Evaluation of Connected Vehicle Warnings Effectiveness on Truck Drivers Behavior: Lessons Learned

Omar Raddaoui, MS
Graduate Research Assistant
Mohamed M. Ahmed, Ph.D., P.E.
Associate Professor

WYDOT | CONNECTED VEHICLE PILOT

UNIVERSITY OF WYOMING

Overview of Wyoming I-80

- 402 mile stretch
- Vital freight corridor
- 30-55% Truck volume
- Difficult road & weather conditions
- 1552 hours of road closure yearly

Source: Wyoming Highway Patrol – April 2015

Wyoming DOT Connected Vehicle Pilot

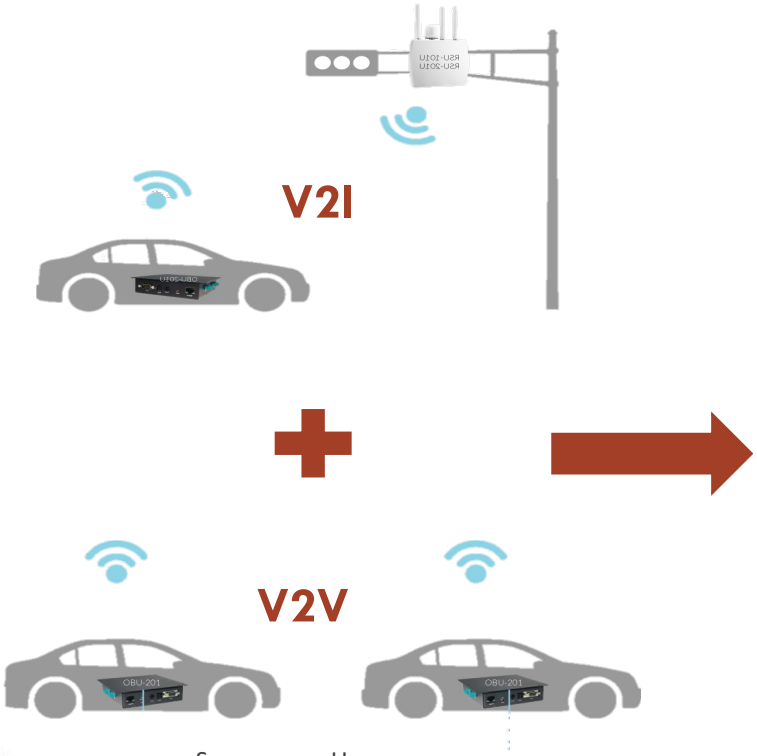
Source: WYDOT

WYDOT | CONNECTED VEHICLE PILOT

- Freight-focused
- Improve travel reliability and safety on I-80 corridor

UNIVERSITY OF WYOMING

Wyoming DOT Connected Vehicle Pilot



Source: Unex

Human Machine Interface (HMI)

UNIVERSITY OF WYOMING

Wyoming DOT Connected Vehicle Pilot

Suite of CV Applications

FORWARD COLLISION WARNING

I2V SITUATIONAL AWARENESS

WORK ZONE WARNING

SPOT WEATHER IMPACT WARNING

DISTRESS NOTIFICATION

Source: WYDOT

Wyoming DOT Connected Vehicle Pilot

Pilot's Performance Measures - Measuring Success

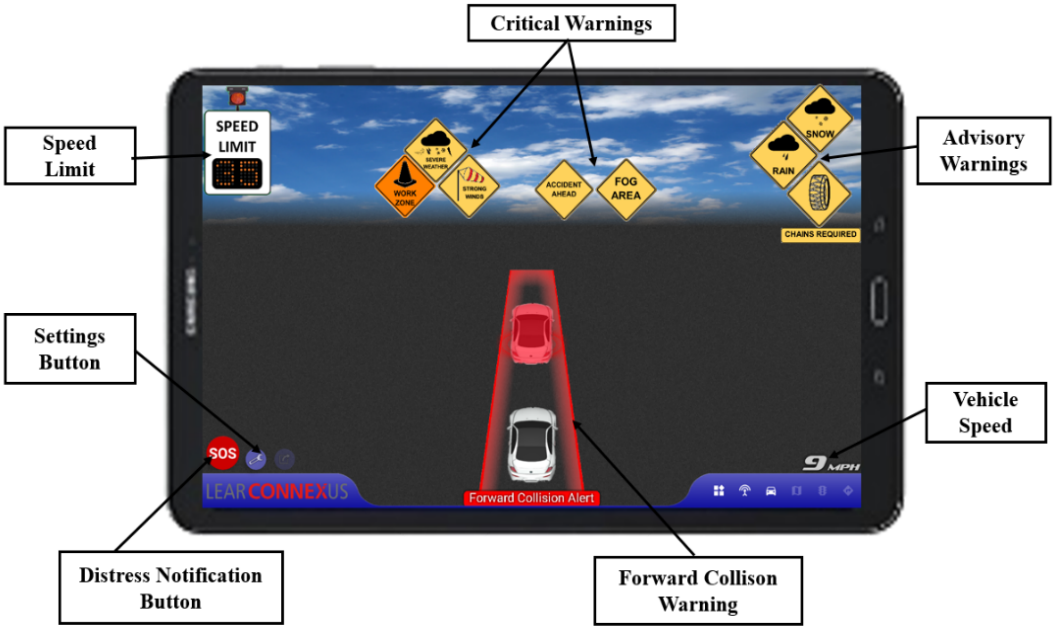
No.	Performance Measure	Target
	Effectively Disseminate and Receive I2V and V2I Alert/Advisory Messages from the TMC	
7	Connected vehicles that likely took action following receipt of an alert • Parked • Reduced speed • Came to a stop safely • Exited	80% of vehicles likely took action based on alert
	Effectively Transmit and Receive V2V Messages	
12	Connected vehicles that took action following receipt of a V2V alert • Parked • Reduced speed • Came to a stop safely • Exited	80% of vehicles took action based on V2V alert
	Improved Speed Adherence and Reduced Speed Variation	
14	Total vehicles traveling at no more than 5 mph over the posted speed (compare before and after CV Pilot)	20% improvement over baseline of total vehicles traveling no more than 5 mph over posted speed during CV Pilot. Baseline will determine what percentage is traveling no more than 5 mph over posted speed prior to CV Pilot.
16	Speed of applicable connected vehicles are closer to posted speed when compared to non-connected vehicles	Connected vehicles are 20% closer to posted speed

Kitchener et al. (2015)

The Team

Objective – HMI/ UX Design

Derive maximal safety benefits from real-life deployment



UNIVERSITY OF WYOMING

Approach

- Driving simulator experimentation
- Stakeholder engagement

Lesson #1: Prompt the Appropriate Driver Response

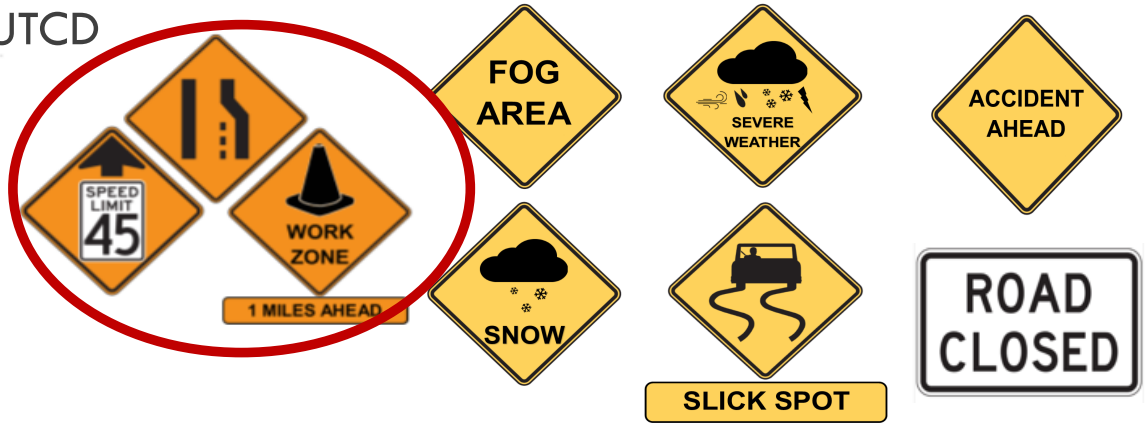
Keep It Easy & Simple

HMI Design Guidelines - FHWA (2015)

- Use familiar & standard signs - MUTCD

Existing Design

- Signs from/adapted from MUTCD



Our Findings

Not Easy at All to Understand — **Moderately Easy to Understand** — **Very Easy to Understand**

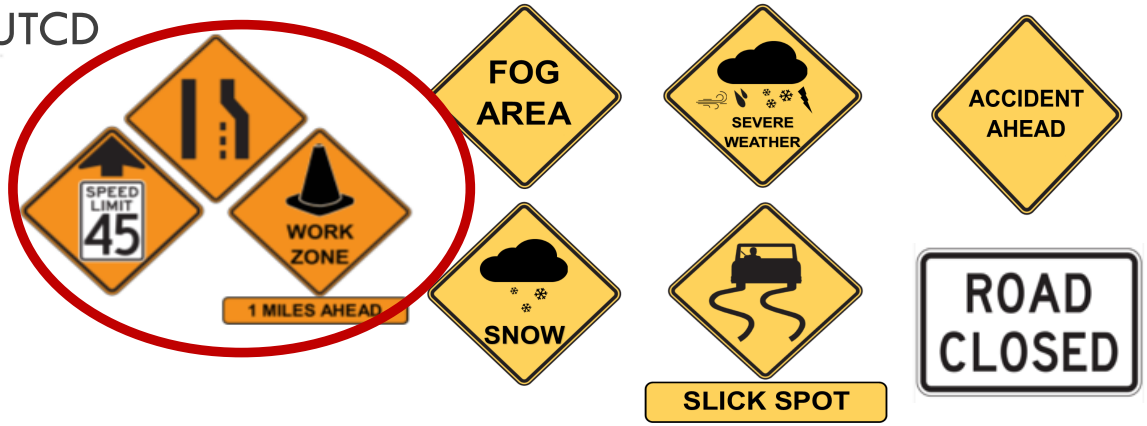
Keep It Easy & Simple

HMI Design Guidelines - FHWA (2015)

- Use familiar & standard signs - MUTCD

Existing Design

- Signs from/adapted from MUTCD



Our Findings

It's All About Driver Response

Problems

- Late and forced merging behavior at work zones
- Truck drivers need early alerts

Existing Design

- Inform drivers of lane closures well in advance

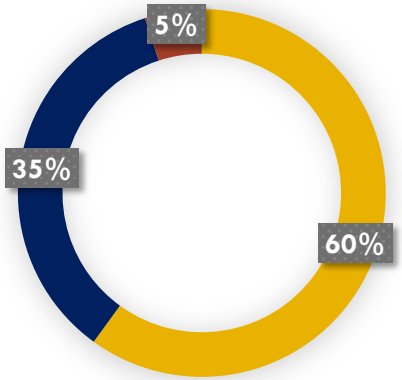
Early

It's All About Driver Response

Existing Design

- Inform drivers of lane closures well in advance

Our Findings



- Merged prior to road static lane merge sign
- Merged after road static lane merge sign
- Merged at taper zone

It's All About Driver Response

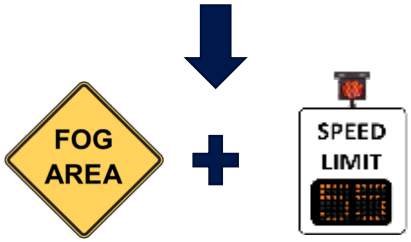
Problems

- Speed variability at work zones
- ~ 20% rear end crashes (FMCSA, 2018)
- Blocked vision & presence of adverse weather
- Speeding of any kind ~ 7% (FMCSA, 2018)

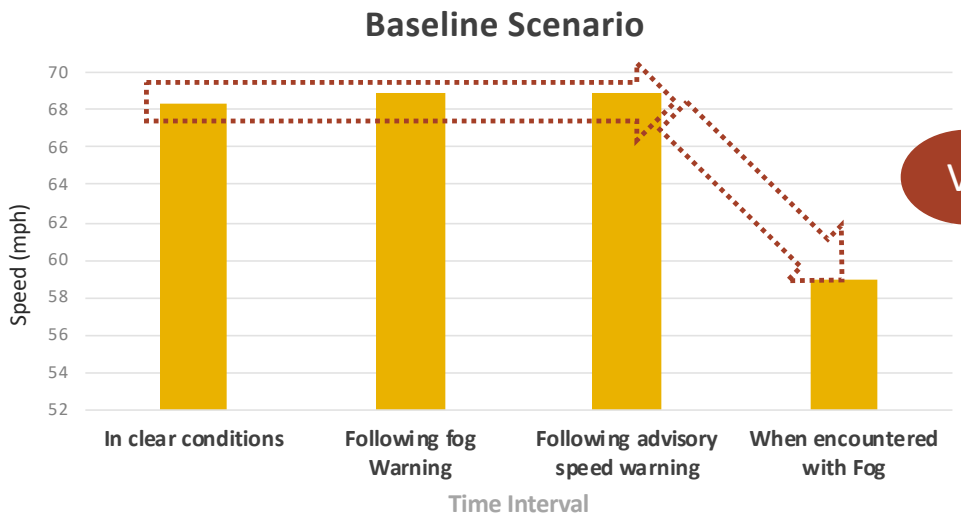
NBC Chicago (2012)

UNIVERSITY OF WYOMING

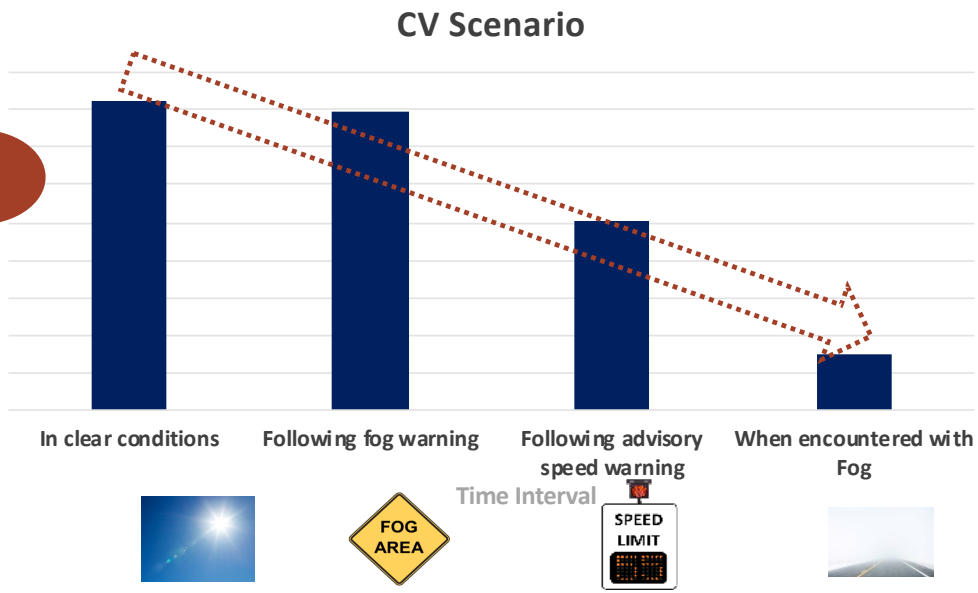
It's All About Driver Response



It's All About Driver Response



VS



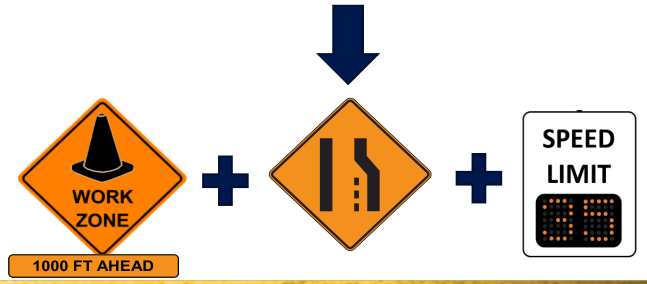
Abrupt Reduction in Speed

Gradual Reduction in Speed

UNIVERSITY OF WYOMING

It's All About Driver Response

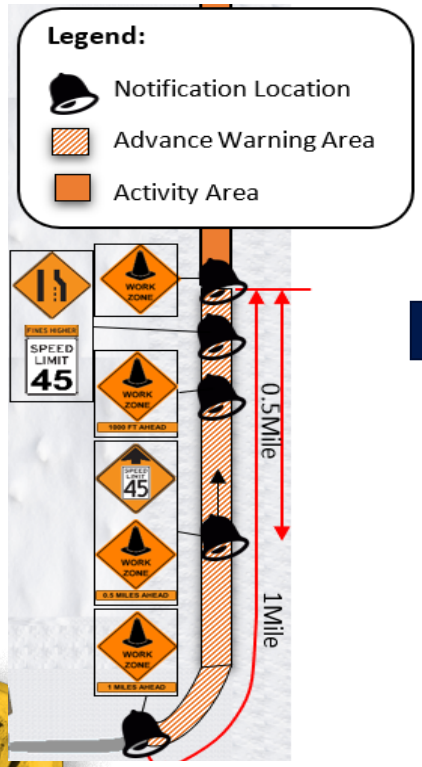
Scenario Design



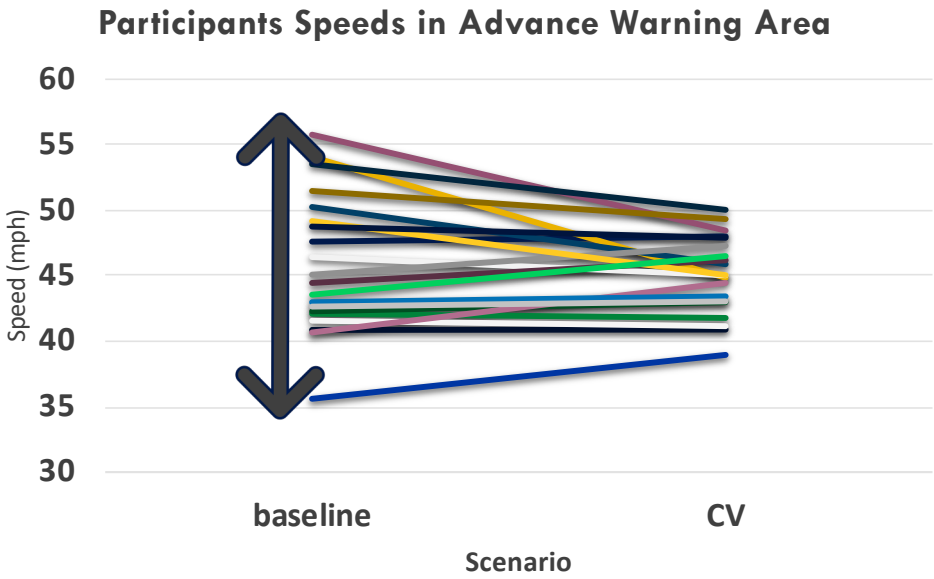
UNIVERSITY OF WYOMING

It's All About Driver Response

Work Zone Warnings



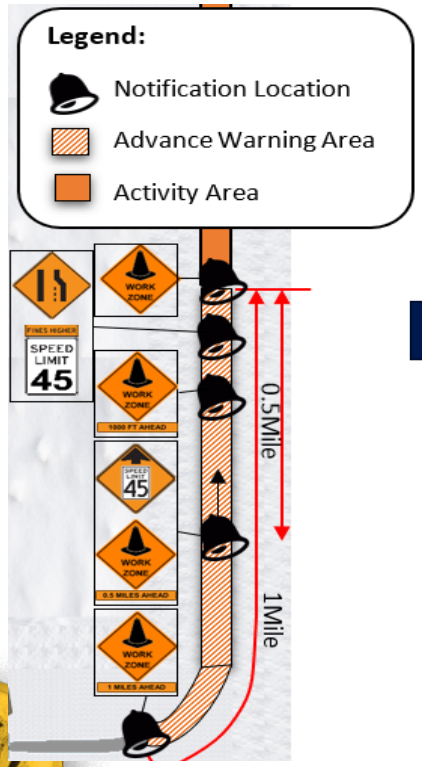
Our Findings



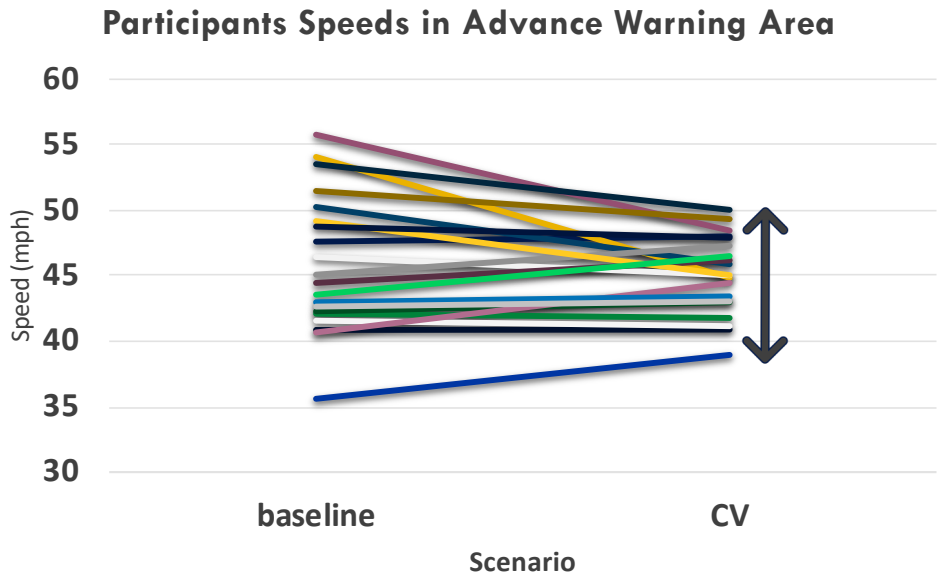
UNIVERSITY OF WYOMING

It's All About Driver Response

Work Zone Warnings



Our Findings



More harmonious speeds

UNIVERSITY OF WYOMING

Lesson #2: Driver Safety is Above All

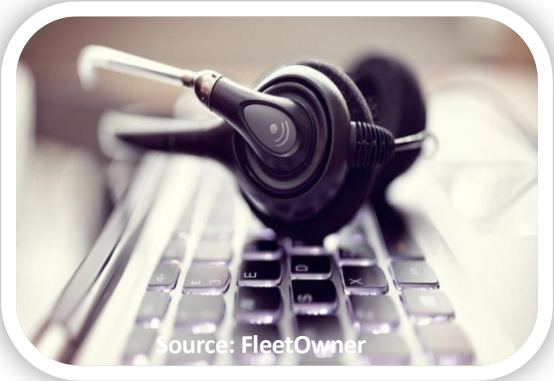

Source: Dolman Law Group

Do Not Distract Truck Drivers

Human Factors – Truck Drivers

- Challenging driving environment

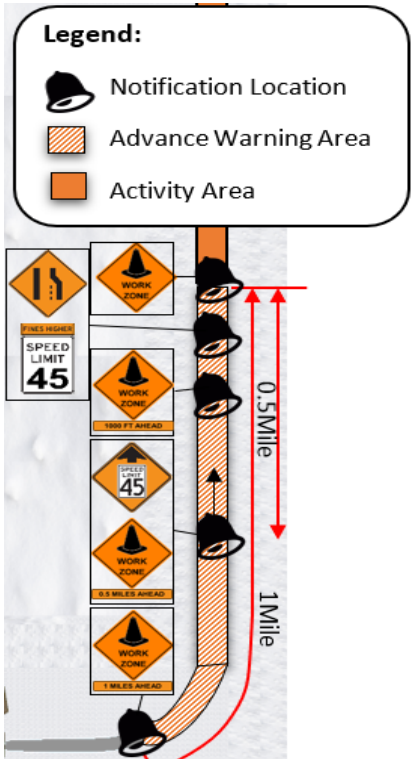

Source: En.Wheelsage – Scania G450


Source: FleetOwner


Source: FleetOwner

Do Not Distract Truck Drivers

Our Findings



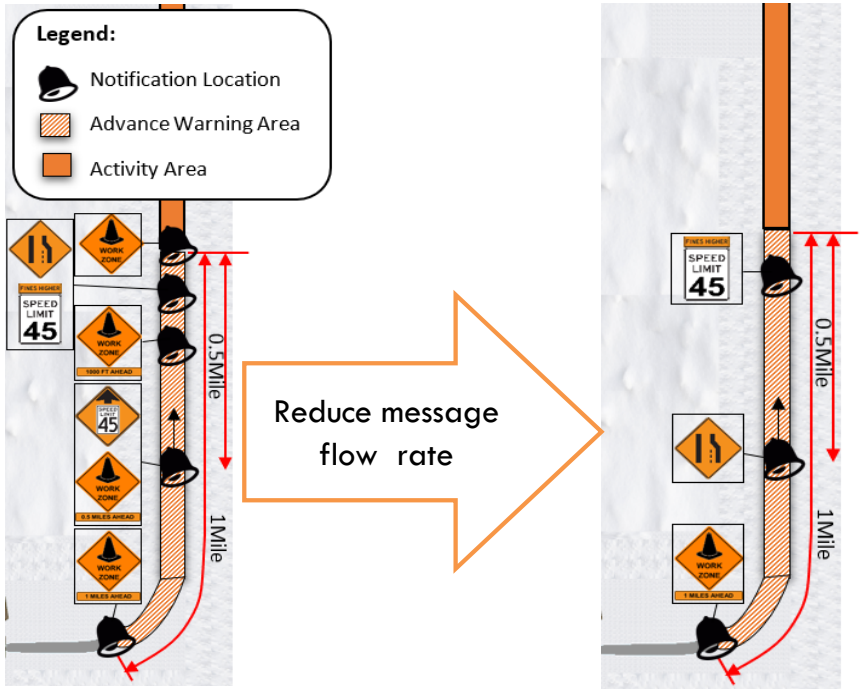
- 30% of simulator participants found CV moderately distracting
- Work Zone Warning application invoked notable distraction

Do Not Distract Truck Drivers

Recommendations

HMI Design Guidelines - NHTSA (2016)

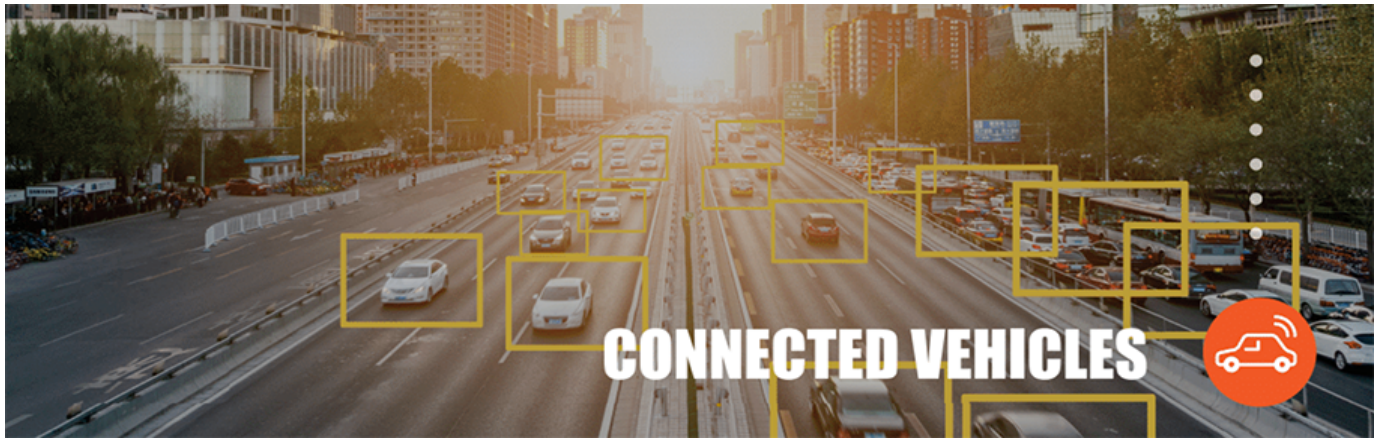
In difficult driving conditions, filter out messages of lower safety relevance



Original design

Recommended design

Lesson #3: Build User Trust & Approval



Understand Truck Drivers' Needs

Human Factors – Truck Drivers

- Low tolerance for nuisance

➔Minimize redundancy with road static signs

Our Findings

- Higher approval for CV apps with marked safety/operational benefits

➔ Allow user customizability

Source: Fleet Owner (2017)

Communicate in a Balanced Way

INTERSTATE 80

Improve Situational Awareness

VS

Minimize distraction & Nuisance