Implementing Safe Systems in the United States

Guiding Principles and Lessons from International Practice

September 18, 2019
Project Team

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Conventional Wisdom:

Table 1. Driver-, Vehicle-, and Environment-Related Critical Reasons

<table>
<thead>
<tr>
<th>Critical Reason Attributed to</th>
<th>Number</th>
<th>Estimated Percentage* ± 95% conf. limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drivers</td>
<td>2,046,000</td>
<td>94% ± 2.2%</td>
</tr>
<tr>
<td>Vehicles</td>
<td>44,000</td>
<td>2% ± 0.7%</td>
</tr>
<tr>
<td>Environment</td>
<td>52,000</td>
<td>2% ± 1.3%</td>
</tr>
<tr>
<td>Unknown Critical Reasons</td>
<td>47,000</td>
<td>2% ± 1.4%</td>
</tr>
<tr>
<td>Total</td>
<td>2,189,000</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Percentages are based on unrounded estimated frequencies (Data Source: NMVCCS 2005–2007)

Source: NHTSA, 2015
Driver Error

• **Recognition error**, which may include driver inattention or distraction, as well as inadequate surveillance for oncoming hazards before entering an intersection of making a lane change.

• **Decision error**, such as driving too fast for conditions or misjudging gaps in oncoming traffic.

• **Performance error**, such as poor directional control over the vehicle prior to a crash, a factor most often attributable to drowsy driving.
Rethinking “Critical Factors”

**Counterfactual Reasoning:** A form of logic that falsifies antecedents to determine whether they negate consequences.

**Antecedent → Consequence**
The Simulation Heuristic

**Outcome Closeness:** We focus on antecedents that are immediately proximate to consequences.

**Outcome Normality:** Exceptional outcomes are presumed to follow from exceptional antecedents. We construct counterfactuals that shift the exceptional antecedent to its “normal” value.

**Extant Norms:** Counterfactual content is based on social norms of expected behavior (which are modifiable and socially constructed).

Source: Roese, 1997
The Simulation Heuristic: Blame the Victim

<table>
<thead>
<tr>
<th>Factors</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to yield right of way</td>
<td>216</td>
<td>25.7</td>
</tr>
<tr>
<td>Not visible (dark clothing, no lighting, etc.)</td>
<td>87</td>
<td>10.4</td>
</tr>
<tr>
<td>Failure to obey traffic signs, signals, or officer</td>
<td>83</td>
<td>9.9</td>
</tr>
<tr>
<td>Under the influence of alcohol, drugs, or medication</td>
<td>53</td>
<td>6.3</td>
</tr>
<tr>
<td>Making improper turn</td>
<td>43</td>
<td>5.1</td>
</tr>
<tr>
<td>Improper crossing of roadway or intersection</td>
<td>39</td>
<td>4.6</td>
</tr>
<tr>
<td>Operating without required equipment</td>
<td>31</td>
<td>3.7</td>
</tr>
<tr>
<td>Wrong-way riding</td>
<td>31</td>
<td>3.7</td>
</tr>
<tr>
<td>Failure to keep in proper lane or running off road</td>
<td>22</td>
<td>2.6</td>
</tr>
<tr>
<td>Riding on wrong side of the road</td>
<td>20</td>
<td>2.4</td>
</tr>
<tr>
<td>Inattentive (talking, eating, etc.)</td>
<td>17</td>
<td>2.0</td>
</tr>
<tr>
<td>Darting or running into road</td>
<td>16</td>
<td>1.9</td>
</tr>
<tr>
<td>Improper or erratic lane changing</td>
<td>15</td>
<td>1.8</td>
</tr>
<tr>
<td>Failing to have lights on when required</td>
<td>8</td>
<td>1.0</td>
</tr>
<tr>
<td>Physical impairment</td>
<td>7</td>
<td>0.8</td>
</tr>
<tr>
<td>Vision obscured (reflected glare, parked vehicle, sign, etc.)</td>
<td>6</td>
<td>0.7</td>
</tr>
<tr>
<td>In roadway improperly (standing, lying, working, playing)</td>
<td>5</td>
<td>0.6</td>
</tr>
<tr>
<td>Making improper entry or exit from trafficway</td>
<td>4</td>
<td>0.5</td>
</tr>
<tr>
<td>II, blackout</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>Improper passing</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>Traveling on prohibited trafficways</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Erratic, reckless, careless, or negligent operation</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Passing with insufficient distance</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Other factors</td>
<td>26</td>
<td>3.1</td>
</tr>
<tr>
<td>None reported</td>
<td>163</td>
<td>19.4</td>
</tr>
<tr>
<td>Unknown</td>
<td>204</td>
<td>24.3</td>
</tr>
<tr>
<td><strong>Total Pedalcyclists</strong></td>
<td><strong>840</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Notes: The sums of the numbers and percentages are greater than total pedalcyclists killed as more than one factor may be present for the same pedalcyclist.

Source: NHTSA, 2016
SAFETY DOESN'T HAPPEN BY ACCIDENT.

WHEN DRIVING, WALKING, OR BICYCLING...
PAY ATTENTION.
READ THE SIGNS.
LEARN THE RULES.

AVOID DISTRACTIONS.
STOP BEFORE TURNING RIGHT ON RED.
USE THE SIDEWALK AND CROSSWALKS.
BICYCLE PREDICTABLY, WITH TRAFFIC.
EYES ON THE ROAD
DON’T DRIVE DISTRACTED
ARRIVE ALIVE

DON'T DRINK & DRIVE

ENJOY SPRING BREAK RESPONSIBLY

#SpringBreakFL
Anatomy of a Crash: 
The Case of Raquel and A.J. Nelson

Pedestrian convicted of vehicular homicide in own child's death

By Elise Hitchcock
The Atlanta Journal-Constitution

A Marietta mother may serve more time than the driver who hit and killed her 4-year-old son.

Raquel Nelson, 30, could be sentenced to up to 36 months at a hearing July 25, said David Savoy, her attorney. She was convicted Tuesday of homicide by vehicle in the second degree, crossing roadway elsewhere than at crosswalk and reckless conduct, said Savoy.

Jerry L. Guy, the driver who admitted hitting the child when pleading guilty to hit-and-run, served a 6-month sentence. He was released Oct. 29, 2010, and will serve the remainder of a 5-year sentence on probation, according to Cobb court records.
Conventional Safety Practice
A Safe Systems Perspective

**Active Failure**: Actions taken by individuals that result in crashes.

**Latent Error**: Dormant conditions that, when combined with active triggers, lead to crashes. These are the “resident pathogens” in the system.
A Safe Systems Perspective

Latent Error Pathway

Causal Chain
Organizational
- Development Policy
- Regional Dev. Plans
- Performance Measures
- Zoning Ordinances
- Subdivision Regs.

Environmental
- Error-Producing Conditions
- Geometric Design
- Network Design
- ROW Allocation
- Traffic Control

Organizational
- Error/Violations
- Education
- Licensure
- Enforcement
- Legal Sanctions

Active Failure

Engineering Countermeasures

Crashes
Cognition, Behavior, and Error Production

Active Failure may occur spontaneously during the course of driving

Driving Behavior

Operation
- Speed
- Position
- Placement

Driving Experience
- Comfort
- Control
- Conflict

Security

Safety

Driver-Related Factors
- Education
- Experience
- Individual Characteristics
- Motivation

Latent Conditions exist when there is a mismatch between safety and security
The Recognition Heuristic
Cognition and Driving Behavior

• **Scripts**: Behavioral routines adopted in response to our understanding of our operating environment

• **Schema**: Expectancies regarding the existence and location of hazards
Self-explaining Roads

• There is a **communicative process** between the driver and behavior.

• Roadways should **clearly convey desired behavior**.

• This requires a deeper understanding of **behavioral scripts and schema**, and mechanisms for influencing them.
The Netherlands’ Self-Explaining Roads

• Adapt the structure and function of the transportation system to the complexities of human behavior.

• The Netherlands: Self-explaining roads (SWOV, 2012)
  – Limit speeds and promote mass homogeneity on roads
  – Strictly control access and mobility
  – Match roadway design to land development

Figure 1 shows how the different road types make up a road network.

*Figure 1. Three functional road types as the basis of a sustainably safe road traffic system.*
# New Zealand’s One Network Road Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Straight open road/urban motorways</th>
<th>Curved open road</th>
<th>Winding open road</th>
<th>Urban (not motorway)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High volume national</td>
<td>100–110km/h</td>
<td></td>
<td>60–80km/h</td>
<td>50km/h</td>
</tr>
<tr>
<td></td>
<td>Depends on design and safety risk (e.g. divided 4–5 star, grade separated intersections, safety barriers) and factoring in enforcement thresholds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Class 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National, Regional, Arterial</td>
<td>80–100km/h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depends on safety risk and whether volumes justify investment to bring the road up to 3 star equivalent, also enforcement thresholds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Class 3</strong> Primary and secondary collector</td>
<td>60–80km/h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access and low-volume access</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All winding/tortuous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depending on roadside development, pedestrian and cyclist volumes, whether sealed or not</td>
<td></td>
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</tr>
</tbody>
</table>
New Zealand’s Speed Management Program

DRAFT SPEED MANAGEMENT MAP

OVERLAY BASE INFORMATION
ONRC: Land use, Speed limits, Current operating speeds

OVERLAY ROAD SAFETY METRICS DERIVED FROM URBAN KIWRAP:
Corridor personal risk, Corridor collective risk

CALCULATE INFRASTRUCTURE RISK RATING

IDENTIFY SAFE AND APPROPRIATE SPEEDS

HIGH BENEFIT FILTER
Divide evenly between big gains and self-explaining, filtering top 2.5% -5% of each by total network length

DRAFT SPEED MANAGEMENT MAP
Safety and efficiency benefits: Highest potential to reduce DSI
Credibility benefits: Highest potential public support for speed limit reductions

ENSENSE BEST MODERATION
ENGINEERING AND LOCAL ENGAGEMENT

Engineer up: Higher ONRC with high risk, Justify investment at current or higher speed
Challenging conversations: High risk but don’t meet current investment criteria Interim lowering of speed limit

OVERLAY
Transport and growth strategies, Strategic priorities, Network operating plans, Local knowledge, Community views

SPEED MANAGEMENT PLANNING
Infrastructure investment, Targeted enforcement, Speed limit reviews

ACTIVITY MANAGEMENT PLANNING 2018-21 NLTP
Monitor, evaluate, and review
New Zealand’s Speed Management Program

Figure 1.1: Key elements to be considered in speed management
A Safe Systems Approach to Project Planning and Design

- Contextual Assessment
- Identification of Most Vulnerable Users
- Road Class Determination
- Identification of Environmental Risk Factors
- Alternatives Development
  - Geometric Design
  - Network Design
  - ROW Allocation
  - Intersection Control
Principles of Safe Systems

1. Human error should not be viewed as the primary cause of crashes.

2. Transportation facilities should be designed for the safety of the most vulnerable user.

3. A shared responsibility exists amongst those who design, build, manage and use roads and vehicles.

4. All parts of the system must be strengthened to multiply their effects; and if one part fails, road users are still protected.
Safe Systems: A Different Approach

• Transportation safety management in the United States has followed a series of paradigms (Norton, 2015)
  – Safety First (1900s-20s): Drivers bear responsibility for the safety of others
  – Control (1920s-60s): Expert control through the “3 Es”—Engineering, Education, and Enforcement
  – Crashworthiness (1960s-80s): Cars redesigned for greater occupant protection
  – Responsibility (1980s-today): Drivers responsible for their own safety and the safety of others
  – Is Safe Systems the 5th paradigm?
Safe Systems: A Different Approach

- Emphasizing management of latent risk over high-crash locations.
- Considering kinetic energy, not design standards, the key consideration in roadway design.
- Aligning functional classification with design and speed.
- Leveraging feedback loops and shared funding streams to create change.
Safe Systems: A Different Approach

• Safe Systems requires a move to systems thinking.

Traditional Approach

- Characterized by linear thinking
- Design speed and speed limits
- Intersection design and throughput
- Crashes and hot spot treatment

Safe Systems

- Characterized by systems thinking
  - Self-explaining roads and access control
  - Intersection design and kinetic energy
  - Severe crashes and systemic treatments
Safe Systems: The International Experience

• Sweden
  – Center guardrails to eliminate fatal crashes
  – Speed limit reductions
  – “2+1” roads

• The Netherlands
  – Self-explaining roads
  – Bicycle facilities in rural areas
  – Buy-in from non-government partners and communities to adopt safe road policies

• New Zealand
  – Flexible road safety barriers
  – Side and median barriers
  – Rumble strips
  – Widening centerlines
  – Widening shoulders
  – Speed management

Source: Dumbaugh et al., 2019
NZ Transport Agency, 2019