The Safe System Approach: Lane Departure Application in WI

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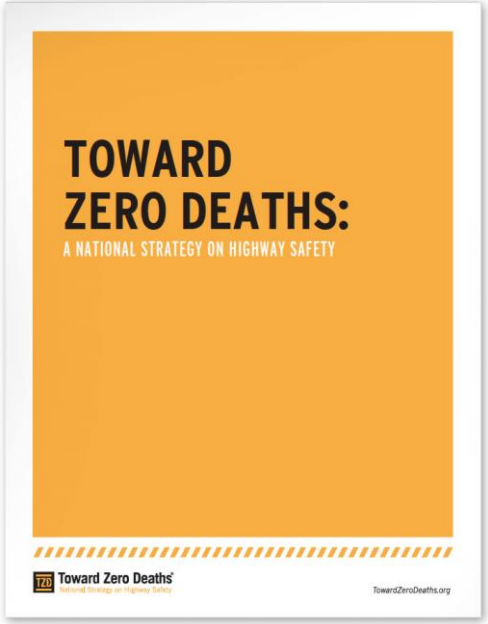
Toward Zero Deaths

A National Strategy on Highway Safety (2014)

ZERO IN WISCONSIN
Together we can save lives.

National Goal:

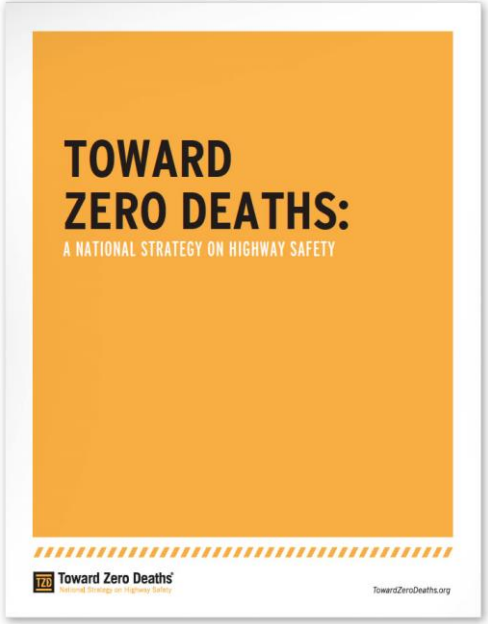
"A highway system free of fatalities through a sustained and even accelerated decline in transportation-related deaths and injuries."



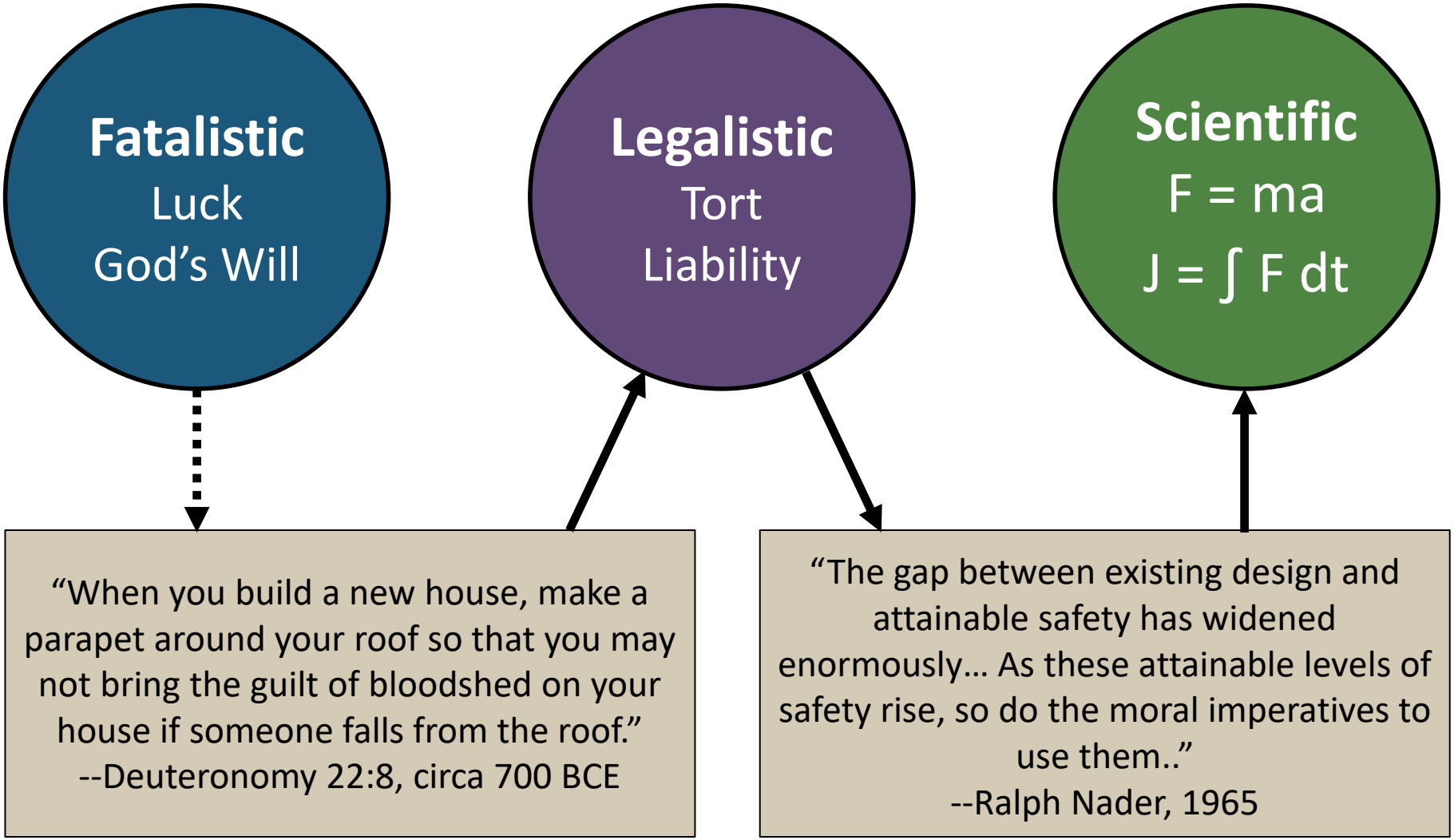
http://www.towardzerodeaths.org/wp-content/uploads/TZD_Strategy_12_1_2014.pdf

Toward Zero Deaths: Elements

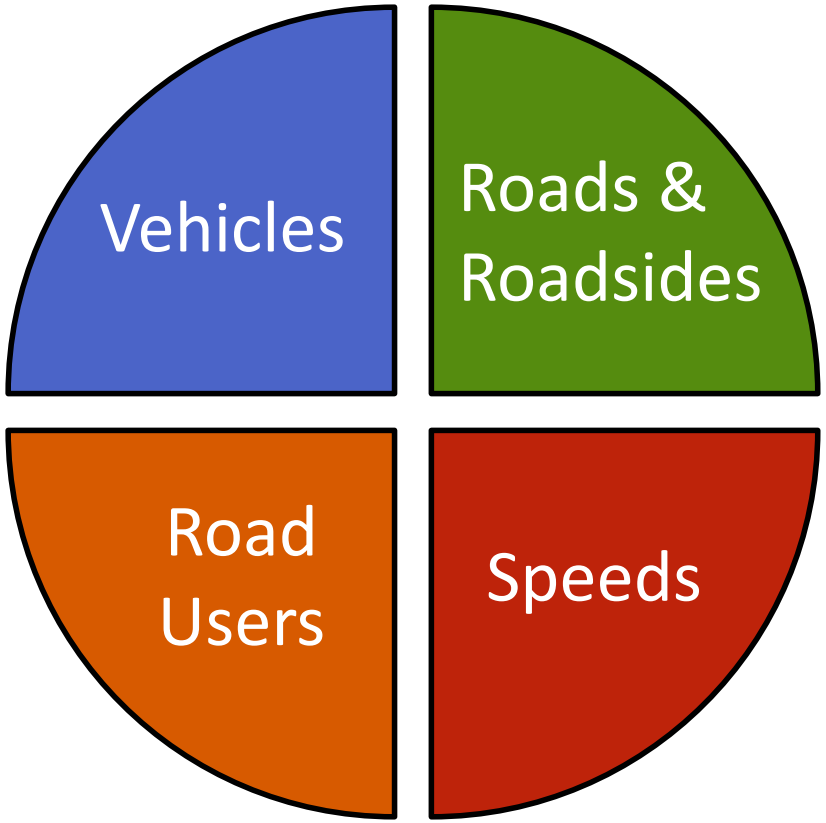
- "Improve speed management and enforcement to reduce the risk of fatalities."
- "Improve design and operations."
- "Educate drivers on safer driving practices."
- "Educate workers on safety practices."
- "Educate judges, prosecutors and law enforcement on…."
- "Enact legislation…including pervasive automated speed enforcement and applications for school and work zones."



Perspectives on Safety



The Safe System Approach



Source: FHWA Office of Safety

100 Years of Vehicle Safety Engineering

World's Best-Selling Automobile 1916

Photo: Views of the Past

World's Best-Selling Automobile 2016

Photo: Car gurus

What safety features were standard in 1916? In 2016?

Traditional Approach: The 3 (or more) E's

"Every road safety problem can be solved by applying the 3Es"

Engineering • Education • Enforcement

Emergency Medical Services • Evaluation

Example • Encouragement • Everyone

- Developed circa 1915 and promoted by auto industry
- Works best for issues that involve a relatively small number of agencies and stakeholders
- Can be difficult to apply to problems that cut across professional disciplines or agency boundaries

Example of Difficulties with 3Es Approach

Single-vehicle run-off-the-road crashes involving fatigued drivers.

Engineering:
Not isolated to specific locations, roadway reconstruction expensive

Enforcement:
Unsuitable for targeted enforcement – can happen almost anywhere

Education:
Public outreach effectiveness limited

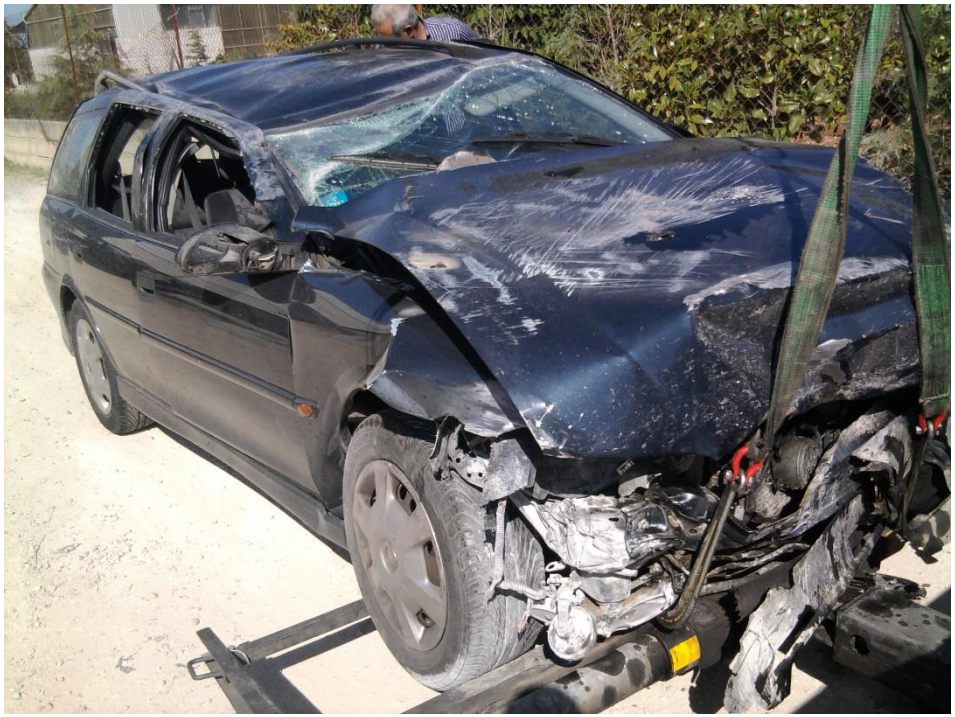
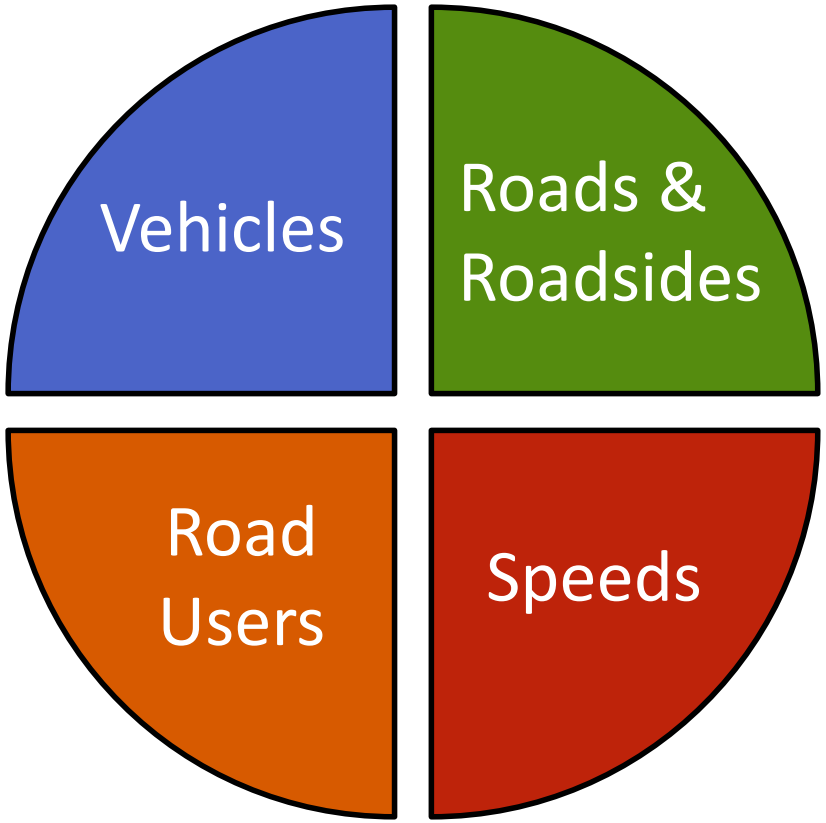


Photo: La Cara Salma/WikiMedia Commons

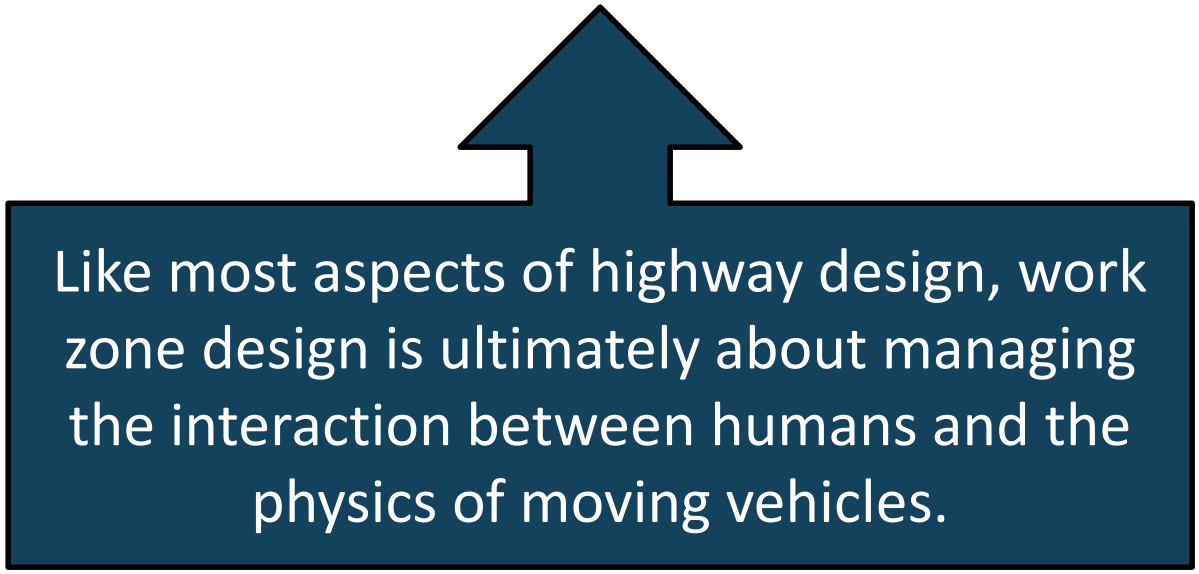
The Safe System Approach



Source: FHWA Office of Safety

Safe System Principles

- Human bodies don't withstand crash forces well.



Physics 101

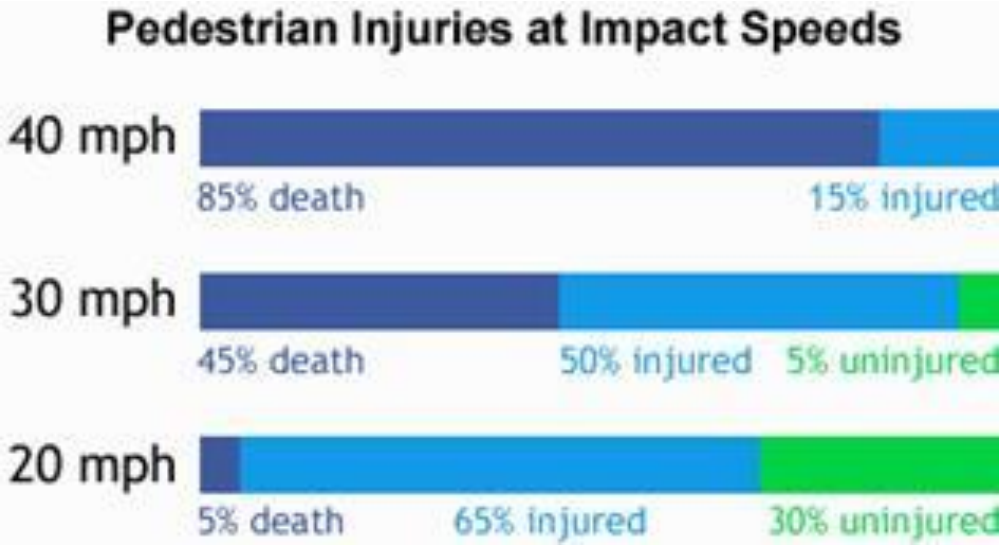
SUV
4400 lb
(2000 kg)

Kinetic Energy = ½mv^2

At 20 mph (30 km/h): KE = 0.5 x 2000 x (30000/3600) ^{2} = 70 kJ
At 30 mph (50 km/h): KE = 0.5 x 2000 x (50000/3600)^2 = 190 kJ
At 60 mph (100 km/h): KE = 0.5 x 2000 x (100000/3600)^2 = 770 kJ

Doubling speed quadruples kinetic energy

Pedestrian or Worker-On-Foot Struck by Car: Probability of Death



Graph: FHWA

Safe System Principles

- Human bodies don’t withstand crash forces well.
- Focus on preventing death and serious injury from crashes.
- Although some crashes involve an element of misbehavior, many are due to simple mistakes such as momentary inattention.

Drivers make mistakes.
Can we make our projects more forgiving of driver error?

Non-Forgiving Roadside

Photo: FHWA-SA-10-018

Evolution of Roadway Safety Engineering

Photo: Wikipedia

Safe System Principles

- Human bodies don't withstand crash forces well.
- Focus on preventing death and serious injury from crashes.
- Many crashes are due to simple mistakes such as momentary inattention.
- Strengthen all parts of the system: roads and roadsides, speeds, vehicles, and users.
- **System designers and system users must share responsibility for managing crash forces to a level that doesn't result in death or serious injury.**

Safety Culture in Organizations

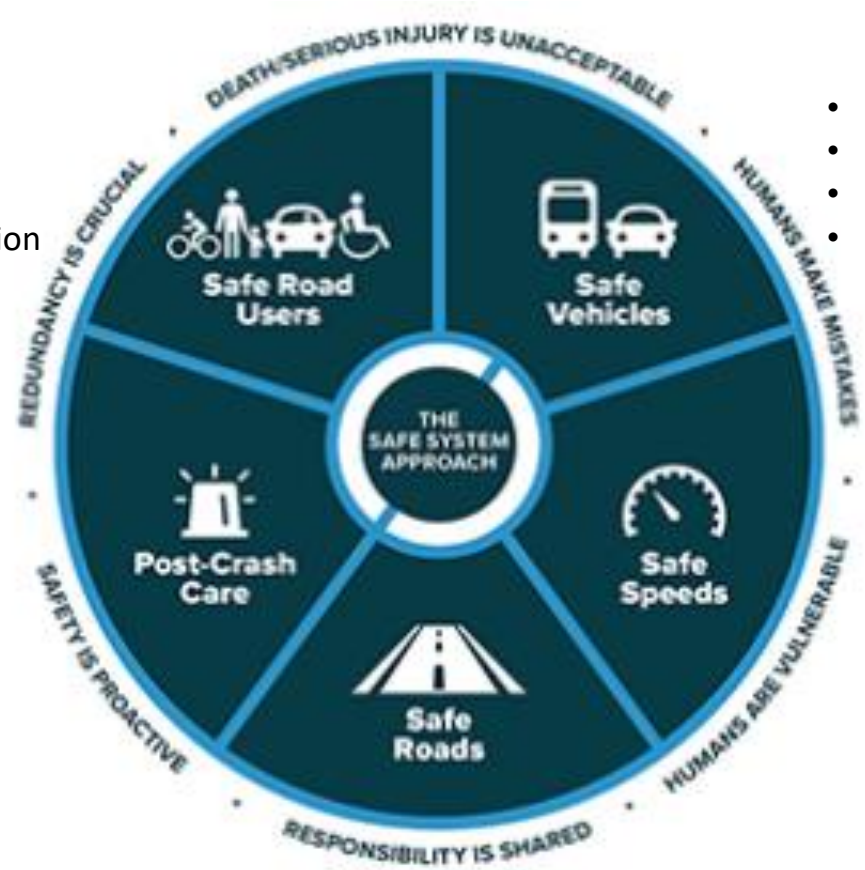
- **Pathological:** The organization thwarts changes that improve safety, even when the need is obvious and the payoff is rapid.
- **Reactive:** Changes accepted only in response to a significant incident/threat.
- **Calculative:** Potential improvements considered systematically as part of cost control and risk management.
- **Proactive:** Organization actively searches for ways to improve performance and reduce risks.
- **Generative:** Safety is an integral part of everything the organization does.

The 1960 Corvair dash baby cradle. Before infant car seats were a major requirement, this was considered to be a safe and comfortable way for a baby to ride in a car. The warmest place in the vehicle was the rear engine and the vibrations from the engine would help the baby fall asleep

Applying These Principles

Predictive Analytics

- Bike
- Distracted
- Impaired
- Occupant Protection
- Pedestrian
- Teen Driver
- 65+
- Aggressive



- CMV
- Motorcycle
- ATV
- School Bus

- Speed

- Severity
- County Profiles

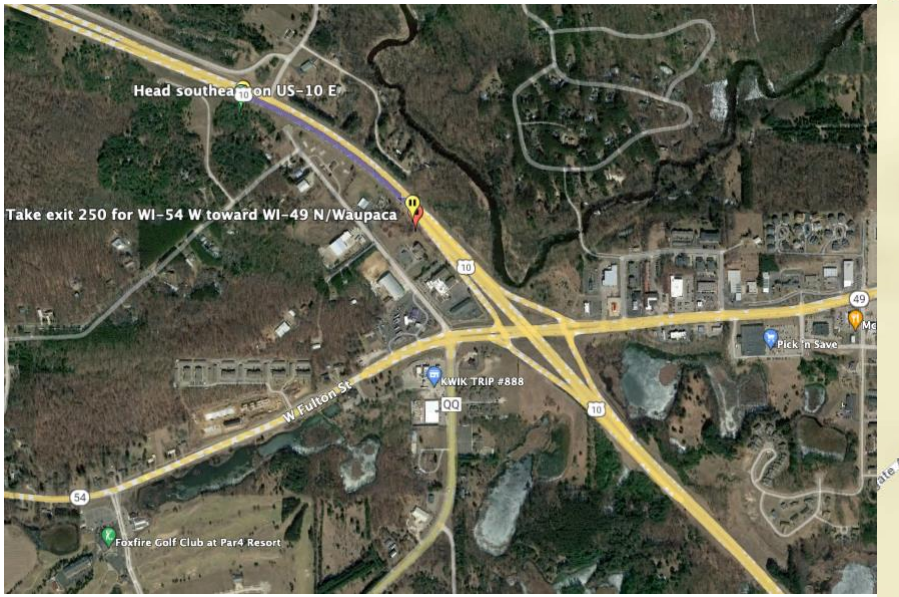
- Work Zones
- Lane Departure 1 and 2+
- Intersection

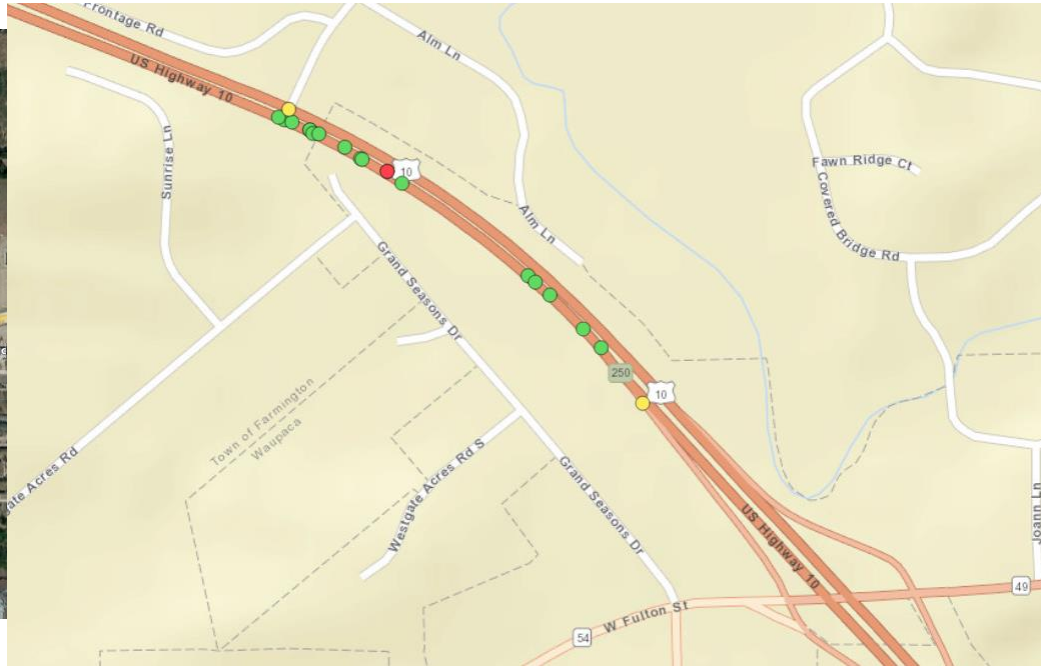
Horizontal Curve

- Identify curves: 2020 STN using CurveFinder
- Default threshold, no calibration
- Filter for curve length and radius
- Join crashes to curves
- 2014-2020 crashes
- Crashes between PC and PT of the curve were identified
- Compute B/C ratio for HFST at each curve

CurveFinder and Crash Join

CurveFinder and Crash Join





Curve ID: 010E_22_16

Challenges

- CurveFinder
  - Digitization impacts (vertex density) impacts output quality
  - Used default threshold
- Join crashes to curves
  - Spatial join can result in mapping error
  - Estimated cumulative mileages for curves and crashes
  - Depends on STN quality

B/C Estimation

- Costs: HFST costs
  - HFST cost of $20/SY
  - HFST Area: Curve length * total paved width (from MetaManager)
  - Traffic control cost: 6% extra
- Benefits: Reduction in crash costs
  - CMF from FHWA report
  - Crash severity distribution from crashes on curves
  - Crash costs for KABCO costs adjusted to 2021
- Compute B/C ratio for HFST at each curve

B/C Estimate

Curve ID	ONHWY	Div / Undiv	Radius (ft)	Length (ft)	Paved Width	Crash Count	Crash Reduction	HFST Cost ($)	Safety Benefits ($)	B/C ratio
002E_1_7	2	U	1600	1760	24	5				
002E_1_9	2	U	5323	1653	24	10				
002E_1_11	2	U	5451	1573	24	6				

WisDOT incorporation into HSIP

- Horizontal Curve Initiative
  - WisDOT has utilized the horizontal curve analysis done by UW TOPS Lab to create an initiative within HSIP for safety funding.
  - Initial implementation is on the state trunk network only
  - Minimum criteria set based on curve analysis and B/C estimation
  - Map and data file sent to WisDOT region staff to screen for potential projects
  - Primary safety countermeasure is high friction surface treatment (HFST), but other appropriate safety countermeasures are allowed.
    - HFST material type is calcined bauxite

Additional Lane Departure Initiatives

- High Risk Rural Roads (HRRR)
  - Focus on county trunk highway corridors classified as “rural major or minor collectors”
  - Statewide screening to identify top corridors based on crash data
  - Consultant performs corridor safety evaluation (CSE) of top corridors
    - CSEs are used as a basis for application for HSIP funding
- Cross Median Crash (CMC)
  - Cross median crashes analyzed and minimum criteria set for screening purposes
  - Most common treatment type is median cable barrier
  - Projects are submitted to HSIP review committee for review and approval
- Shoulder Rumble Strips
  - Includes shoulder widening and rumble strips
  - Screen of two-lane, undivided roadways on the state trunk network that meet minimum benefit cost ratio criteria