Safety Impact Methodology

Mikio Yanagisawa
RITA / Volpe

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Safety Benefits – Basic Equations

\[
\# \text{Crashes Avoided} = \# \text{Target Crashes} \times \text{Application Effectiveness}
\]

\[
\text{Application Effectiveness} = 1 - \text{Exposure Ratio} \times \text{Crash Prevention Ratio}
\]

\[
\text{Exposure Ratio} = \frac{\text{Exposure to Driving Conflicts with V2V}}{\text{Exposure to Driving Conflicts without V2V}}
\]

\[
\text{Crash Prevention Ratio} = \frac{\text{Crash Probability in Driving Conflict with V2V}}{\text{Crash Probability in Driving Conflict without V2V}}
\]

Data Sources

- # Target Crashes: Crash databases (GES, FARS,...)
- \textbf{Exposure Ratio}: Field operational tests and controlled experiments
- \textbf{Crash Prevention Ratio}: Field tests, objective tests, controlled experiments, and computer simulation → \textbf{Safety Impact Methodology (SIM) tool}
SIM Tool Overview

Safety Impact Methodology (SIM)

- Crashes without V2V
- Harm from crashes without V2V
- Conflict exposure with / without V2V
- Probability of crash
- $\Delta V$ distributions
- Crashes prevented
- Harm reduced

- SIM estimates effectiveness of individual scenarios
- SIM estimates are based on 100% system deployment
Rear-End Pre-Crash Simulation

**VEHICLE**
- Host Vehicle State
- Remote Vehicle State

**DRIVER**
- Reaction Time
- Braking Level
- Control vs. Treatment

**SYSTEM**
- Time-to-Collision of Warning
- Automatic System Activation

**Rear-End SIM Simulation**
- Crashes
- Non-Crashes
- Impact Speed
- $\Delta V$
- Effectiveness
Rear-End Pre-Crash Walkthrough (LVS)

Control

\[ \Delta v (m_{HV}, m_{HV}, v_{HV}, v_{RV}) \]

Treatment

No Crash
Lane Change Pre-Crash Walkthrough

Control

Treatment
Straight Crossing Paths – Both Vehicles Moving

Control

Treatment

\[ \Delta v \left( m_v, v_x, v_y \right) \]
Straight Crossing Paths – Stopped and Starting

Control

Treatment

\[ \Delta v (m_v, v_x, v_y) \]
Input Parameters

*Example Mock Data

- Data
  - Field
  - Track
  - Experiment
  - Literature
- Relationships
- Dependencies
- Variable inputs
SIM Results and Analysis

- Results from SIM analyzed for effectiveness
- Applied to appropriate target population
- Pre-crash scenarios combined
- Effectiveness estimates lead to overall benefits

SIM

Pre-Crash Mode
Crash Count
Impact Mode
Treatment Type
Crash Severity

Analysis

pCrash
Crash Ratio
Crash Severity
Speed Reduction
Exposure Ratio