Measuring Freeway Safety Performance: The Freeway Accident Risk Analysis (ARA) Tool

Introduction

- **Presenter:**
  - Coco Briseno; Division Chief
  - Caltrans Division of Research, Innovation, & System Information (DRISI)
- **Caltrans Project Manager:**
  - Fred Yazdan; CTMLabs Manager
  - E-mail: *fred.yazdan@dot.ca.gov*, Tel.: (949) 936-3462
  - DRISI; Office of Technology Applications
- **Principal Investigator:**
  - James Marca, Project Scientist,
  - E-mail: *jmarca@translab.its.uci.edu*, Tel.: (949) 824-6287
  - Institute of Transportation Studies, University of California, Irvine

Measuring freeway safety performance: The Freeway Accident Risk Analysis (ARA) Tool

Problem Statement

- Understanding the benefits of improved traffic flow (reduced congestion) that is critical to the assessment of investments in infrastructure and traffic management and control.
- Research needed to understand the usefulness and benefits of the Intelligent Transportation System (ITS) strategies that Caltrans is spearheading, particularly the manner in which safety is improved by smoothing traffic flow.
- By quantifying the safety benefits accrued from smooth and efficient traffic operations, transportation management agencies will be able to incorporate safety measures in assessment of performance gains resulting from deployment of ITS measures.

Measuring freeway safety performance: The Freeway Accident Risk Analysis (ARA) Tool

Research Performed

- The primary purpose of this project was to:
  - Develop a tool for measuring freeway safety performance based on raw loop detector data.
  - Re-estimate the original models with more recent accident and traffic data;
  - Conduct a limited deployment of the models for Caltrans use;
  - Validate the predictions of the models against actual accidents for more recent data.
- Accident data was obtained from the Federal Highway Safety Information System (HSIS) multistate database.
- Raw, 30 second loop data was downloaded from Caltrans' Performance Measurement System (PeMS) bulk data repository.
- The models were estimated on 2007 data, and validated with 2008 data.

Research Results

- Freeway Accident Risk Analysis (ARA) Tool
  - The final product of this project is a freeway safety performance measurement tool called Accident Risk Analysis (ARA) for analyzing accident risks for urban freeway mainlines with 3+ directional lanes.
  - By using this safety performance measurement tool, Caltrans will be able to evaluate the safety impacts of roadway changes over time.
    - ARA links traffic dynamics with the relative safety of a roadway.
  - This tool evaluates and quantifies freeway safety performance based on the dynamic behavior of drivers in time and space.
- Operations:
  - Suitable for long-term monitoring.
  - Enable before and after studies to quantify safety improvements.
  - Measure the accident risk impacts of traffic flow changes.

Measuring freeway safety performance: The Freeway Accident Risk Analysis (ARA) Tool

Research Results (cont'd)

- Planning:
  - Identify areas that would benefit from improvements
  - Open access to intermediate data and model predictions

- The research developed models do not "*predict accidents based on current conditions. Instead they should be understood to predict slight increases or decreases in the risk of collision as traffic patterns change throughout the day. By summing up these probabilities over time, an overall picture of the relative safety of the roadway section emerges.*"

Measuring freeway safety performance: The Freeway Accident Risk Analysis (ARA) Tool

Research Recommendations

- The ARA tool is well suited to examine and quantify changes in the relative safety characteristics of a general purpose freeway section.
- In the aggregate (whole freeway, 3 months or longer, all of District 12, all of 2008, etc.) the models are close to observed accident characteristics.
- One of the primary uses of ARA application is to evaluate the differences in predicted accident characteristics and quantities for an entire section of roadway before and after a significant modification.

Measuring freeway safety performance: The Freeway Accident Risk Analysis (ARA) Tool

Implementation Status

- The ARA tool is currently hosted by the California Traffic Management Laboratories (CTMLabs) Website, as a beta version, and can be accessed at the following link: http://www.ctmlabs.net/, go to Projects tab, select ARA.
- The tool is in a limited prototype deployment being used by Caltrans District 12 engineers to provide feedback on enhancing the user interface.
- The models were estimated and deployed for Caltrans District 12 located in Southern California. Moving the application to other locations in California would be possible by using the Caltrans' PeMS raw data repository.
- The modeling variables are also available through the website generated by this project for any other modeling work that might relate traffic dynamics to some variable of interest. One such area is to model the number of heavy duty trucks in the traffic stream, using Weigh-In-Motion data.

Measuring freeway safety performance: The Freeway Accident Risk Analysis (ARA) Tool

Implementation Strategy

- The ARA Application can be tailored to any freeway location where raw traffic data and accident information are available.
- The data and modeling system can be scaled up roughly in proportion to the size of the input data.
- Model input and output data will require approximately 1GB per detector per year, because each detector site's 30-second observations of volume and occupancy in each lane must be transformed into 27 key variables.
- Models should be re-estimated by a trained analyst for each urban area, as driver behavior cannot be assumed to be a constant throughout the state
- Important legal issues to resolve prior to a public deployment.

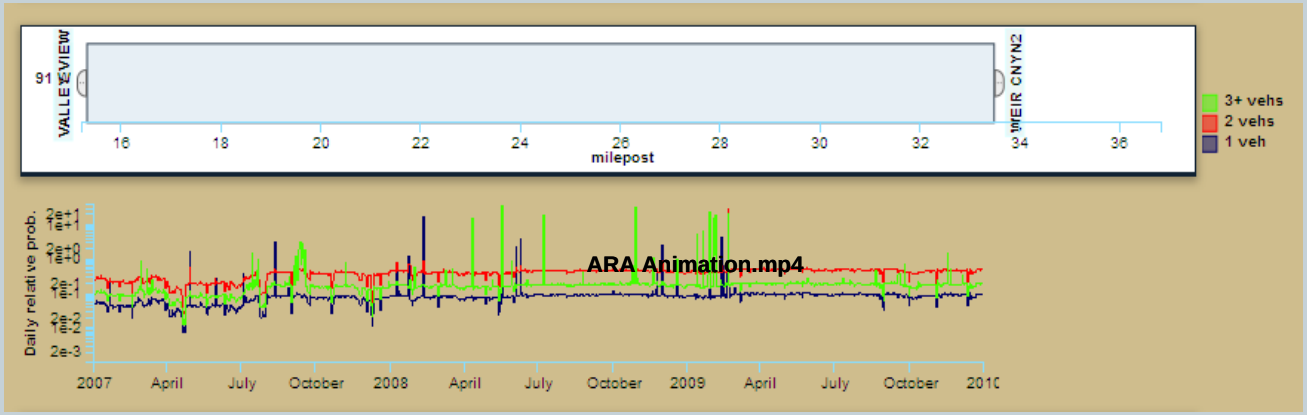
Value of Implementing the Research

- Use of this tool allows Caltrans to evaluate the safety impacts of roadway changes over time, evaluating the differences in predicted accident characteristics and numbers before and after significant roadway modifications are implemented.
- The models indicate when accident propensity inches up or down and why.
- The predictions are best used to evaluate the cumulative probability of accidents and accident characteristics over longer time horizons and extended stretches of roadway.
- The research highlights the interaction between driver behavior, physical roadway, and collision risk.
  - "Safe" roads need "safe" behavior.
  - Elevated risks should be addressed.
  - Lower risk areas, and periods should be emulated.

Measuring freeway safety performance: The Freeway Accident Risk Analysis (ARA) Tool

Sample of Accident Plots

- Risk Analysis Plot on WB SR91:



- A Live Animation of the Application:

ARA Animation