Road Safety Evolution, Revolution, Convolution and Resolution – a North American Perspective

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Overview of lecture

- **Evolution of road infrastructure safety management**
  - Stakeholders interest
  - Practical solutions
  - Research revolution

- **Current resolution initiatives**
  - Highway Safety Manual
  - AASHTO strategic highway safety plan
    - Applied safety evaluation research

- **Future directions**
Evolution of road safety management

- **Pre-1950’s**: emphasis on providing mobility

- **> 1950**: increasing importance of congestion management (1st edition of the Highway Capacity Manual)

- **1960’s**: Increasing interest of administrators: Start of revolutionary practical resolutions
  - Guide-rail, barriers and crash-cushions
    - Reduced severity, but increased hits
  - Breakaway-poles – eliminate severe accidents
    - but also reduce non-severe ones!
Evolution of road safety management, ctd.

- **Early 1980’s: Start of the knowledge revolution**
  - Recognition of problems with existing knowledge on safety implications of roadway improvements
    - Regression-to-mean in before after studies – safety benefits overestimated
    - Knowledge from cross-section studies -- safety benefits tend to be underestimated
    - Better methods for before-after and cross-section studies
    - *5 papers on safety analysis submitted to TRB in 1985.*

- **Mid-1980’s: From congestion management to safety management**
  - Managing congestion to improve safety
Is it better to be ..........

- DEAD?

- OR ALIVE AND STUCK IN TRAFFIC??
Evolution .... ctd.

- **Mid-1980’s to mid-1990’s:** *Dramatic increase in road safety research, researchers and practitioners*
  - Mostly ad hoc research
  - Road Safety Auditor as a profession
  - Safety considerations in design, construction and maintenance

- **1997:** *Ezra Hauer’s landmark book on observational before-after studies*

- **Late 1990’s:** *Formal recognition by administrators of need for science based road safety management;*
  - Increase in research directed to facilitate the management process
    - Identify locations for detailed safety investigation
    - Detailed safety investigations of sites and development of remedies
    - Prioritization and implementation of remedies
    - Evaluation of remedies
Evolution of road safety management, ctd.

**TURN OF THE CENTURY:** *Formalizing safety considerations in the design, construction and maintenance processes*
- Explicit consideration of safety in design guides and manuals
- Interactive Highway Safety Design Model
- Safety audits
  - Pre-construction
  - During construction
  - Post-construction
  - During maintenance

**2000’s:**
- AASHTO Strategic Highway Safety Plan
- Highway Safety Manual
- PIARC Road Safety Manual

**2007:** *80 papers on highway safety analysis submitted to Transportation Research Board Annual Meeting*
THE HIGHWAY SAFETY MANUAL

– a new era in highway safety analysis
To provide the best factual information and tools in a useful form to facilitate roadway planning, design, operations, and maintenance decisions based on explicit consideration of their safety consequences.
The ‘vision’ of the HSM -- a document akin to the HCM

- Definitive; represents quantitative ‘state-of-the-art’ information
- Widely accepted in professional practice
- Science-based; updated regularly to reflect new research
First edition outline

Part I  – Introduction and Fundamentals
Part II – Knowledge
Part III – Predictive Methods
  -- Two lane roads
  -- Urban/suburban arterials
  -- Multilane rural roads
Part IV – Safety Management
Part V  – Safety Evaluation
AASHTO STRATEGIC HIGHWAY SAFETY PLAN

- A comprehensive plan to substantially reduce vehicle-related fatalities and injuries on U.S. highways
  - Achieve less than 0.6 fatalities per 100 million vehicle-km

- Produce guidebooks for emphasis areas
  - Identify proven, tried and experimental countermeasures

- Not just a plan!
  - Stimulate/support research to fill in gaps in countermeasure knowledge
  - Market research to ensure implementation of results
Emphasis areas

- **Drivers**
  - Young
  - Unlicensed/Suspended/Revoked
  - Older
  - Aggressive
  - Impaired
  - Distracted/Fatigued
  - Seat Belt Use
  - Speed

- **Highways**
  - Trees
  - Run Off the Road
  - Horizontal Curves
  - Utility Poles
  - Unsignalized Intersections
  - Head-On Collisions
  - Work Zones

- **Special Users**
  - Pedestrians
  - Bicyclists

- **Vehicles**
  - Motorcycles
  - Heavy Trucks

- **Emergency Medical Services**
  - Rural EMS

- **Management**
  - Data
  - Integrated Safety Management Process
Guide for addressing run-off-road collisions — *Strategies to keep vehicles from encroaching on the roadside*

- shoulder rumble strips
- edgeline “profile marking,” edgeline rumble strips
- midlane rumble strips
- enhanced shoulder or in-lane delineation and marking for sharp curves
- improved highway geometry for horizontal curves
- enhanced pavement markings
- skid-resistant pavement surfaces
- shoulder treatments
- shoulder drop-offs
- wider and/or paved shoulders
Research to fill in gaps in knowledge

The Challenges

- Need for sound evaluation methodology
  - Example of rail-highway crossings

- Extensive data needs to support new methodologies
  - Before-after accident and traffic data at large enough sample of treatment and non-treatment sites
  - Accident prediction models for condition before treatment

- Need for trained analysts in new methodologies
  - E.g. Opportunity in Enna’s road quality management Master’s programme
INSTALLING GATES AT 934 U.S. RAIL CROSSINGS WITH FLASHERS

Accidents before = 286
Accidents after = 114

Apparent savings = 172
(60% reduction)

The Reality:
Accidents expected = 208

Actual savings
(208 – 114) = 94
(45% reduction)
Research to fill in gaps in knowledge

The Challenges

- Need for sound evaluation methodology
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Recent safety evaluations with latest methods (for AASHTO SHSP)

- Flashing beacons
- Two way left turn lanes
- Raised pavement markers
- Centre line rumble strips
- Improve skid resistance
Flashing Beacons
Accident reductions at 106 sites

<table>
<thead>
<tr>
<th>Angle</th>
<th>Injury &amp; Fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3%</td>
<td>10.2%</td>
</tr>
</tbody>
</table>
Two-way left turn lanes

Percent reduction in crashes (standard error)

<table>
<thead>
<tr>
<th></th>
<th>Rear-end</th>
<th>Injury</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>38.7</td>
<td>26.1</td>
<td>20.3</td>
</tr>
<tr>
<td>(standard error)</td>
<td>(4.0)</td>
<td>(6.8)</td>
<td>(3.0)</td>
</tr>
</tbody>
</table>
**SAFETY EVALUATION OF CENTRE LINE RUMBLE STRIPS**

340 km at 98 U.S. sites

<table>
<thead>
<tr>
<th>All Impact types</th>
<th>% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opposite direction and sideswipe</td>
<td>21-25%</td>
</tr>
</tbody>
</table>
### SAFETY EVALUATION OF Pavement markers

#### % Reduction in crashes

<table>
<thead>
<tr>
<th></th>
<th>Night</th>
<th>Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Jersey Non-Selective</td>
<td>0.9</td>
<td>3.2</td>
</tr>
<tr>
<td>174 miles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New York Selective</td>
<td>12.7</td>
<td>20.2</td>
</tr>
<tr>
<td>82 miles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Improve skid resistance at targeted locations (*High skid numbers and wet weather accident frequency*)

% reduction in crashes

<table>
<thead>
<tr>
<th>Location Type</th>
<th>All Crashes</th>
<th>Wet-road</th>
<th>Rear-end Wet-road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segments</td>
<td>23%</td>
<td>56%</td>
<td>43%</td>
</tr>
<tr>
<td>Intersection approaches</td>
<td>20%</td>
<td>57%</td>
<td>68%</td>
</tr>
</tbody>
</table>
Where do we go from here?

... Future directions
My vision for the future of infrastructure road safety

- Road safety as public health issue
  - Research funding/interest from Health Institutes
  - Publications in public health journals

- Interdisciplinary/multidisciplinary approaches
  - Accommodation in all road engineering disciplines
  - Canadian multidisciplinary examples
    - Network Centre of excellence: AUTO21
    - Fatigue related accidents .. Canadian Institutes for Health Research

- International cooperation
  - Research transferability – Is it possible?
    - E.g., transferability of accident prediction models

- High level research using microscopic data
  - SHRPII