Max Donath Bio

Max Donath is Director of the Intelligent Transportation Systems Institute at the University of Minnesota, a congressionally designated University Transportation Center. The ITS Institute, under his direction since 1997, involves 30+ faculty, 15+ staff researchers and 100+ students pursuing research in: human performance and behavior, driver interfaces, sensors, communications, vehicle and traffic controls, modeling and simulation – developing new approaches for confronting difficult transportation issues.

Dr. Donath was responsible for the strategic plan that re-engineered the Institute when it was re-authorized in 1998. Its new focus on human centered technology to enhance safety and mobility brought together cognitive psychologists and research engineers to focus on novel solutions to transportation problems—solutions that adapt technology to humans rather than the other way around. Building on the core funding provided by the ITS Institute and partnerships with the Minnesota DOT, the Minnesota Department of Public Safety, Metro Transit and other agencies, a team of research staff led by Donath was able to successfully compete nationally and internationally on many programs focused on the human-vehicle interface. Donath has successfully led several major US DOT and Minnesota DOT sponsored programs, field operational tests and multi-state DOT initiatives, integrating the efforts of multiple organizations and their staff.

Dr. Donath has published widely, documenting the design, development and experimental validation of innovative approaches that integrate sensors, intelligence, and motor control in order to assist humans with the performance of complex tasks. His most recent efforts have been directed toward the application of sensors and control systems to reduce driver error and the resulting road fatalities and life changing crashes. He together with his team has adapted theory to design and have built tools that can be experimentally validated on the road. As a result, many of these innovations are now being deployed in the field, including systems that are being integrated into the fleet of a major vehicle OEM. In addition to research and teaching, Dr. Donath has been active in many organizations, including service on TRB committees and government advisory panels.

Reducing Fatalities and Life Changing Crashes:

Human Centered Technologies Enabling New Solutions

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National Surface Transportation
Policy & Revenue Commission
Field Hearings,
April 18-19, 2007

from Leonard Evans (2004)
"Traffic Safety"

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Intelligent Transportation Systems Institute
a National University Transportation Center
authorized under SAFETEA-LU, TEA-21, ISTEA

Human-Centered Technology to Enhance Safety and Mobility

Disciplines from 5 colleges
and 2 campuses including:
- Civil Engineering
- Computer Science
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering
- Policy and Public Affairs
- Psychology
- Law

MINNESOTA VALLEY TRANSIT AUTHORITY MVTA

Metro Transit

…and many counties

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Road Mortality

- **In the US, traffic crashes cause more deaths between the ages of 2 and 33 than any *other injury or illness*.**
  - 25% of all deaths in this age range are from traffic crashes.
- **Traffic crashes are the leading cause of *unintentional injury-related death between the* ages of 2 to 76.**
- **By 2020, traffic crashes are predicted to become the *third largest cause* of death and disability worldwide.**
  - Globally, more deaths and disability are expected from traffic crashes than from wars or AIDS.

[WHO, 2000; NSC, 2006, p. 14]

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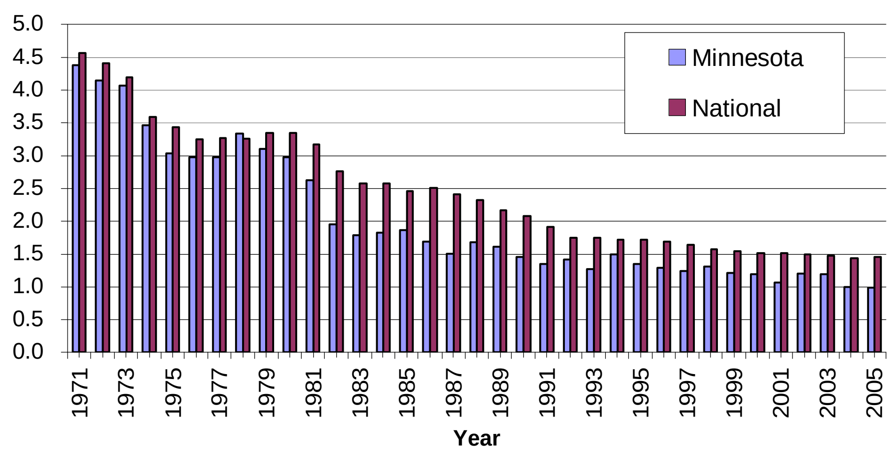
Fatalities per 100 Million Vehicle Miles of Travel
Minnesota vs. National
Total (1971-2005)

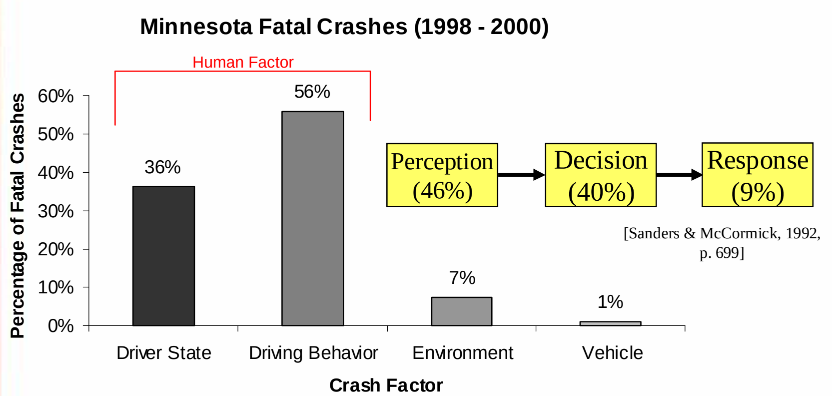


Vision

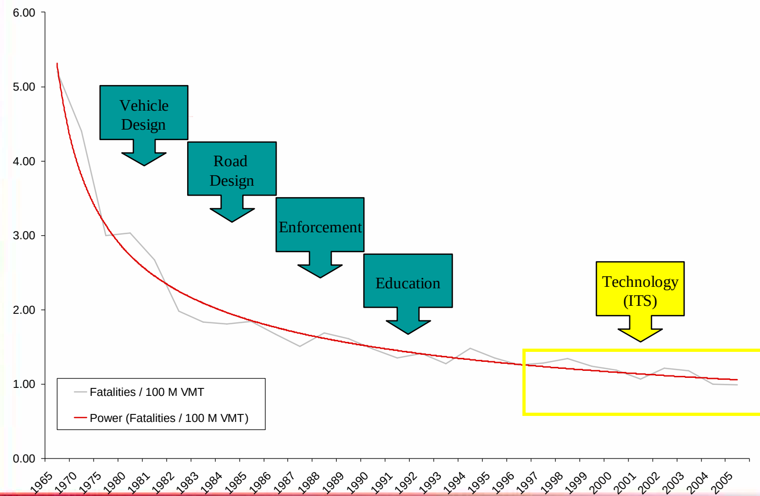
Can reduce fatalities and life changing crashes …

- Focus on those at highest risk (teens, rural driving, lane departure, older drivers)
  - Teens (16-19 years old) make up only 4.7% of all licensed drivers, but are involved in 10.1% of all fatal crashes (2005).
  - Teen drivers have a higher fatality risk than any other driver age group on the road.
  - Rural road fatalities outnumber urban fatalities (over 2:1)
  - Lane departure crashes represents over 1/3 of all road fatalities; 2/3 of these occur on rural roads
  - Older driver fatalities are over-represented at rural unsignalized intersections

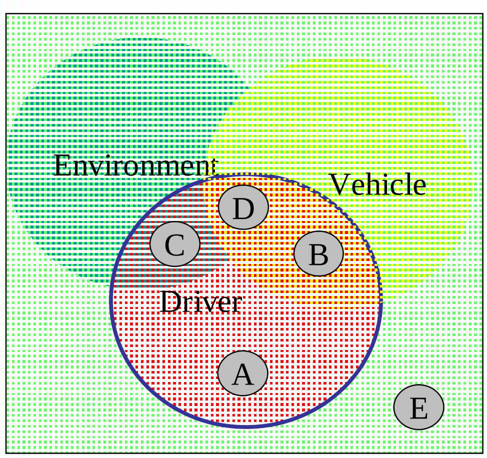
Human Centered Technology:
Need to Focus on the Driver (Human Factors)



Traditional approaches have been effective, but over the last 10 years their impact has been marginal: Need Innovation



Human-Centered Systems Perspective



A. Human Factor – Impairment

B. Vehicle-based Driver Support Systems

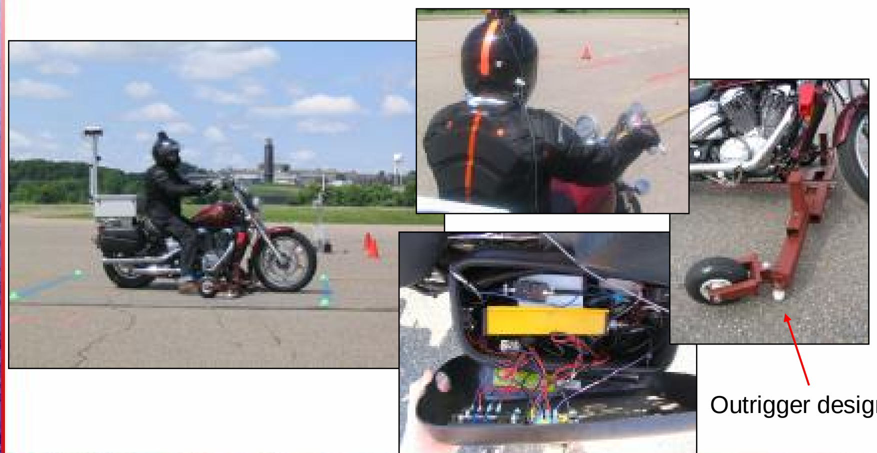
C. Infrastructure-based Driver Support Systems

D. Cooperative Driver Support Systems

E. Traffic Safety Culture

Motorcycle Driver Behavior

Approximately 35% of fatal motorcycle crashes are alcohol-related
Goal: Quantify behavioral impairment of motorcycle riders on test track when sober and at different BAC levels (0.02, 0.05 & 0.08)



Outrigger design

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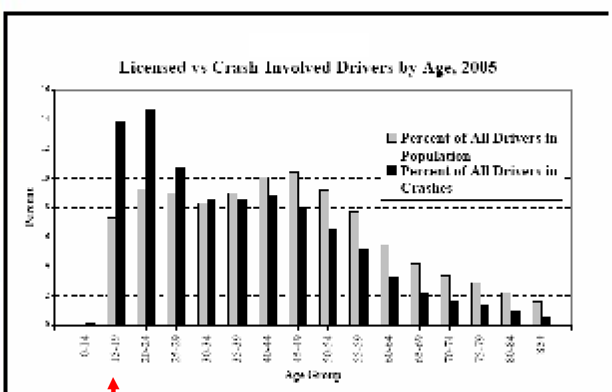
In MN, teens (15-19 years old) represent 7% of licensed drivers, but 14% of crash-involved drivers.
(Minnesota Crash Facts, 2005)



- **Novice teen drivers -> most crashes and years of lost productive life.**
- **Changing teen behavior early may improve their behavior when they are 20-24 year olds.**

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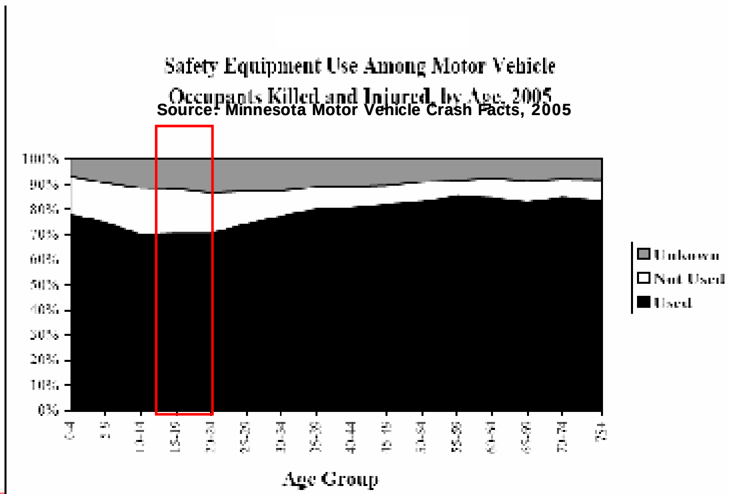
Teen Fatality Contributing Factors: Seatbelt Use

In Minnesota, seatbelt use is lowest among teenagers.



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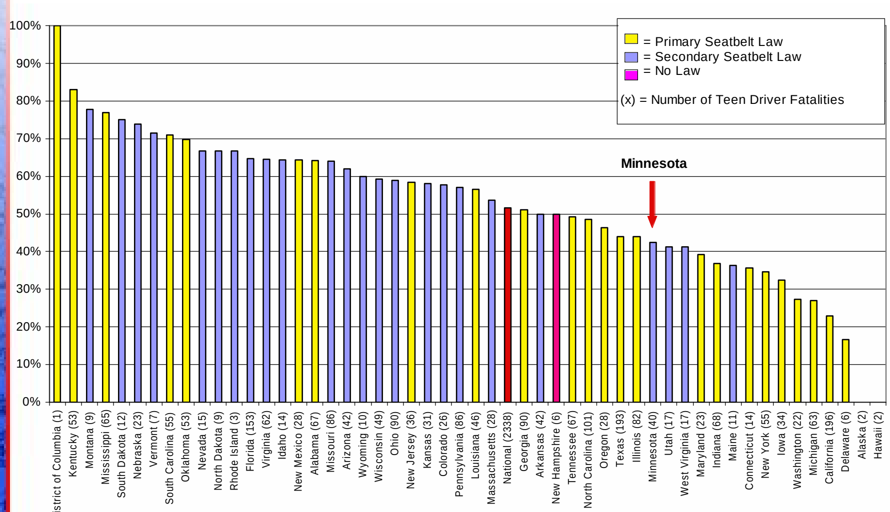
Teen (16-19) Driver Fatalities, % Unrestrained (Passenger vehicles only) Source: FARS 2005



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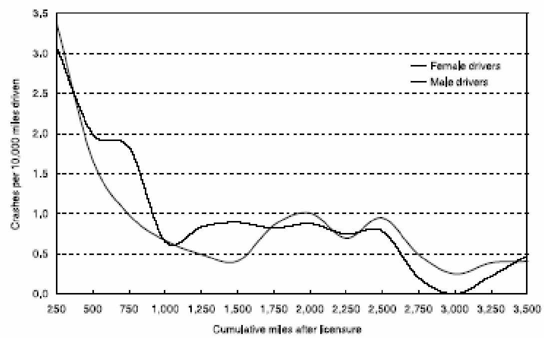
New tools needed. When?
Crash rate by cumulative miles driven after licensure and by gender (Ref. 1)

- First 250 miles aggregate crash involvement rate: 3.2 (per 10K miles)
- First 500 miles rate: 1.8 (per 10K miles) (1)
- For novice drivers, crash rates decrease dramatically from the 1st to the 7th month (41%), then gradually decrease through the 24th month after licensure (60% overall reduction) (Ref. 2)



(1) McCartt A.T.; Shabanova V.I.; Leaf W.A. (2003). "Driving experience, crashes and traffic citations of teenage beginning drivers," Accident Analysis and Prevention, 35, (3), pp. 311-320

(2) Mayhew, D.R., Simpson, H.M. and Pak, A. (2003). "Changes in collision rates among novice drivers during the first months of driving." Accident Analysis and Prevention, 35, pp. 683-691.

Behavioral Modification: Functions

In-vehicle technology has the ability to address teenage crashes by forcing behavior, providing driver feedback, and reporting driving behavior of teenagers.

….. Focus on the novice teen driver

- **Forcing Behavior.**

Some unsafe actions (risks) may be habitual. **Forcing requires specific behavior to occur prior to or during vehicle operation.**

- **Driver Feedback.**

Drivers may not be aware of risks. **Real-time warnings can alert the driver in case of poor driving behavior or potential risks.**

- **Reporting Behavior.**

Some drivers may purposely take risks because they feel anonymous. **Vehicle parameters can be saved for inspection by parents (or other authorities).**

Existing commercially off-the-shelf system deficiencies

See www.gps-practice-and-fun.com/teen-car-tracking.html

- Current systems in USA are too passive.
- None of the systems:
  - Provide context: *Modify* speed warning threshold based on individual road's local speed limit, or upcoming road curvature (as per ISA), time of day or weather (RWIS).
  - *Force* behavior such as using seatbelt or maintaining sobriety.
  - *Recognize* current driver.
- Need teen driver-parent centric system, designed to modify dangerous teen driving behavior and empower parents. Must accommodate all parents.
- Must include incentives and consequences. Tie to GDL?

Enabling Technologies for Teen Driver Support System (TDSS)

- Prototypes Important for learning about what works and doesn't; difficult to gage reaction to abstract concepts.
- Have designed/demonstrated working prototypes that incorporate:
- Intelligent Speed Adaptation (ISA)
  - Speed Limits: Digital maps updated with speed limits
  - Curve speed warning.
  - Weather related speed. Real-time wireless access can be used for pavement condition and weather. Available in Minnesota.
- Seatbelt Interlock (and monitoring)
- Real-time Feedback
  - Auditory Contextual Voice-based Warnings
- Real-time and Off-line Reporting
  - Automated cell phone report (to parents, monitoring "computer")
- Driver identification:
  - Biometric fingerprint identification (to identify who is driving and whether parent is in vehicle)

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Certain interventions best introduced at vehicle manufacture

- The ability to turn on an interlock capability for teens can be easily facilitated at vehicle manufacture
- Sensors already on board for sensing seatbelt engagement
- Sensors on recent model cars detect number of passengers
- Interlock functionality already built in (associated with transmission, theft prevention, etc.)
- “Smart” keys can identify driver (and presence of supervising adult)
- Trivial to “enforce” selected behaviors with after-market system, if certain signals were made accessible

  … but vehicle manufacturers have thus far chosen not to.

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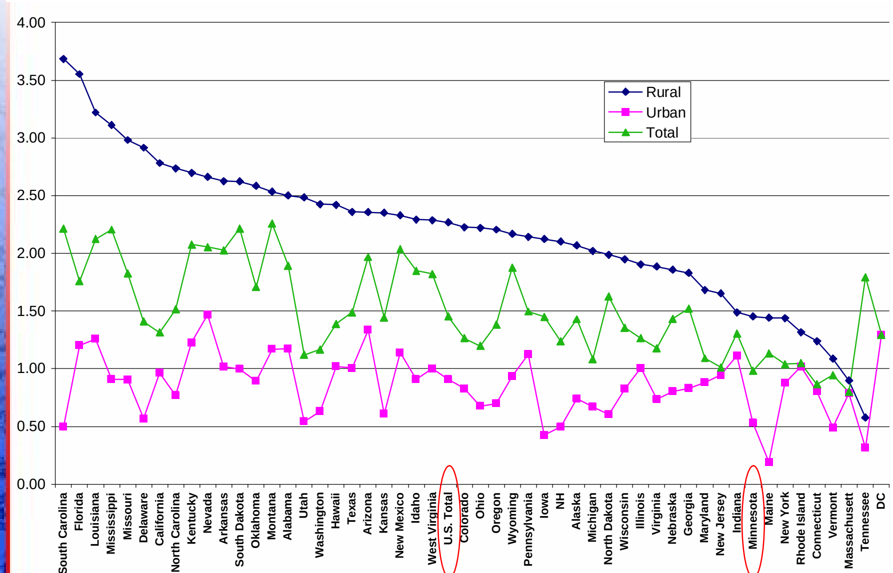
Fatalities/100 Million VMT (Rural, Urban and Total), 2005



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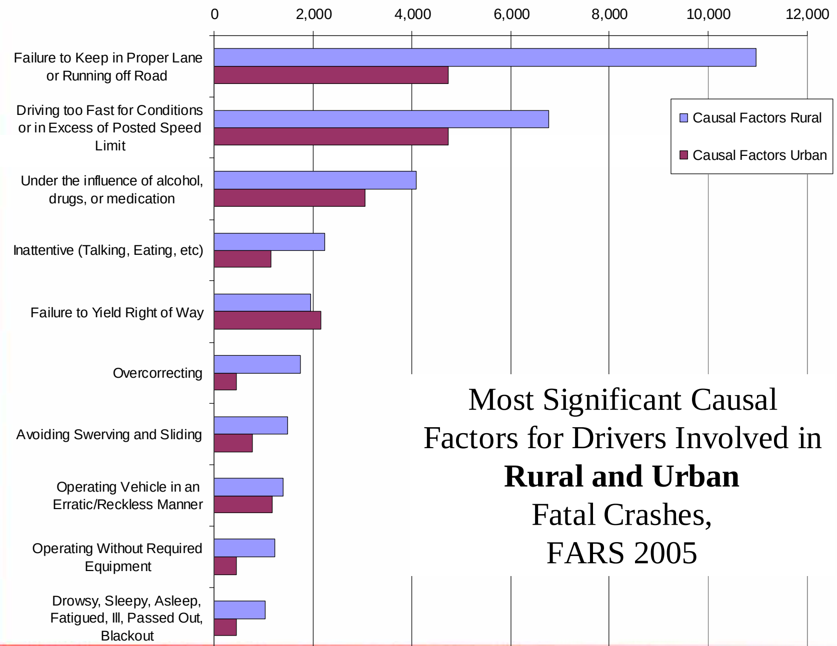

Most Significant Causal Factors for Drivers Involved in **Rural and Urban** Fatal Crashes, FARS 2005

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Can Technology Prevent Lane Departure?

- Focus on HUMAN CENTERED APPROACH.
  - Detect/predict whether the vehicle is about to leave the road or lane
  - Sensed lateral vehicle position used to generate a steering wheel torque that helps the driver stay in lane.
  - Detect whether the driver is driving inappropriately, has lost control.
- If driver does lose control (or DWI), implement aggressive intervention strategies.
  - Example: Automatically steer the vehicle to the shoulder and then bring it to a safe stop.

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Bus Rapid Transit (BRT)
on 250+ mile Bus-Only Shoulder “Busway” Network

Driver Stressors

- Narrow width
- Bridge abutments
- Stopped vehicles
- Shoulder violations
- (Heavy) vehicles in adjacent lane
- Bus bouncing and hitting curb
- Tires dropping off paved edge
- Vehicles and pedestrians crossing at intersections

Minnesota Lane Assist System

- D-GPS and Hi-accuracy map
- Radar & LIDAR
- Virtual Mirror
- HUD (lane marking, hazards)
- HUD color coding
- Directional haptic feedback in seat at lane boundary
- Directional steering torque relative to deviation from center line.

(Video available on request)

High accuracy maps for our rural roads can enable lane departure warnings and other safety applications

Day time view to show accuracy of projected lane markings (2001) on Minnesota Hwy 101

(Video available on request)

Intersection Crashes

- 2.52 million intersection related crashes (2005).
- Represents 40% of all 6.2 million police reported crashes.
- In the US, 8,655 of 39,189 (22.1%) of fatal crashes were intersection related:
  - 32% occurred at signalized intersections
  - 68% occurred at unsignalized intersections (stop sign, no controls, other sign)
- In Minnesota (2005), 149 out of 500 (29.8%) fatal crashes were intersection related:
  - Equivalent to 168 of 559 fatalities (30%).
  - During a three-year period (1998-2000), 62% of all intersection-related fatal crashes in Minnesota occurred at rural through/stop intersections.

NHTSA, *Traffic Safety Facts 2005 Table 28 Chapter 2*
Minnesota Office of Traffic Safety, *Minnesota Motor Vehicle Crash Facts*

Older Drivers and Intersections

- Older drivers (> 65 years) have a high crash risk at intersections:
  - Drivers > 75 years
    … Greatest accident involvement ratio
    (Stamatiadis et al., 1991)
  - Drivers > 65 years
    … 3 to 7 times more likely to be in a fatal intersection crash (Preusser et al., 1998)
  - Drivers > 65 years
    … Over-represented in crashes at rural thru-stop intersections in Minnesota (Preston & Storm, 2003)

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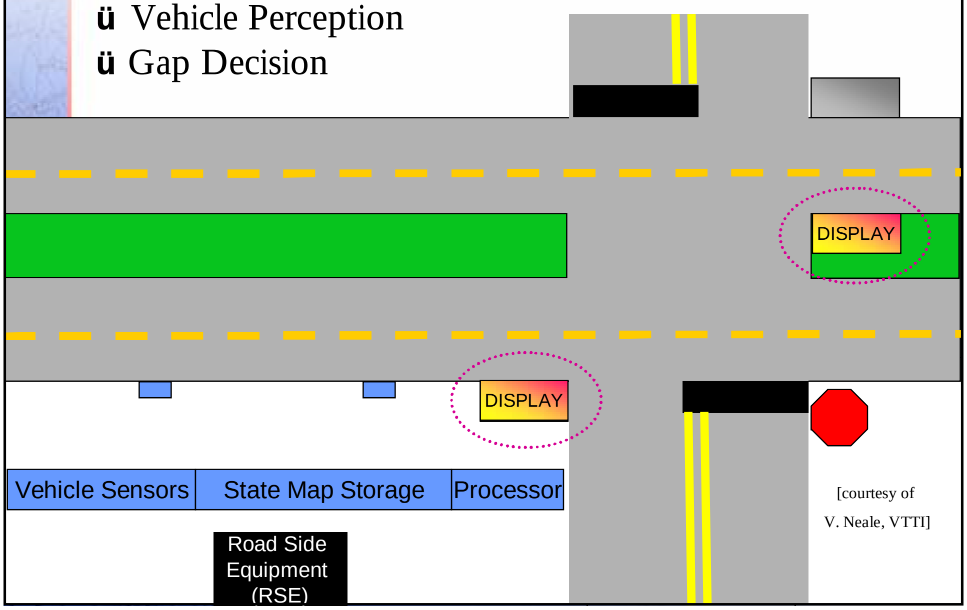
Cooperative Intersection Collision Avoidance Systems: Stop Sign Assist -> CICAS-SSA

ü Vehicle Perception
ü Gap Decision



We need new solutions!

- Must pursue unconventional solutions.
- Focus on areas that have implications to fatality reduction.
- Focus on drivers who are already at risk.
- Work closely with the local keepers of the infrastructure: states, counties, etc. Demonstrate end-to-end solutions.
- Get systems into the hands of real drivers operating in their real world as soon as possible:
  More field operational tests
- Do not cut funding for safety focused ITS R&D to generate new $ for congestion mitigation initiative

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