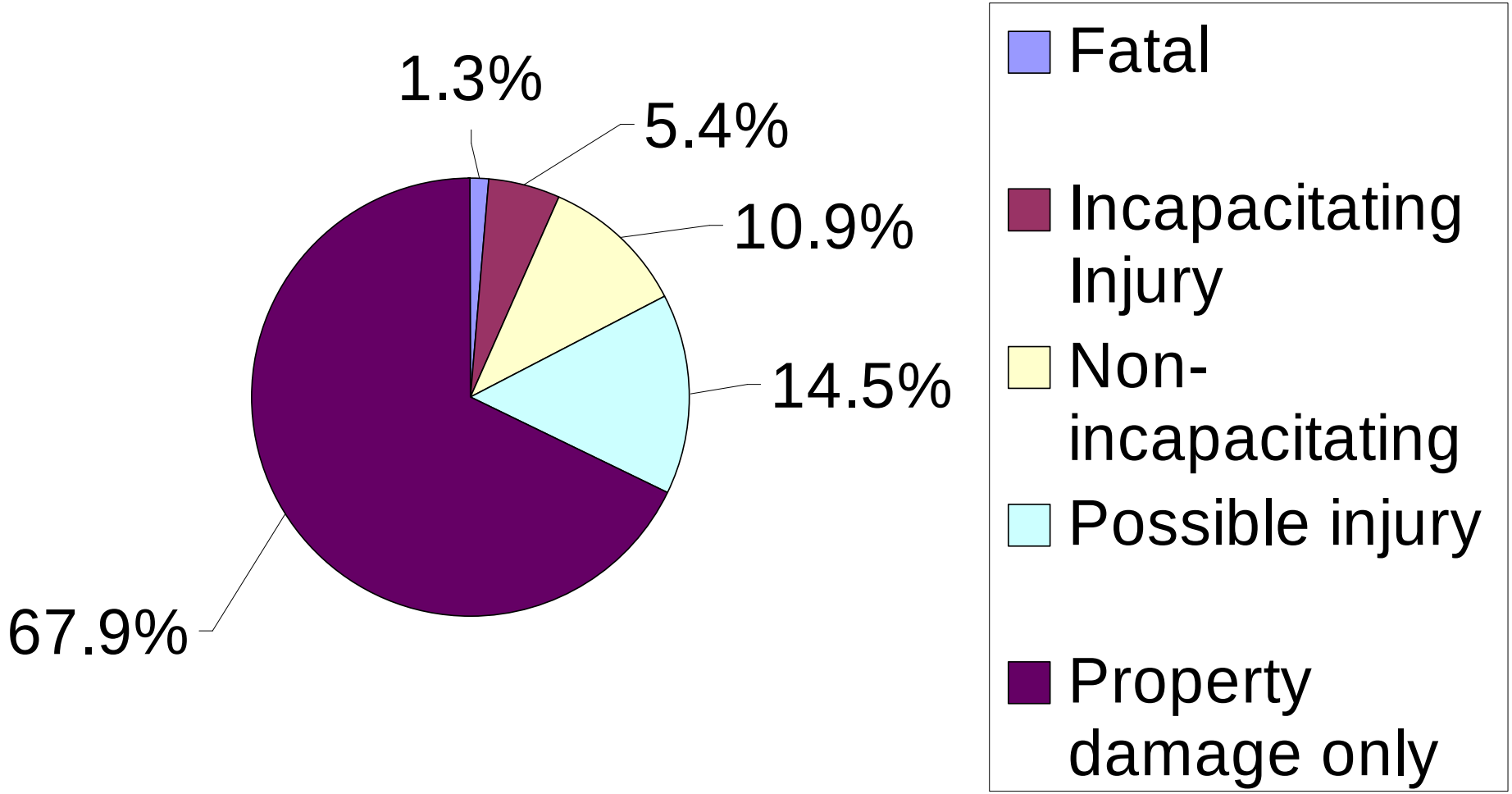
A_{ES} *= Accidents expected on similar locations (Result from SPF)*

A_C *= Count of accidents on this segment or intersection*

Crash Severity and Type Distributions

- Use Default or Local Distributions
- Apply to Predicted Frequency

Example Severity Distribution



Applying the Results

- Sum the estimates for each segment and intersection
- Results Used as Input to the Broader Evaluation & Decision Making Process

Schedule and Basic Cost for First Edition of the Highway Safety Manual

www.highwaysafetymanual.org

LNEC

June 2007

Some Key Issues

- Quality of crash data
- Quality & availability of other safety data
- Many factors not included in prediction
- Proposed method does not account for combined effects of factors
- Evolving approaches to modeling
- Limited or no information for many strategies (tip of the iceberg)

What do potential users want/ need?

- Understand fundamental substantive safety principles
- Perform quantitative safety analyses
- User-friendly methods and decision-making tools
- HSM will fill only part of that need

Related Safety Initiatives

- AASHTO Strategic Highway Safety Plan
- Interactive Highway Safety Design Model (IHSDM)
- SafetyAnalyst
- Human Factors Guide
- Improved Quality of Safety Data

AASHTO Strategic Highway Safety Plan

Comprehensive approach to reducing road fatalities by helping & encouraging states to address issues related to:

- Drivers
- Other Users
- Vehicles
- Emergency Medical Services (EMS)
- Management (NCHRP Report 501)
- Highways

24 Implementation Guides (NCHRP Report 500 Series)

- Horizontal Curves
- Trees in Hazardous Locations
- Unsignalized Intersections
- Unlicensed Drivers
- Suspended/Revoked
- Aggressive Driving
- Work Zones
- Head-On
- Utility Poles
- Older Drivers
- Pedestrians
- Seat Belt Use
- Signals
- Heavy Trucks
- Alcohol
- Run-off-Road
- Motorcyclists
- Rural EMS
- Distracted/Fatigued
- Freeway Head-on Crashes
- Young Drivers
- Bicyclists
- Speed
- Data

Now Part of Federal Legislation

- Safe, Accountable, Flexible and Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU)
- The current law authorizing the federal highway and public transportation programs

Strategic Highway Safety Plan
TOOLS FOR LIFE

http://safety.transportation.org

http://www.trb.org/

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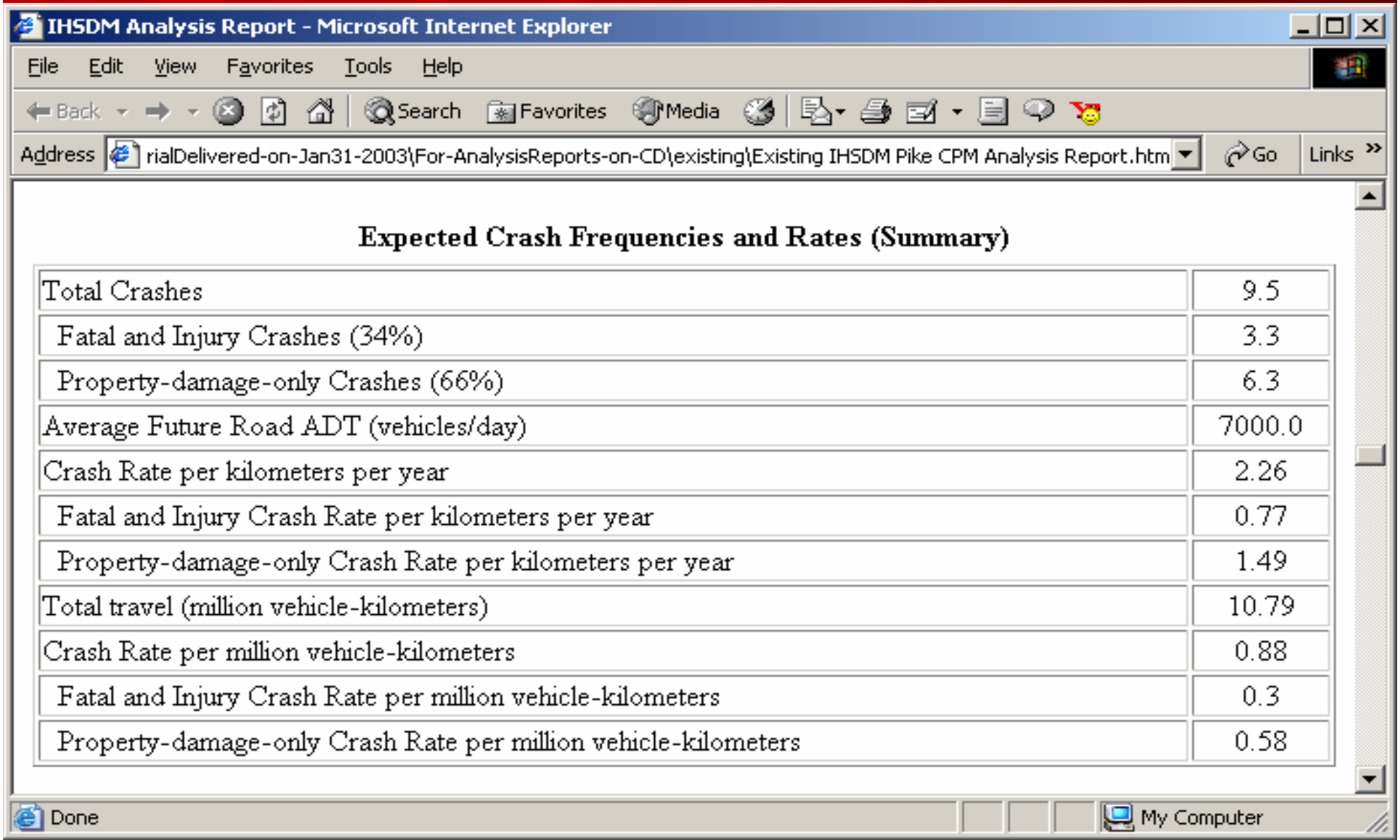
IHSDM Overview

- Suite of software tools
- Support project-level geometric design decisions
- Estimates expected safety and operational performance
- Facility types:
  - 2-lane & multilane rural highways
  - Urban & suburban arterials
- Software form of HSM Part III

IHSDM Evaluation Capabilities

- Nominal safety evaluation
  - Policy Review Module
- Objective safety estimation
  - Crash Prediction Module
- Operational evaluation
  - Design Consistency Module
  - Intersection Review Module
  - Traffic Analysis Module

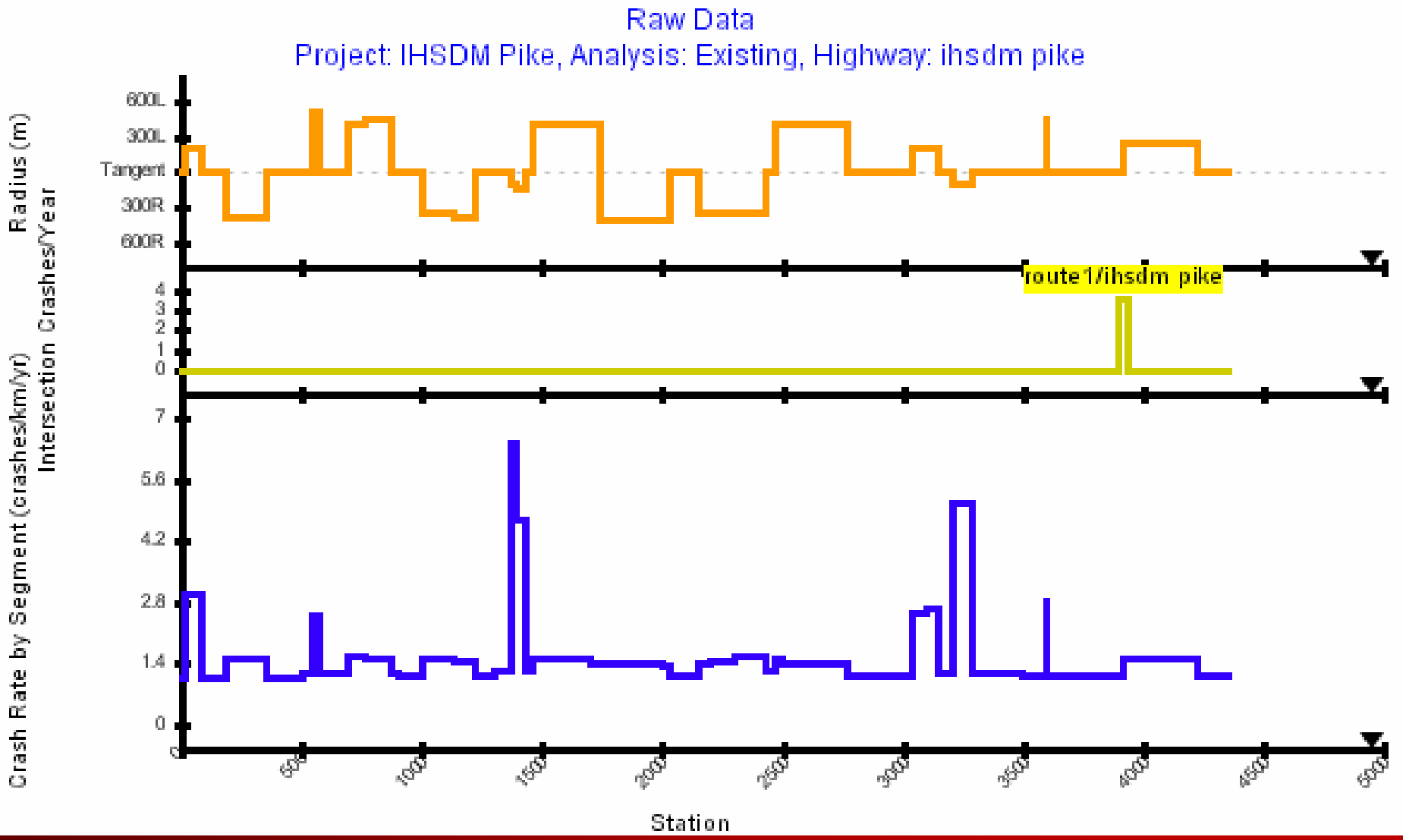
Expected Crashes Summary



Expected Crash Frequencies and Rates (Summary)

Total Crashes	9.5
Fatal and Injury Crashes (34%)	3.3
Property-damage-only Crashes (66%)	6.3
Average Future Road ADT (vehicles/day)	7000.0
Crash Rate per kilometers per year	2.26
Fatal and Injury Crash Rate per kilometers per year	0.77
Property-damage-only Crash Rate per kilometers per year	1.49
Total travel (million vehicle-kilometers)	10.79
Crash Rate per million vehicle-kilometers	0.88
Fatal and Injury Crash Rate per million vehicle-kilometers	0.3
Property-damage-only Crash Rate per million vehicle-kilometers	0.58

Expected Crashes Graphs



2006 Release

- May be downloaded free-of-charge at: http://www.ihsdm.org
- Technical support by e-mail at: IHSDM.Support@fhwa.dot.gov
- IHSDM Training Course:

  FHWA-NHI-380071 in NHI catalog at http://nhi.fhwa.dot.gov

Future Plans

- 2007: updated annual release for two-lane rural highways
- 2008: release with crash prediction capabilities matching the HSM:
  - Two-lane rural highway crash prediction
  - Urban & suburban arterial crash prediction
  - Multilane rural highway crash prediction

Cooperative Effort of FHWA and 20 States

Provide state-of-the-art analytical tools for use in the decision-making process to identify and manage a system-wide program of site-specific improvements to enhance highway safety by cost-effective means.

http://www.safetyanalyst.org/

Tools Available in SafetyAnalyst

- Network screening to identify sites with promise for safety improvement
- Diagnosis of safety concerns
- Selection of countermeasures
- Economic appraisal of countermeasures
- Priority ranking of countermeasures
- Evaluation of implemented projects

Why is *SafetyAnalyst an improvement* ?

- Integrates/automates all parts of safety management process
- State-of-the-art analytical procedures
- Strong cost-effectiveness component
- Encourages use and collection of all types of data
- Enables engineers to make informed decisions efficiently
- Software available from FHWA at no cost

Roles of HSM, IHSDM & SafetyAnalyst

	SafetyAnalyst	IHSDM
Scope	Network Level Analyses (HSM)	Project Level Analyses (HSM)
Supports	Project Selection Decisions	Geometric Design Decisions

Status and Schedule

- Release interim tools – December 2006 (under review)
- Release final tools – September 2008
- "New Approaches to Highway Safety Analysis" training course – at final release

Human Factors Guide (HFG)

- Provide the best factual information & insight on road users' characteristics
- HSM includes overview of human factors
- HFG provides detailed guidelines
- 2008 - Full-media version of 10 chapters suitable for a CD or on a website
- Further chapters under development

Improved Safety Management & Data

- AASHTO formed Subcommittee on Safety Management with 6 task forces
  - Technical Information and Resources
  - At Risk Roadway Users
  - Strategic Highway Safety Plan
  - Safety Data Systems and Analysis
  - Safety Information Packages
  - Research.
- $350K R&D scoping study to start in 2008

Some New Safety Data Intiatives

- National Highway Traffic Safety Administration (NHTSA)
  - Improved data quality and availability
  - Electronic collection and processing
  - Uniform and Integrated Data (MMUC)
  - Training
- NCHRP - National Roadside Database ($1mil)

Final Observations

- Much is being done in the US about highway safety
- Paradigm shift
- New technologies
- New concepts and tools
- New policy emphasis
- It is a new beginning for something very old

Organizations Providing Slide Materials

- AASHTO
- CH2M Hill
- FHWA
- iTrans
- Midwest Research Institute

End of Presentation

http://www.highwaysafetymanual.org/