THE EASTERN TRANSPORTATION COALITION

CONNECTING FOR SOLUTIONS

Virtual Information Exchange:
Moving the Needle on CAV Research: Recent TETC Projects for Connected Vehicles

November 9, 2023

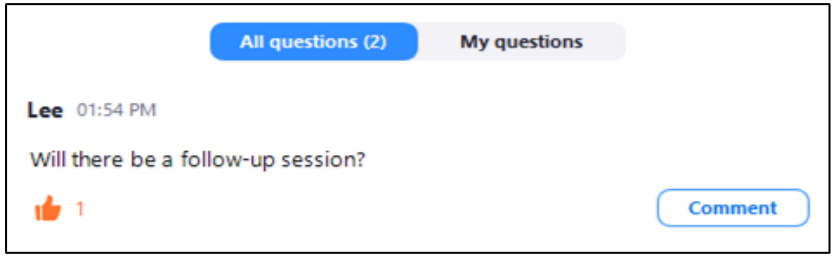
Welcome

- We are using **Zoom Webinar**
- **AUDIO (Computer):** Use your computer speakers and microphone by clicking the “Join Audio” button at the bottom left of the screen. You will be muted.
- **Alternate Audio (Phone):** Call into the meeting by dialing the phone number based on your location (provided in the confirmation email) and enter the Meeting ID at the prompt. You will be muted.
- **This web meeting is being recorded.**
- **Questions** with the audio or web? Please contact Esther via email (ekleit@kmjinc.com)

Asking Questions in the Q&A Box

- Click on the Q&A icon at the bottom of your screen

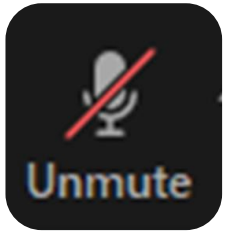
- The questions in the Q&A box will be monitored and answered either between presentations or at the end of the meeting
- You can keep track of your questions in the “My Questions” tab in the Q&A box



Asking Questions Verbally

- Please raise your hand *(click on the hand icon at the bottom of the screen)*, and a host will unmute you.
- Please give your name and agency before asking your question

- **Please mute yourself when you are finished speaking**



Polling & Discussion Questions

- Please participate in the meeting!
- For any **polling** or **discussion** questions, please feel free to enter additional information or additional thoughts into the Q&A.

  If you use the Q&A, please note that **poll #** for reference.

Welcome

Lisa Miller
Innovation Program Associate
The Eastern Transportation Coalition

Coalition TSMO Update – Recent & Upcoming Events

RECENT

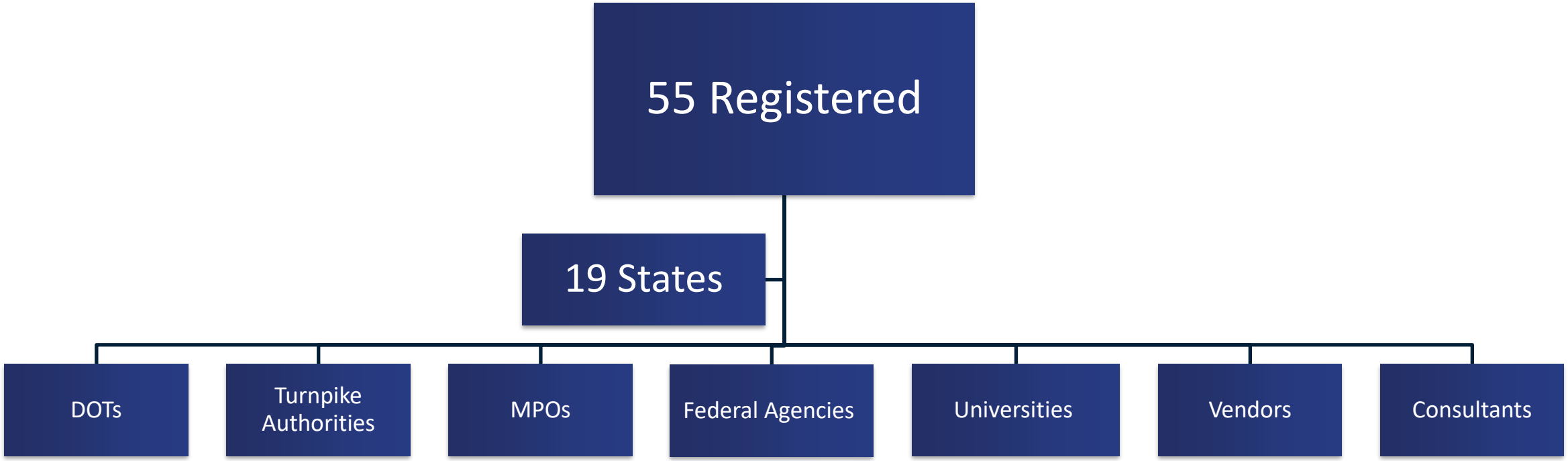
- ✓ Freight Data and Planning Working Group Web Meeting - Sep 13, 2023
- ✓ Regional HOGs In-person Exchange with Virtual Reality TIM Training Session *(invite only)* – Sept 13, 2023 (New England), Oct 19, 2023 (Potomac) and Nov 2 (Delaware Valley)
- ✓ RITIS User Group Meeting - Oct 19, 2023
- ✓ Travel Information Summit, Raleigh, NC & via web *(invite only)* – October 24 & 25, 2023

UPCOMING

- MBUF International Truck Pilot Report - A Scalable Approach that Links Road Use & Payment - Nov 21, 2023
- Southern HOGs In-person Exchanges with Virtual Reality TIM Training Sessions *(invite only)* - December 6, 2023
- TDM State Point of Contact Meeting *(invite only)* - November 14, 2023
- RITIS Workshop - December 5, 2023

tetcoalition.org

The Eastern Transportation Coalition Sponsored Event



Agenda

Topic	Speaker
Housekeeping	Joanna Reagle, KMJ Consulting, Inc.
Welcome & Update from the Eastern Transportation Coalition **Framing the Discussion**	Lisa Miller, Innovation Program Associate, The Eastern Transportation Coalition
2023 ADAS Driver Education Pilot Study	Kathleen Rizk, Senior Director, User Experience Benchmarking & Technology, JD Power Lisa Boor, Senior Manager, Auto Benchmarking, JD Power
CTDOT/TETC AV Lane Marking Evaluation Study Report	Peter Calcaterra, Transportation Planner, Connecticut DOT Shaon Mohammed Associate Research Scientist, University of Connecticut Eric Jackson, Executive Director, Connecticut Transportation Institute/ University of Connecticut
Wrap Up	Lisa Miller

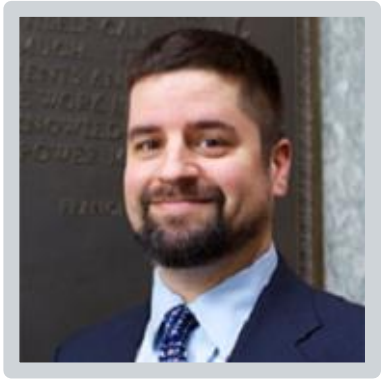
Speakers

Kathleen Rizk
Senior Director, User Experience
Benchmarking & Technology
JD Power

Lisa Boor
Senior Manager, Auto Benchmarking
JD Power

Peter Calcaterra
Transportation Supervising Planner,
Bureau of Public Transportation
Connecticut DOT

Shaon Mohammed
Associate Research Scientist
University of Connecticut



Eric Jackson
Executive Director
CT Transportation Institute/
University of Connecticut

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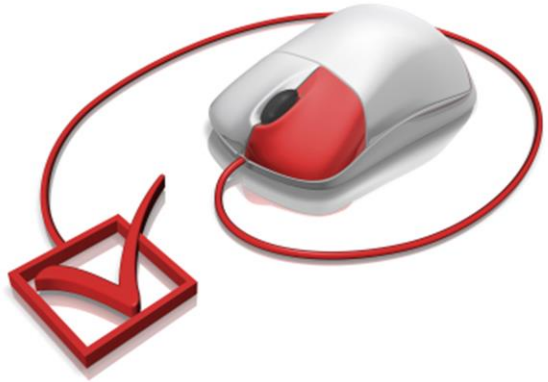
Framing the Discussion

Lisa Miller
Innovation Program Associate
The Eastern Transportation Coalition

Moving the Needle on CAV Research

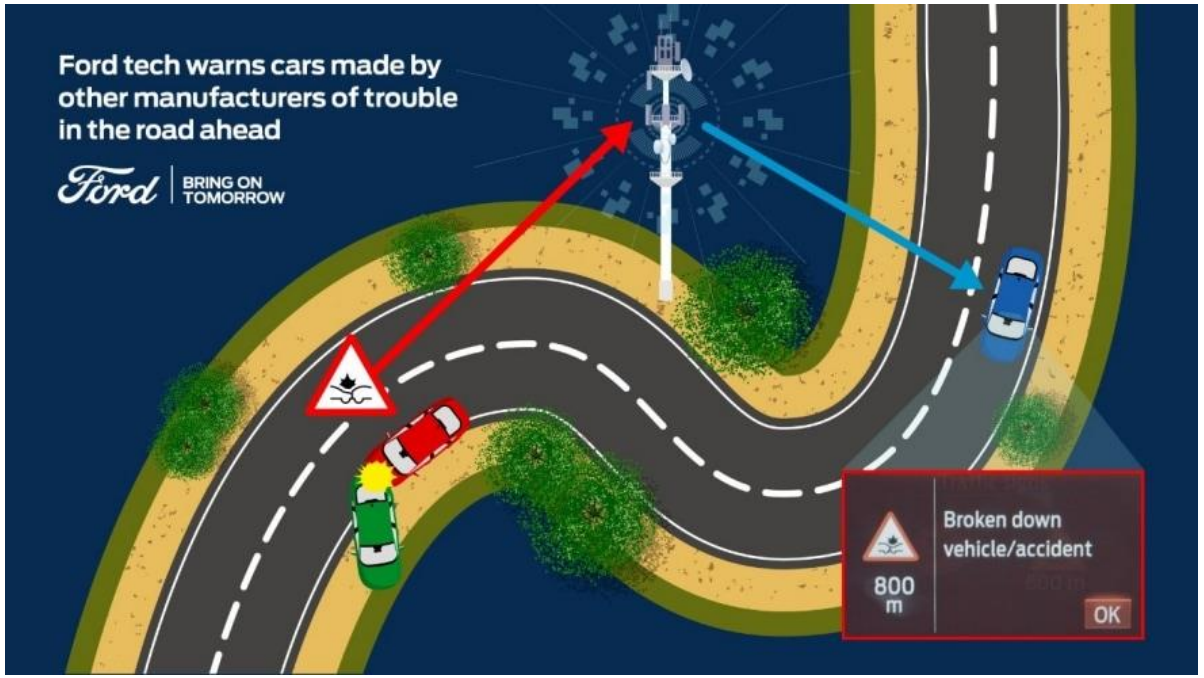
Poll 1:
What are you learning through CAV readiness work in your state? *(open ended question)*

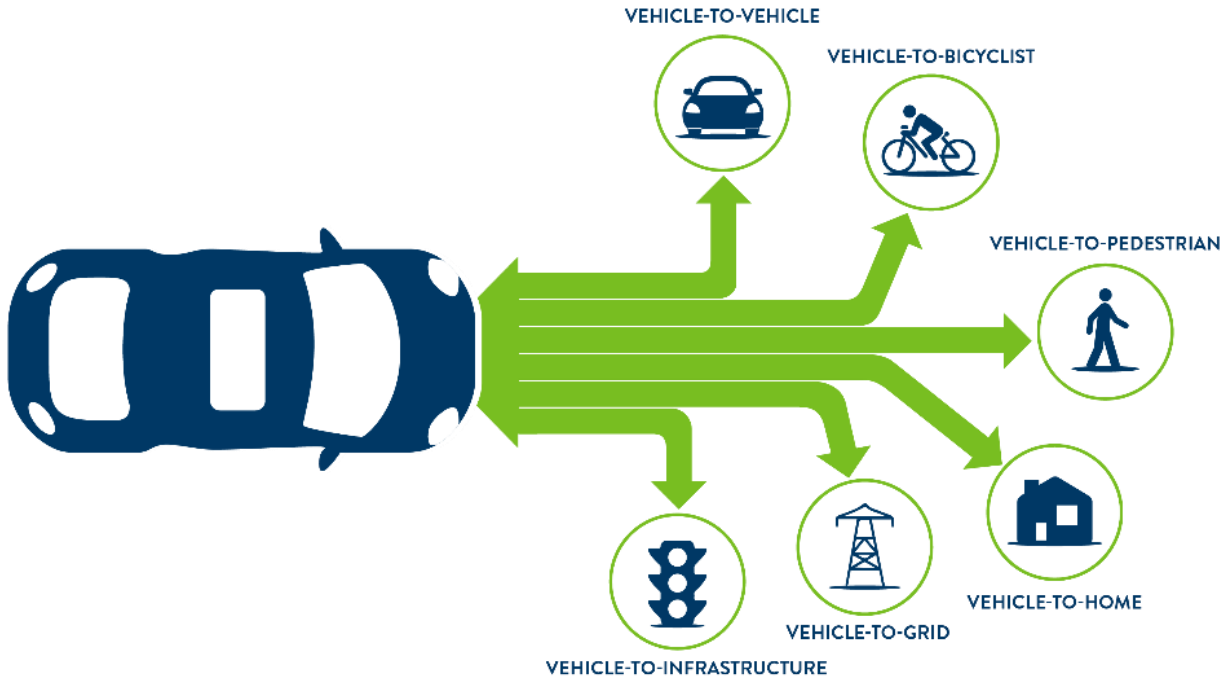
- Please submit your answer in the Q&A box.



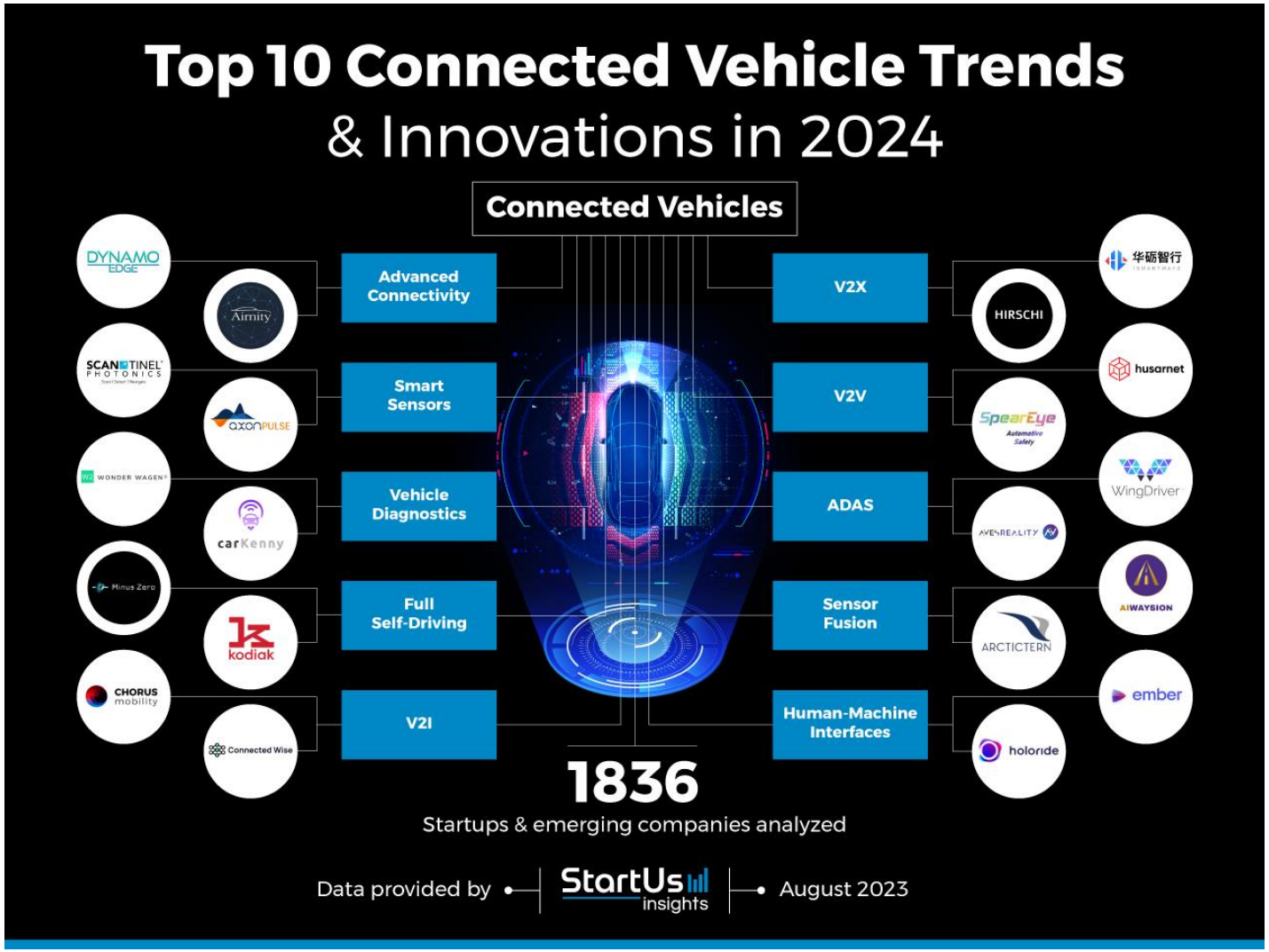
Why should we get ready?

How does safety fit into the mix?



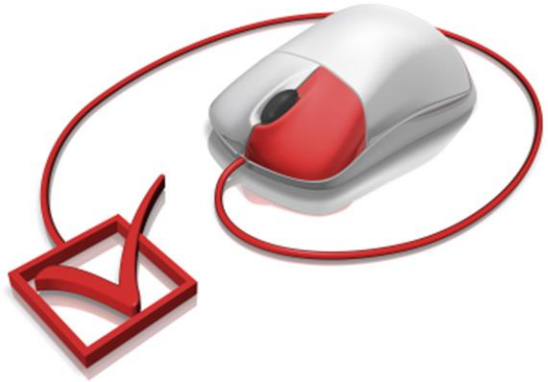


Messaging CAV



Poll 2:
Active Driving Assistance will operate reliably under the following conditions: *(Please select all that apply)*

- When lane paint markings are faded
- At night
- In sharp curves
- When there is snow
- When changing lanes without driver assistance
- None of the above



Welcome to the new TSMO Program Director!

Sheryl Bradley
TSMO Program Director
The Eastern Transportation Coalition

2023 ADAS Driver Education Pilot Study

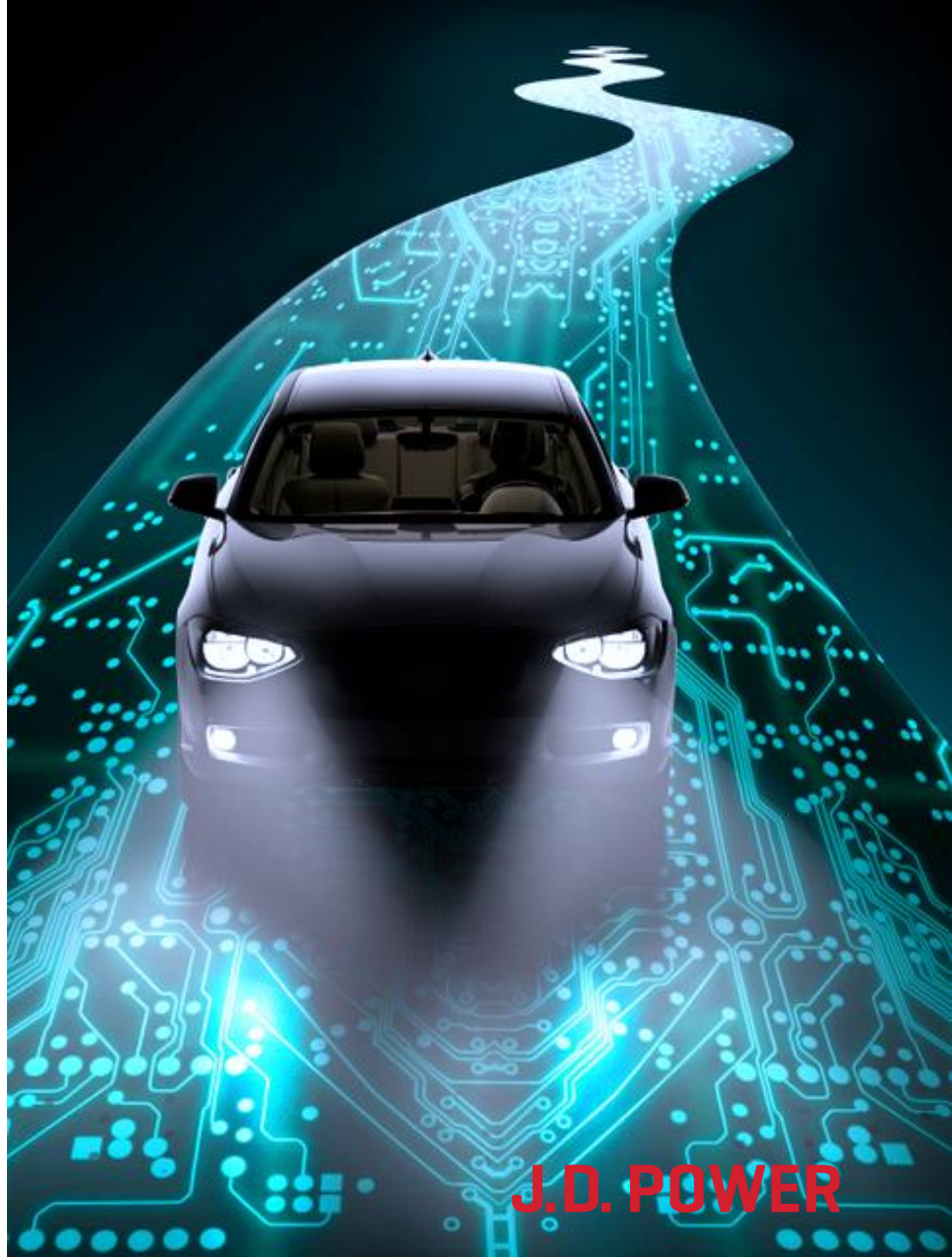
Kathleen Rizk, Senior Director, User Experience Benchmarking and Technology
JD Power

Lisa Boor, Senior Manager, Auto Benchmarking
JD Power

2023 ADAS Driver Education Pilot Study

Findings Presentation

November 9, 2023



THE EASTERN TRANSPORTATION COALITION
STUDY FINDINGS | JULY 2023

J.D. POWER

INTRODUCTION

Background

The Eastern Transportation Coalition (TETC), which is comprised of associated State Departments of Transportations (DOTs), is trying to determine how best to ensure that drivers who have more complex Active Driver Assistance Systems (ADAS) technologies on their vehicle, such as Active Driving Assistance, have been properly trained on how to use the technologies including their limitations. This level of knowledge is critical for road safety.

J.D. Power represents the Voice of the Customer (VoC) and with its vast databases is able to determine which ADAS technologies and brands are particularly problematic for users and, what specifically about those technologies makes them difficult to use/understand. J.D. Power can use this knowledge to create a proper training video to ensure that it covers areas where users have difficulties in understanding.

With that in mind, TETC commissioned J.D. Power to conduct the 2023 ADAS Driver Education Pilot Study.

Objectives

The primary objective of the study is to determine if dedicated training on a ADAS technology that is considered complex could elevate user knowledge, and thus, increase proper usage and improve road safety. Secondary objectives include:

- Understand consumers' perception regarding perceived ease of use of the technology and any items that they considered to be difficult to use/understand
- Measure consumers' baseline knowledge about a technology before completing the training among those with the feature on their vehicle
- Utilize J.D. Power's knowledge of the VoC from its extensive databases to build a 7-minute training video that takes into consideration factors where owners struggle (e.g., limitations, feature reaction, understanding status images in the instrument cluster) as the basis for the training
- Measure consumers' knowledge about the technology after completing the training to determine the effectiveness of proper training
- Conduct a review of the training process, as well as determine where training content needs to be enhanced to further address gaps in user knowledge
- Identify how best to train consumers on ADAS technologies (e.g., in-person, self-administered) based on their learning preferences

J.D. POWER

METHODOLOGY

Methodology

WHO

- 402 completes
- Age 18 and older
- 2020-2023 MY Vehicles
- Must own a qualifying Toyota vehicle with Active Driving Assistant

WHAT

- Understand owner baseline knowledge of their Active Driving Assistant feature and impact on knowledge with proper training

WHEN

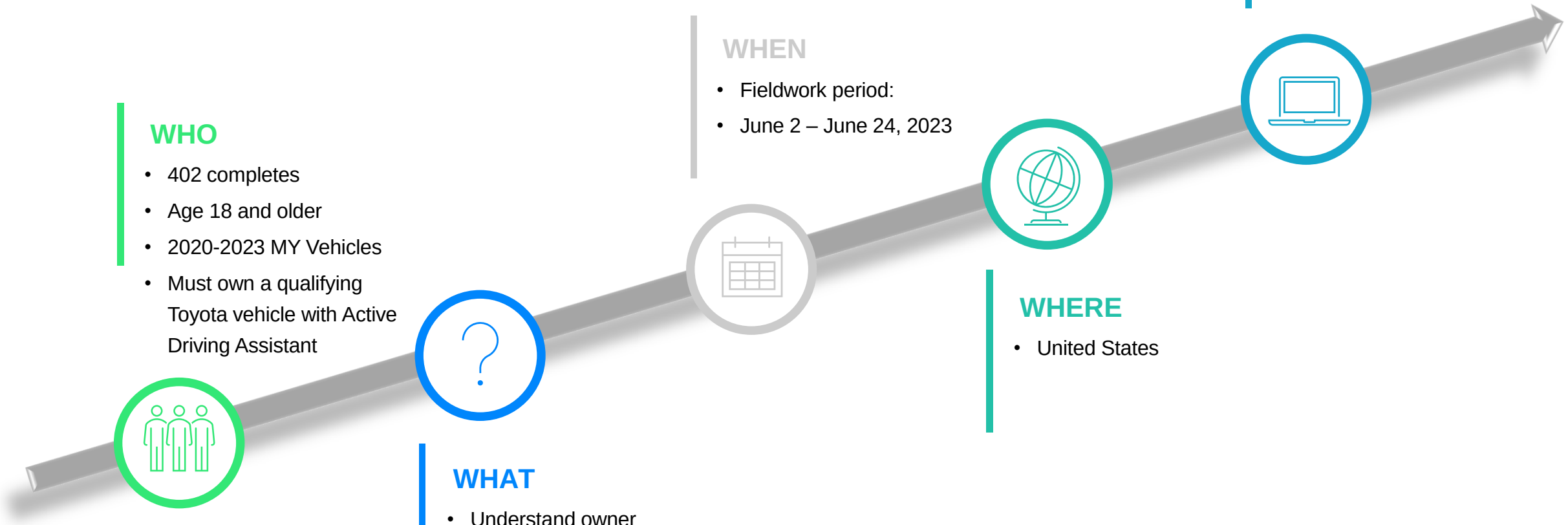
- Fieldwork period:
- June 2 – June 24, 2023

WHERE

- United States

HOW

- Online survey with instructional video



Why Toyota's Active Driving Assistance Technology was Selected

Technology and Brand Selection Consideration Factors

ADAS Technology Consideration Factors:

- Level of user interaction: active vs. passive engagement
- Technology penetration
- J.D. Power quality metrics (Problems Per 100)
- Feature complexity

Brand Consideration Factors:

- Mass Market vs. Premium brand
- Diverse product portfolio across vehicle segments
- J.D. Power quality metrics (Problems Per 100)
- Brand demographics

Toyota

Active Driving Assistance

- Active feature
- Higher-level technology requiring multiple features to be active. This feature is the simultaneous use of lane centering assistance and adaptive cruise control. The driver must supervise and support the feature and maintain responsibility for driving
- Toyota is one of the most problematic brands*
- Toyota is a Mass Market brand with a diverse product portfolio

* 2022 TXI data based on ACC and LKA; 2023 TXI based on ACC and Lane Centering

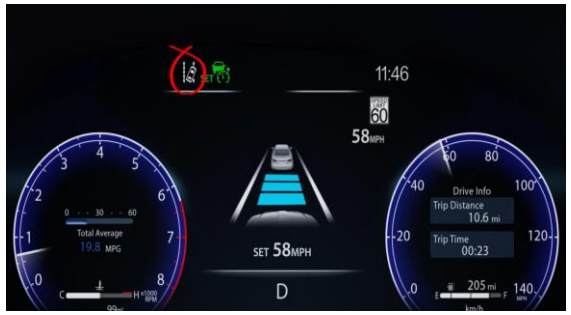
Toyota Active Driving Assistance Training Video Content

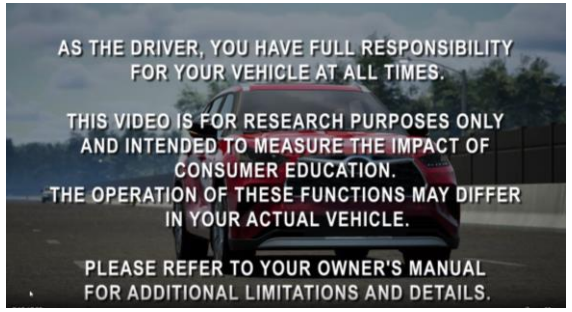
J.D. Power developed a seven-minute video that provided a high-level overview of the technology as well as the specifics of the feature for the Toyota brand.

The video content was highly driven by J.D. Power quality metrics and VoC expertise to highlight the areas customers need to know to improve their experience with the feature.

Video content includes:

- Explanation of the feature settings
- How to engage/disengage the feature, including when the system is in a “ready” state vs. an “active” state
- The requirements to operate the feature (e.g., minimum speed)
- The feature’s reaction under various conditions (e.g., lane markings no longer visible)
- The feature’s limitations (i.e., on curves)
- The meaning of the feature’s display images, icons, warnings and alerts messaging





https://txi3danimations.s3.amazonaws.com/FULL_Version07.mp4

Note: The questions in this study were not designed to mislead the respondent but rather focused on critical information needed to use the feature properly and safely.

J.D. POWER

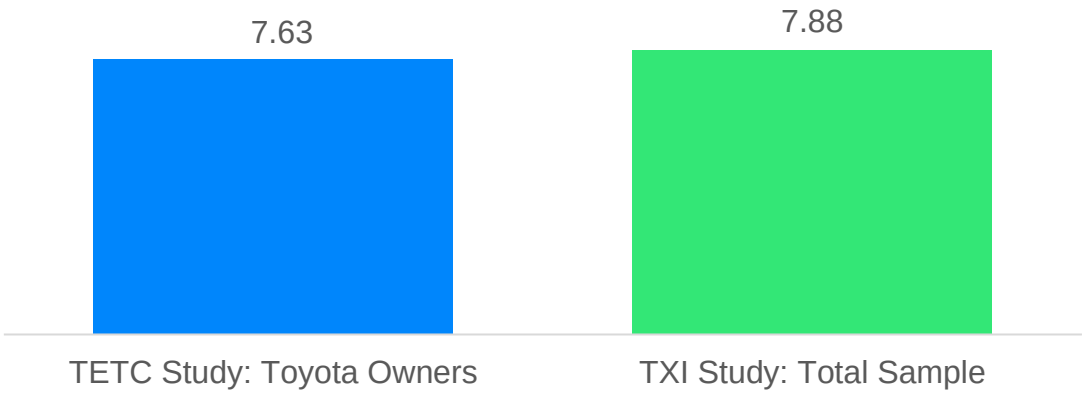
KEY FINDINGS

KEY FINDING

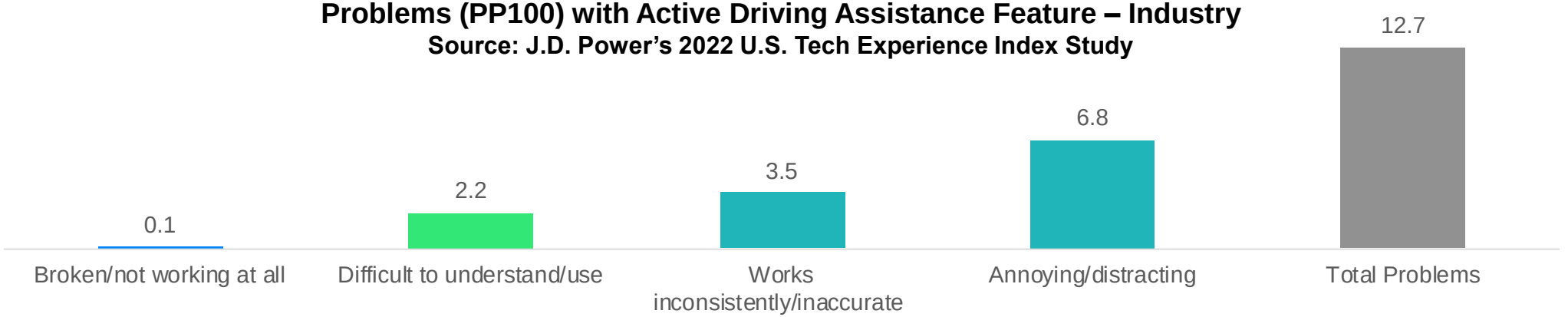
1. While the TETC study focused on Toyota owners of the Active Driving Assistance, most of the findings can be applied across the automotive industry, regardless of brand, and are not only specific to Toyota (1 of 2)

The findings for the Active Driving Assistance feature, in J.D. Power's 2022 Tech Experience Index Study (TXI) are similar to the findings in the TETC Pilot Study that focuses on Toyota's system.

Overall Satisfaction with Active Driving Assistance Feature (10-Point Scale) – Total Sample



Problems (PP100) with Active Driving Assistance Feature – Industry
Source: J.D. Power's 2022 U.S. Tech Experience Index Study



PP100 means problems per 100 vehicles, which is calculated by dividing the total number of problems reported for the model by the number of returns for the model and multiply by 100.

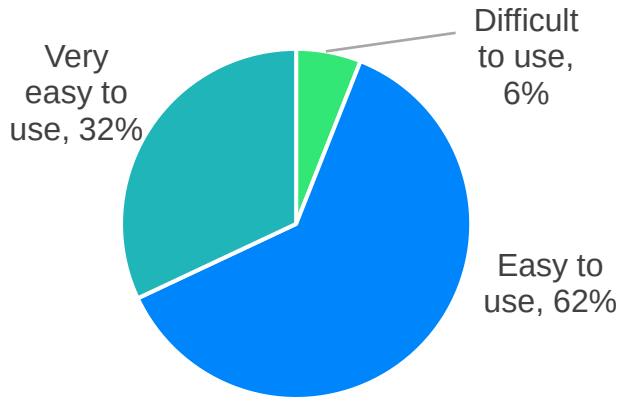
TETC Sample Size: Total Sample: N = 402
J.D. Power 2022 U.S. Tech Experience Index – Active Driving Assistance Sample Size: Total: N = 17,295.

KEY FINDING

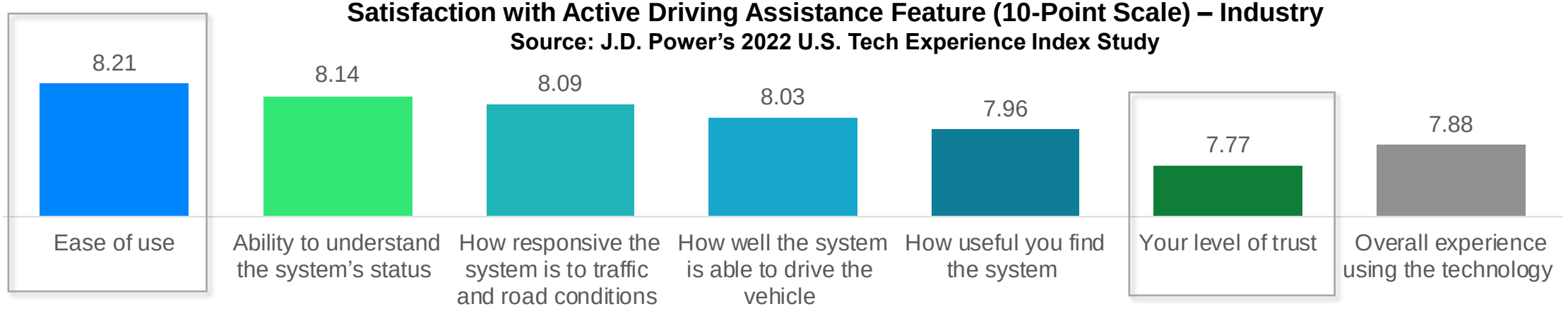
1. While the TETC study focused on Toyota owners of the Active Driving Assistance, most of the findings can be applied across the automotive industry, regardless of brand, and are not only specific to Toyota (2 of 2)

All brands have various issues with their execution of this technology as seen when comparing the findings from the TETC study to the TXI study.

Active Driving Assistance – Ease of Use
2022 TETC Study – Total Sample



Satisfaction with Active Driving Assistance Feature (10-Point Scale) – Industry
Source: J.D. Power's 2022 U.S. Tech Experience Index Study



TETC Sample Size: Total Sample: N = 402
J.D. Power 2022 U.S. Tech Experience Index – Active Driving Assistance Sample Size: Total: N = 17,295.

KEY FINDING

2. *Like other OEMs, Toyota's naming conventions impacted consumer understanding of Active Driving Assistance*

Standardized naming conventions and definitions for Active Driving Assistance features are needed to improve consumer understanding. For example, Toyota uses complex naming conventions for their Active Driving Assistance technology:

- Adaptive Cruise Control (ACC) is called Full-Speed Range Dynamic Radar Cruise Control, which is a tongue-twister
- Lane Centering is called Lane Tracing Assist, and comprised of three levels of lane support (i.e., Lane Departure Warning, Lane Keeping Assist, and Lane Centering)
- To further complicate, the Active Driving Assistance feature is packaged with other ADAS features in what Toyota markets as Safety Sense™

Automakers have developed their own proprietary branded technology names which has resulted in many unique names for each ADAS feature. Examples of Active Driving Assistance features include:

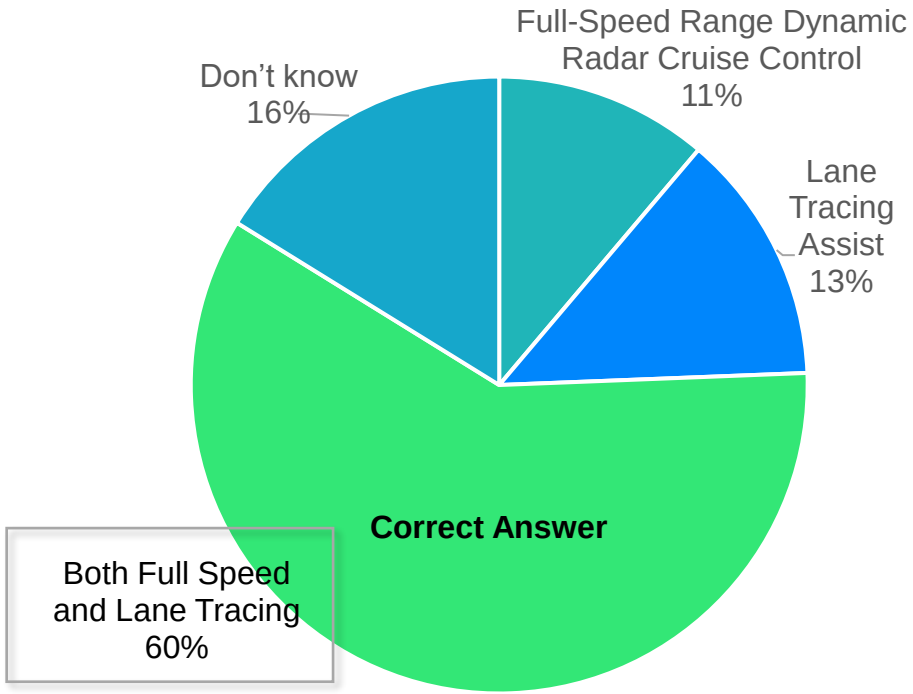
Nissan: ProPILOT Assist
Genesis/Hyundai/Kia: Highway Driving Assist
Mercedes: Driver Assistance Package (Active Distance Assist DISTRONIC® and Active Steering Assist)
Ford: BlueCruise
Porsche: InnoDrive including ACC
Tesla: Auto Pilot
Volvo: Pilot Assist
BMW: Active Driving Assist
GM: Super Cruise

KEY FINDING

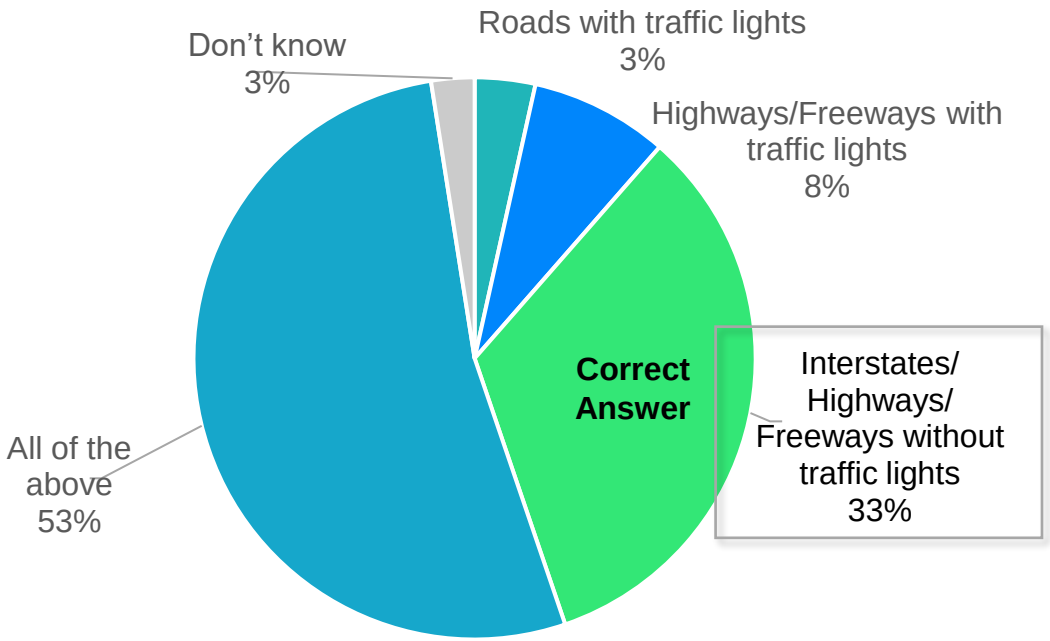
3. *Lack of critical knowledge regarding the Active Driving Assistance feature introduces risk*

Even fundamental questions about Active Driving Assistance are not known by many of the owners, which is very concerning.

Features Required to Use Active Driving Assistance
Total Sample



Type of Road Where Feature Works Properly
Total Sample

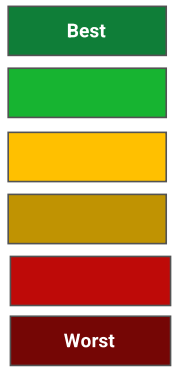


KEY FINDING

4. *Pre-assessment reveals consumer knowledge about the Active Driving Assistance feature is almost non-existent*

The average accuracy rate across the tested metrics was 34% before the training, which is very concerning.

Pre-Video Scorecard



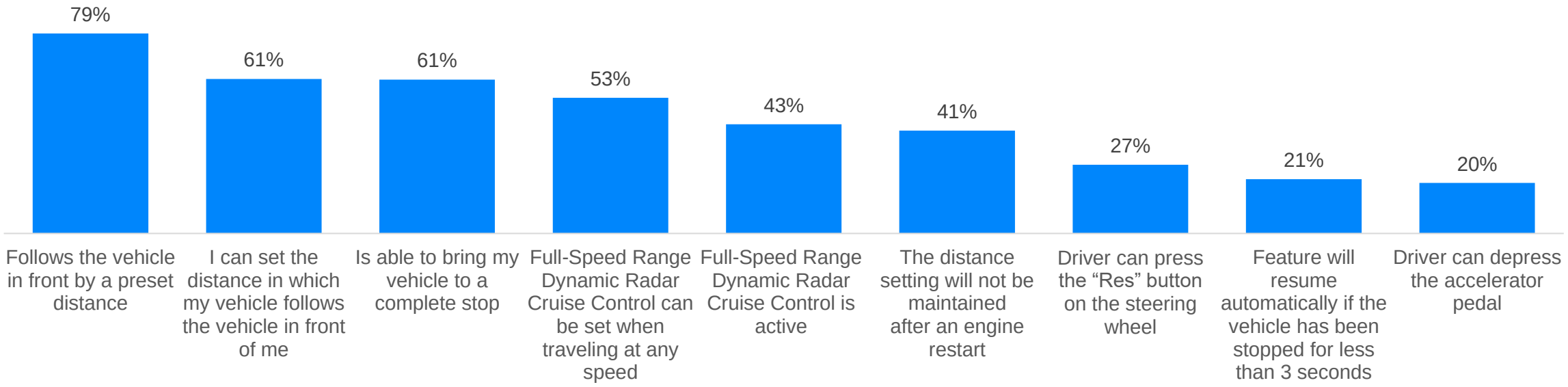
		Total Sample
Limitations	Follows the vehicle in front by a preset distance	79%
Instrument Cluster Image 1 (ADA)	Active Driving Assistance is Activated (Image 2)	61%
Settings	I can set the distance in which my vehicle follows the vehicle in front of me	61%
Limitations	Is able to bring my vehicle to a complete stop	61%
Equipment Needed	Both Full Speed and Lane Tracing	59%
Limitations	Cannot change lanes automatically without driver assistance	59%
Limitations	Isn't able to navigate around potholes	55%
Feature Reaction: No Turn Signal	Resists the lane change	54%
Settings	Full-Speed Range Dynamic Radar Cruise Control can be set when traveling at any speed	53%
Instrument Cluster Image 2 (Departing Lane on Right)	Vehicle is inadvertently exiting the lane on the right	49%
Instrument Cluster Image 3 (LKA on right only)	Full-Speed Range Dynamic Radar Cruise Control is active	45%
Speed Requirement	At 32 MPH or above	44%
Instrument Cluster Image 2 (Departing Lane on Right)	Full-Speed Range Dynamic Radar Cruise Control is active	43%
Settings	The Lane Tracing Assist stays on after an engine restart	43%
Settings	The distance setting will not be maintained after an engine restart	41%
Feature Reaction: Hands Off Wheel	Provides a visual warning “Hold Steering Wheel” in Driver Support Screen	39%
Road Type	Interstates/Highways/Freeways without traffic lights	33%
Instrument Cluster Image 3 (LKA on right only)	Vehicle is receiving steering support for the right side of the lane	32%
Feature Reaction: Resume Driving	Driver can press the “Res” button on the steering wheel	27%
Limitations	Cannot detect pedestrians	24%
Instrument Cluster Image 3 (LKA on right only)	Active Driving Assistance is in standby mode	24%
Feature Reaction: Hands Off Wheel	Beeps	24%
Feature Reaction: No Lane Markings	One or both blue lines no longer appear in the Driver Support screen	23%
Feature Reaction: No Lane Markings	Beeps	23%
Feature Reaction: Resume Driving	Feature will resume automatically if the vehicle has been stopped for less than 3 seconds	21%
Feature Reaction: No Lane Markings	All options (One or both blue lines no longer appear in the Driver Support screen, Beeps, Will no longer keep the vehicle centered in the lane, Goes into standby mode)	21%
Limitations	Does not operate reliably when lane paint is faded	21%
Instrument Cluster Image 2 (Departing Lane on Right)	Vehicle is receiving steering support for the left side of the lane	20%
Feature Reaction: Resume Driving	Driver can depress the accelerator pedal	20%
Limitations	Does not operate reliably in sharp curves	19%
Limitations	Does not operate reliably when there is snow	19%
Limitations	Does not operate reliably when there are gaps in the lane markings for freeway exits/entrances	17%
Feature Reaction: Hands Off Wheel	After issuing one or multiple warnings, the feature will go into standby mode	16%
Feature Reaction: No Lane Markings	Will no longer keep the vehicle centered in the lane	15%
Settings	I can't change the volume of the audible warnings	14%
Feature Reaction: No Lane Markings	Goes into standby mode	12%
Limitations	Does not operate reliably at night	8%
	Average Score 12 Questions	**35%**
	Average Score 11 Questions	**34%**

KEY FINDING

5. *There is a better understanding of the Adaptive Cruise Control component of the Active Driving Assistance feature than Lane Centering before the training* (1 of 2)

The Adaptive Cruise Control (Toyota's Full-Speed Range Dynamic Radar Cruise Control) portion of the Active Driving Assistance feature is both less complex to operate and has been around for many years so numerous owners have prior experience with it. Even so, their knowledge is deficient in terms of knowing the details.

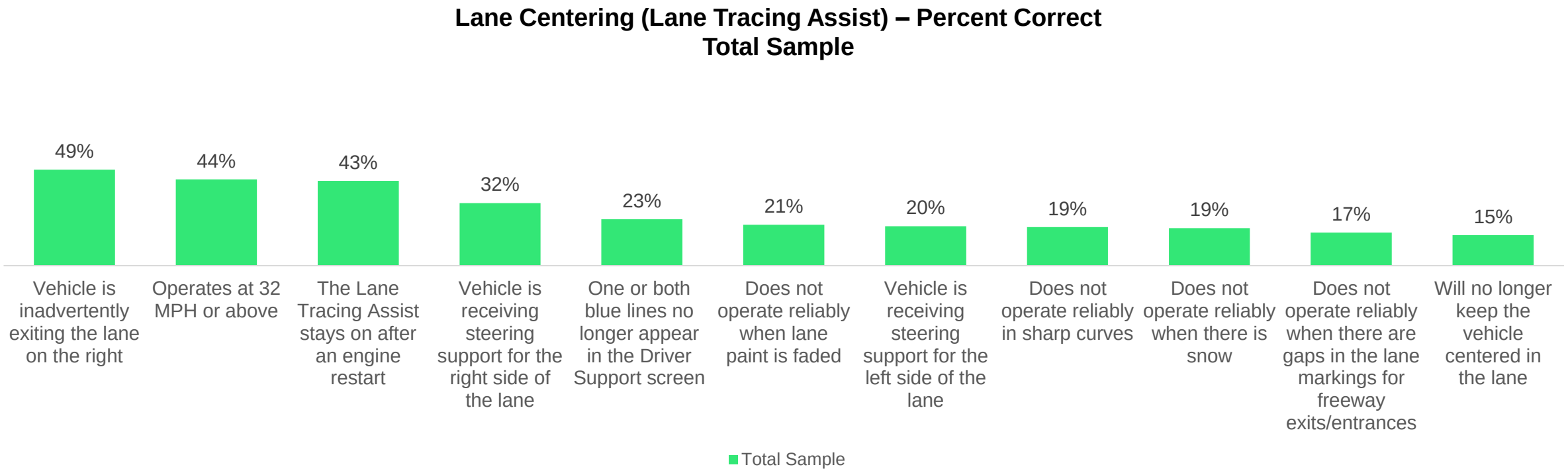
Adaptive Cruise Control (Full-Speed Range Dynamic Radar Cruise Control) – Percent Correct
Total Sample



KEY FINDING

5. *There is a better understanding of the Adaptive Cruise Control component of the Active Driving Assistance feature than Lane Centering before the training* (2 of 2)

Owners have difficulty understanding the Lane Centering (Toyota's Lane Tracing Assist) feature and Knowledge further declines when the user needs to understand how the two features operate together to get Active Driving Assistance.

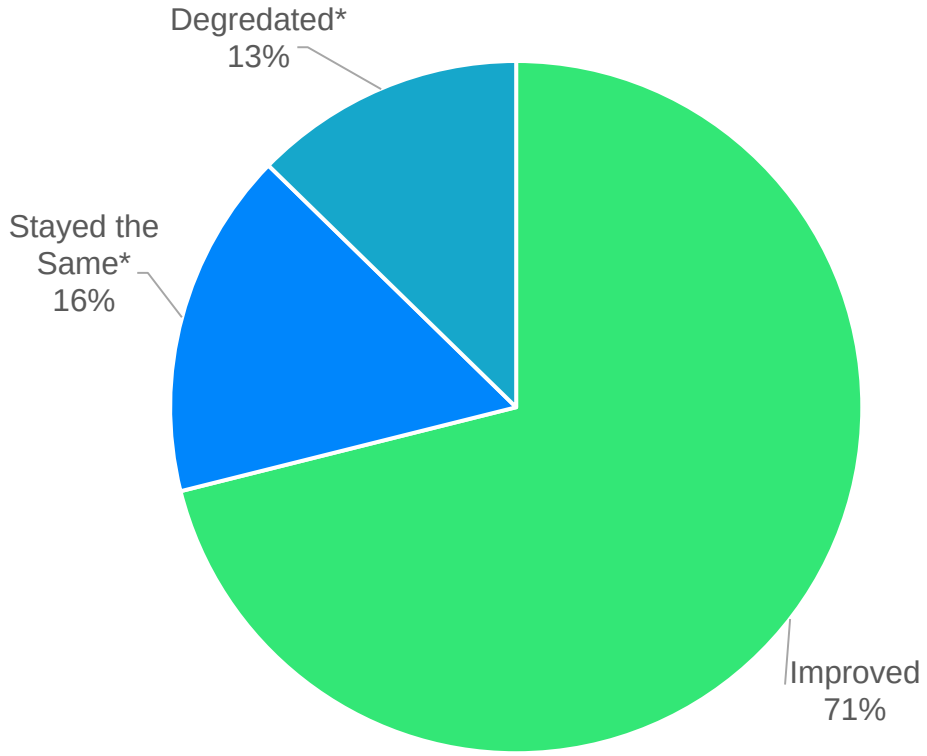


KEY FINDING

6. *Participants positively benefited from the video training with the majority of respondents making learning improvements*

The respondents' education, income, and location were not differentiators of learning improvements. The impact of training was highest among older respondents with higher levels of improved learning.

Impact of Video Training - Total Sample



*Small Sample

KEY FINDING

7. *Almost every metric showed improvement from the training video, but the status images and feature reaction to missing lane markings are still difficult for owners to understand*

Post Video Scorecard

		Total Sample: Pre-Training	Total Sample: Post-Training	Better/(Worse)
Equipment Needed	Both Full Speed and Lane Tracing	59%	N/A	N/A
Limitations	Follows the vehicle in front by a preset distance	79%	93%	14
Settings	I can set the distance in which my vehicle follows the vehicle in front of me	61%	87%	26
Limitations	Is able to bring my vehicle to a complete stop	61%	85%	24
Instrument Cluster Image 1 (ADA)	Active Driving Assistance is Activated (Image 2)	61%	81%	20
Limitations	Cannot change lanes automatically without driver assistance	59%	79%	20
Limitations	Does not operate reliably when lane paint is faded	21%	78%	57
Limitations	Isn't able to navigate around potholes	55%	77%	22
Speed Requirement	At 32 MPH or above	44%	73%	29
Feature Reaction: Hands Off Wheel	Provides a visual warning "Hold Steering Wheel" in Driver Support Screen	39%	73%	34
Limitations	Does not operate reliably when there is snow	19%	71%	52
Feature Reaction: No Turn Signal	Resists the lane change	54%	70%	16
Road Type	Interstates/Highways/Freeways without traffic lights	33%	69%	36
Limitations	Does not operate reliably when there are gaps in the lane markings for freeway exits/entrances	17%	69%	52
Limitations	Does not operate reliably in sharp curves	19%	66%	47
Limitations	Cannot detect pedestrians	24%	65%	41
Feature Reaction: Resume Driving	Feature will resume automatically if the vehicle has been stopped for less than 3 seconds	21%	61%	40
Settings	I can't change the volume of the audible warnings	14%	60%	46
Settings	Full-Speed Range Dynamic Radar Cruise Control can be set when traveling at any speed	53%	58%	5
Limitations	Does not operate reliably at night	8%	57%	49
Feature Reaction: Resume Driving	Driver can press the "Res" button on the steering wheel	27%	56%	29
Settings	The Lane Tracing Assist stays on after an engine restart	43%	53%	10
Settings	The distance setting will not be maintained after an engine restart	41%	53%	12
Instrument Cluster Image 3 (LKA on right only)	Full-Speed Range Dynamic Radar Cruise Control is active	45%	50%	5
Feature Reaction: Hands Off Wheel	Beeps	24%	50%	26
Instrument Cluster Image 2 (Departing Lane on Right)	Vehicle is inadvertently exiting the lane on the right	49%	47%	(2)
Instrument Cluster Image 2 (Departing Lane on Right)	Full-Speed Range Dynamic Radar Cruise Control is active	43%	46%	3
Instrument Cluster Image 3 (LKA on right only)	Active Driving Assistance is in standby mode	24%	46%	22
Instrument Cluster Image 3 (LKA on right only)	Vehicle is receiving steering support for the right side of the lane	32%	45%	13
Feature Reaction: Hands Off Wheel	After issuing one or multiple warnings, the feature will go into standby mode	16%	44%	28
Feature Reaction: Resume Driving	Driver can depress the accelerator pedal	20%	38%	18
Feature Reaction: No Lane Markings	All of the above (One or both blue lines no longer appear in the Driver Support screen, Beeps, Will no longer keep the vehicle centered in the lane, Goes into standby mode)	21%	34%	13
Feature Reaction: No Lane Markings	One or both blue lines no longer appear in the Driver Support screen	23%	32%	9
Instrument Cluster Image 2 (Departing Lane on Right)	Vehicle is receiving steering support for the left side of the lane	20%	32%	12
Feature Reaction: No Lane Markings	Goes into standby mode	12%	30%	18
Feature Reaction: No Lane Markings	Will no longer keep the vehicle centered in the lane	15%	24%	9
Feature Reaction: No Lane Markings	Beeps	23%	17%	(6)
	Average Score 12 Questions	**35%**	**N/A**	**N/A**
	Average Score 11 Questions	**34%**	**57%**	**23**

Best

Worst

KEY FINDING

8. *Active Driving Assistance status images displayed in the instrument cluster are not understood, which is concerning* (1 of 3)

Before training, almost 40% of owners didn't know the basic meaning of the image displayed in the instrument cluster showing the status of Active Driving Assistance. It is alarming that this large share of the user base cannot identify the status of the feature from the image provided.

Instrument Cluster Image Indicating Active Driving Assistance is Activated – View 1
Total Sample

Image 1

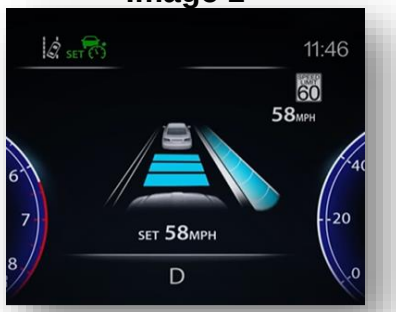


Image 2 (Correct)

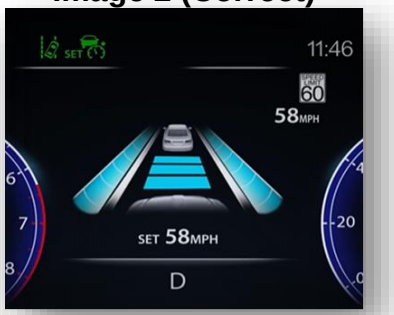


Image 3

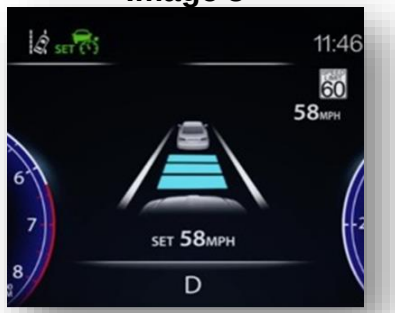
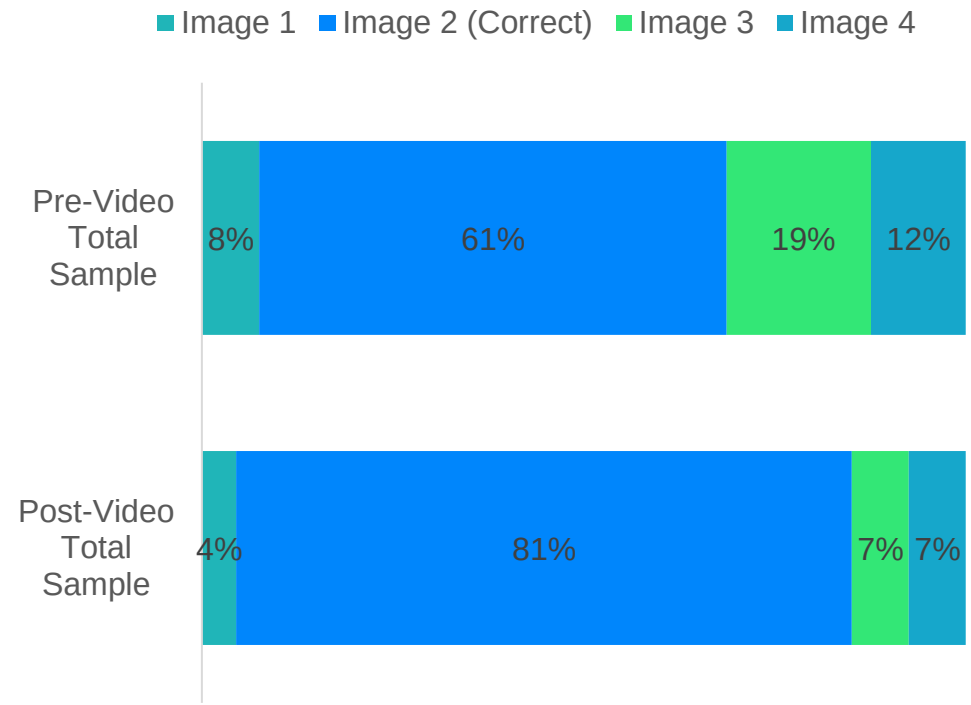


Image 4

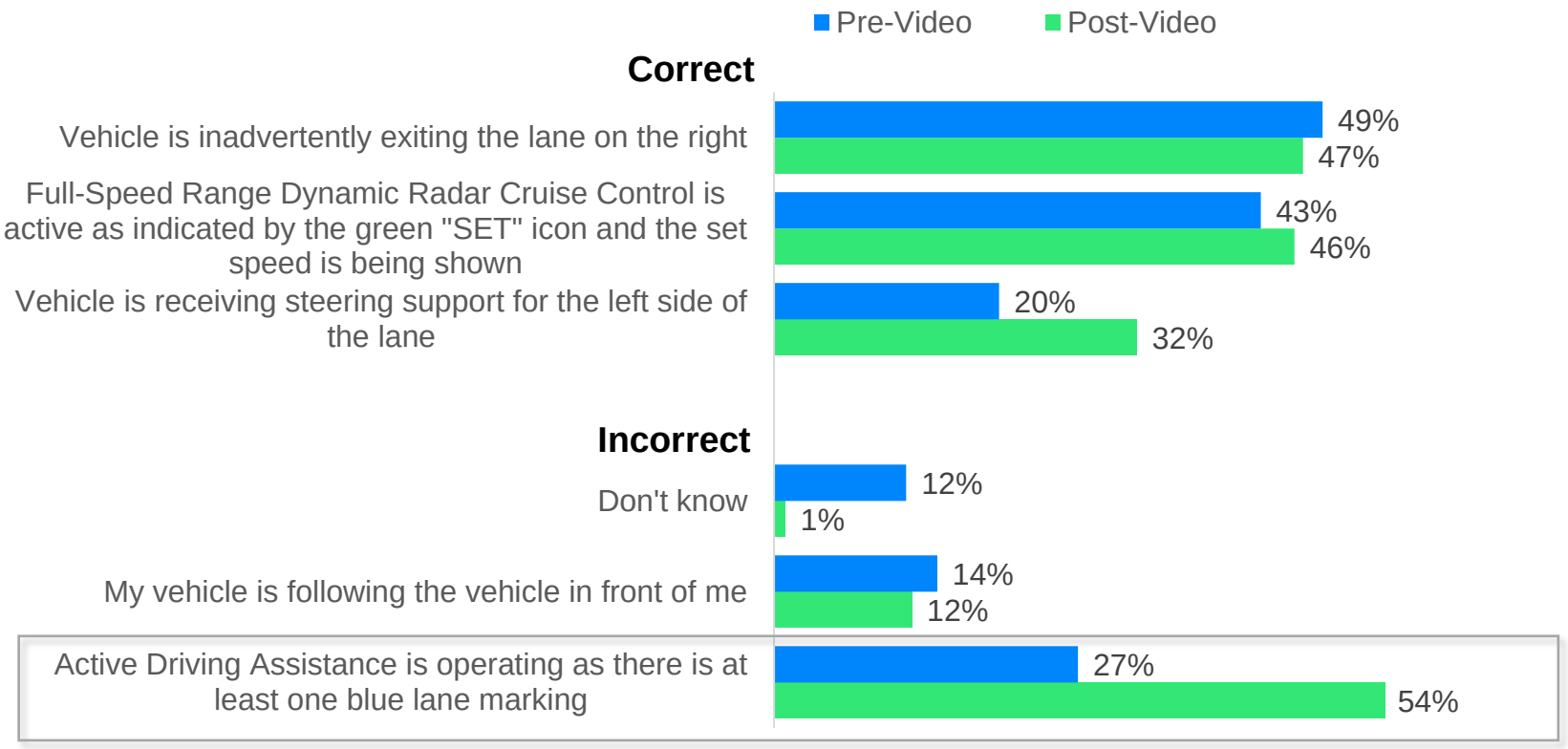


KEY FINDING

8. *Active Driving Assistance status images displayed in the instrument cluster are not understood, which is concerning* (2 of 3)

Understanding the instrument cluster images remains a challenge with more respondents making incorrect selections post-video.

Instrument Cluster Active Driving Assistance Status Image Indication – View 2
Total Sample

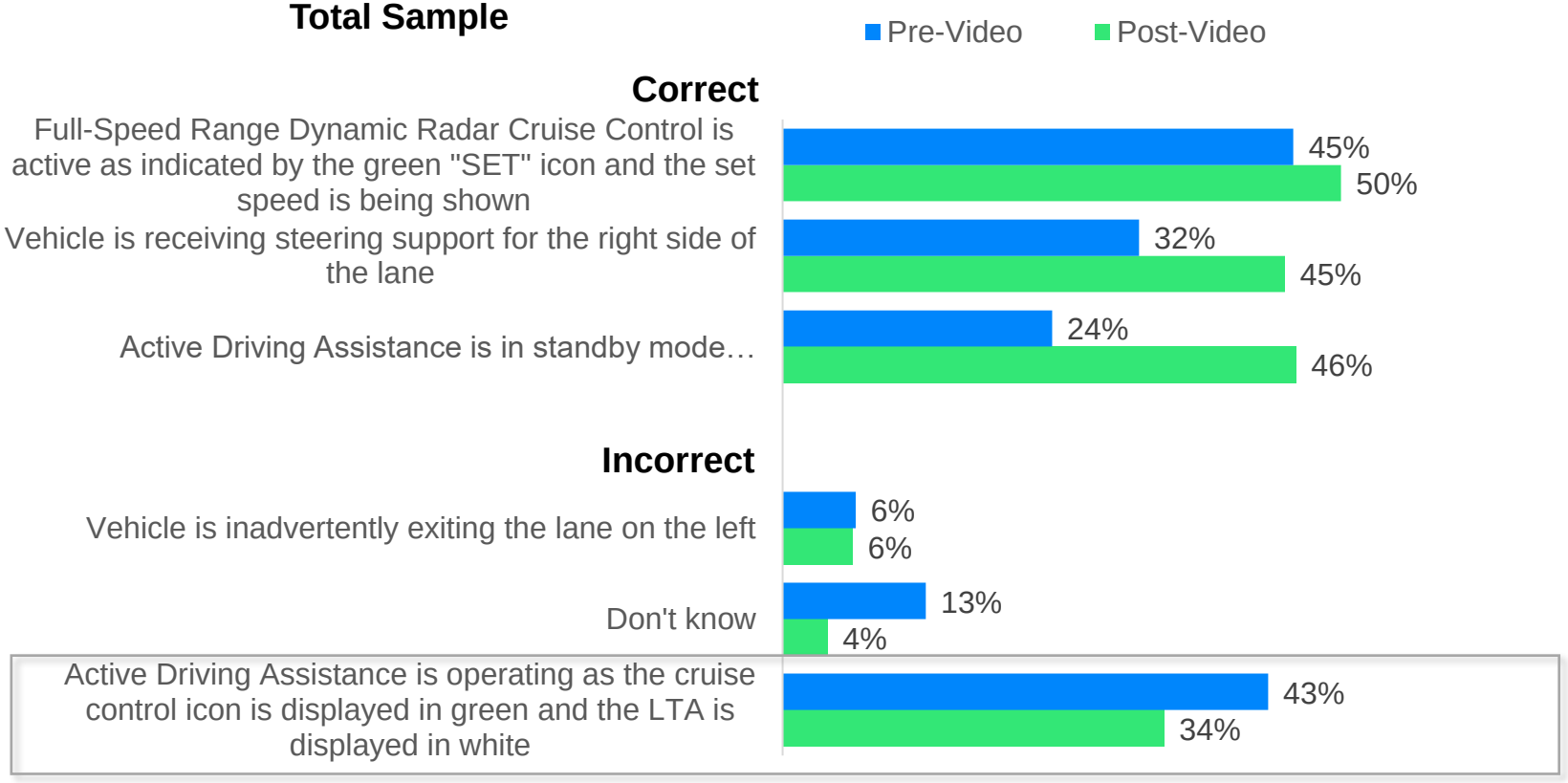


KEY FINDING

8. *Active Driving Assistance status images displayed in the instrument cluster are not understood, which is concerning* (3 of 3)

Difficulty deciphering between the Active Driving Assistance and the Adaptive Cruise Control instrument cluster images remain and result with one-third of owners incorrectly thinking the feature is active post-training.

Instrument Cluster Active Driving Assistance Status Image Indication – View 3
Total Sample



KEY FINDING

9. *Feature reactions and limitations are not known by the majority of owners, which has the potential to create risky situations on the road* (1 of 2)

Adding to the urgency of needing to be educated on this technology is the clear lack of understanding the feature's reactions and limitations. Even after watching the video, feature reaction deficiencies persist among those who use the feature.

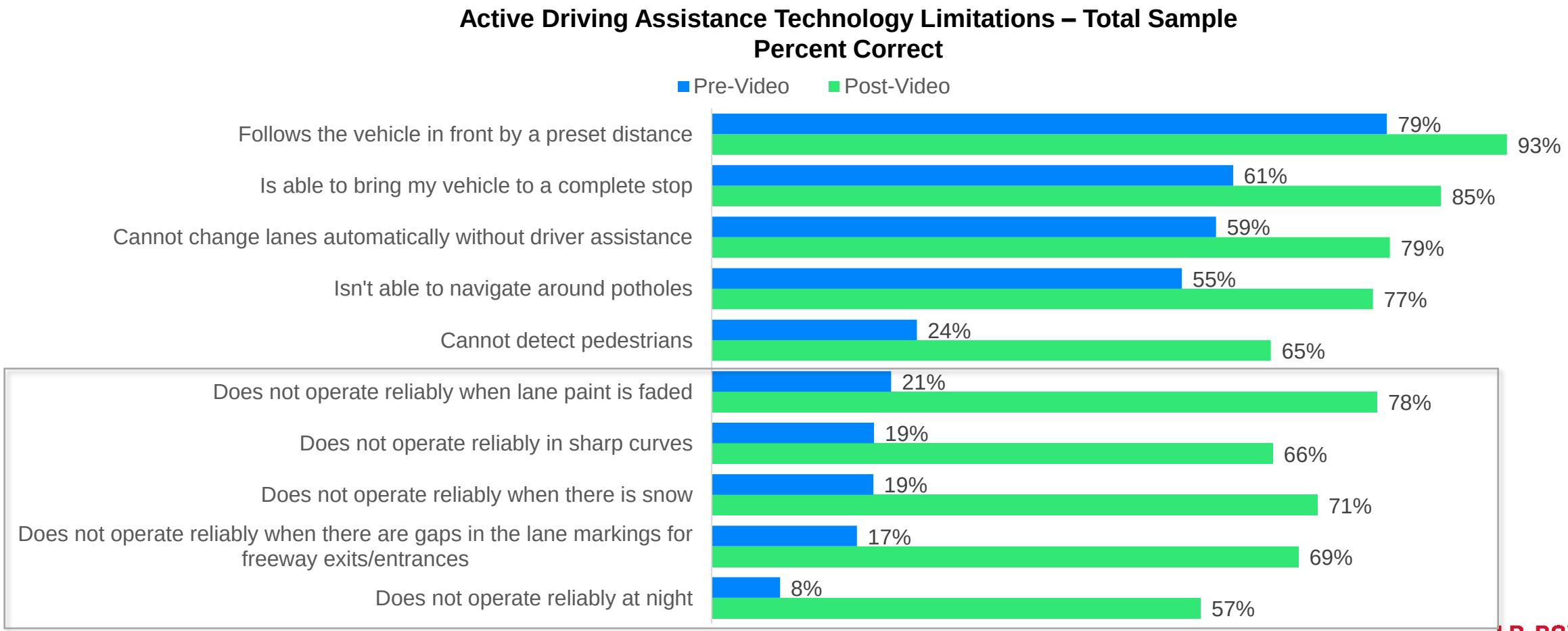
Features Reaction – Percent Correct
Total Sample

Feature Reaction	Correct Answer	Total Sample: Pre-Training	Total Sample: Post-Training
No Turn Signal	Resists the lane change	54%	70%
No Lane Markings	All of the above (See "memo" list below)	21%	34%
	Memo: One or both blue lines no longer appear in the Driver Support screen	23%	32%
	Memo: Beeps	23%	17%
	Memo: Will no longer keep the vehicle centered in the lane	15%	24%
	Memo: Goes into standby mode	12%	30%
Hands Off Wheel	Provides a visual warning "Hold Steering Wheel" in Driver Support Screen	39%	73%
	Beeps	24%	50%
	After issuing one or multiple warnings, the feature will go into standby mode	16%	44%
Resume Driving	Driver can press the "Res" button on the steering wheel	27%	56%
	Feature will resume automatically if the vehicle has been stopped for less than 3 seconds	21%	61%
	Driver can depress the accelerator pedal	20%	38%

KEY FINDING

9. *Feature reactions and limitations are not known by the majority of owners, which has the potential to create risky situations on the road* (2 of 2)

Adding to this concern is the fact that owners don't understand the limitations of the feature including some that could introduce risk.



KEY FINDING

10. Toyota owners found the video training to be helpful and are more likely to use the Active Driving Assistance feature more often and hopefully, use it properly (1 of 2)

Upon completion of the research exercise, respondents were asked to assess the training video. Almost all of Toyota owners found the training helpful.

"Did not understand all the different icons on my car screen until I saw this video clip."

"I couldn't figure out some things earlier but now I have a better understanding."

"I did not know that this feature had all of these capabilities before watching the video."

"I honestly never paid attention to this feature and now I'm going to check it out and use it when necessary!"

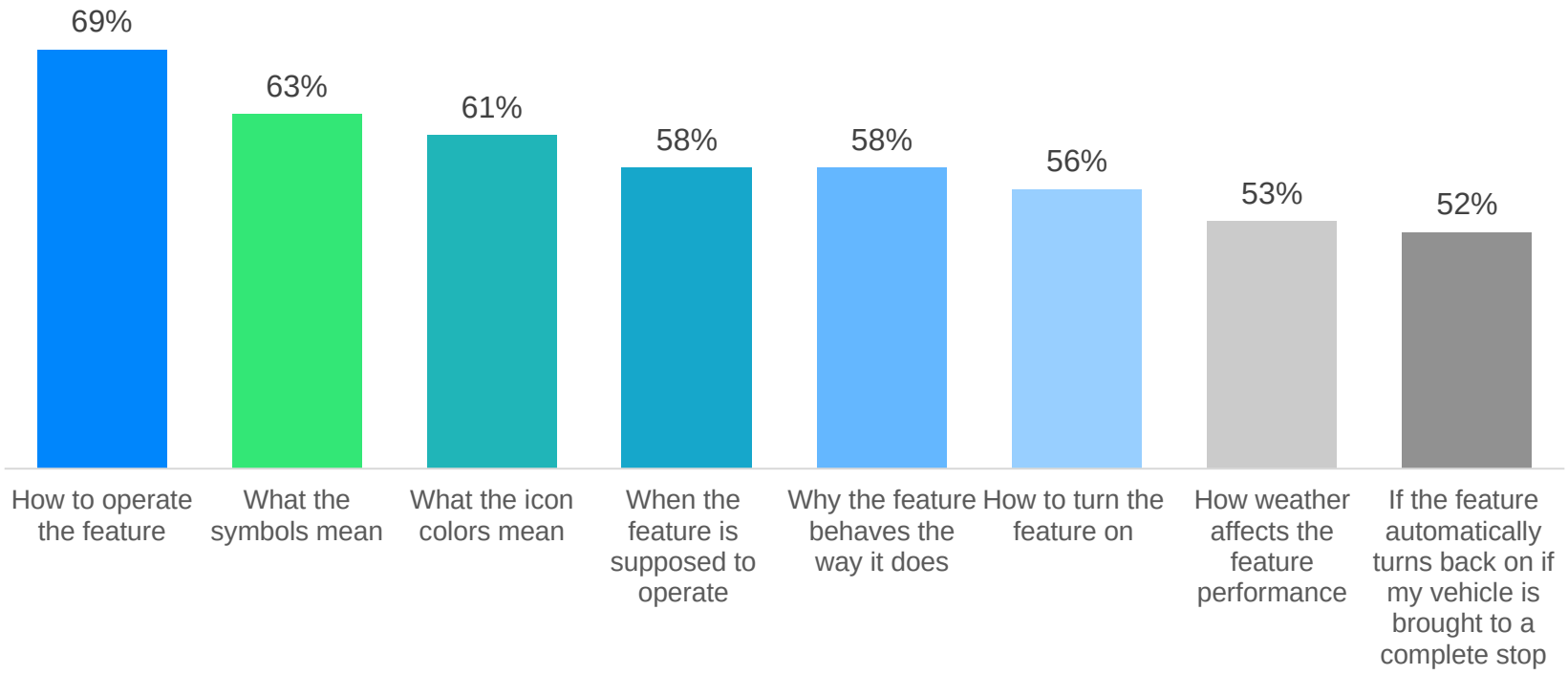
"I feel more confident about using the feature now."

KEY FINDING

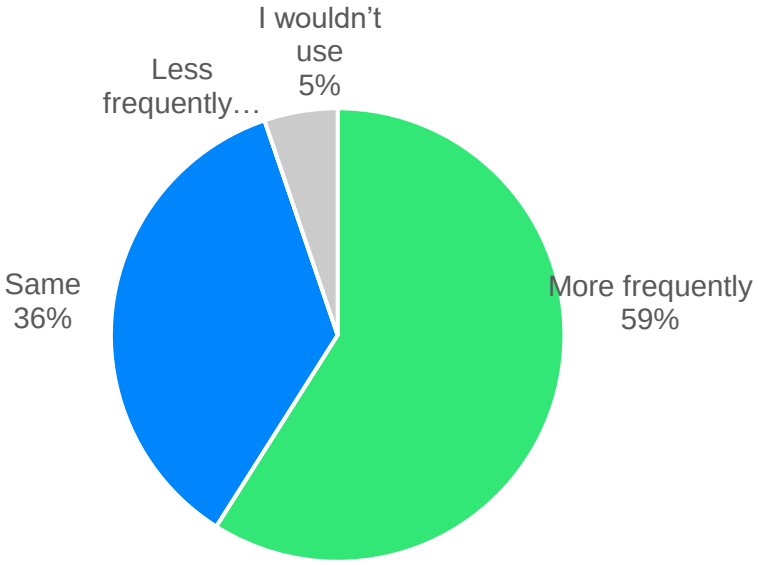
10. Toyota owners found the video training to be helpful and are more likely to use the Active Driving Assistance feature more often and hopefully, use it properly (2 of 2)

The training elevated the user's understanding across a variety of metrics. The training video increases likelihood for more frequent use; over forty percent of those that don't use it currently indicate they will use it frequently after the training.

Training Video Learnings – Total Sample



Likelihood to use Active Drive Assistance after Training Video



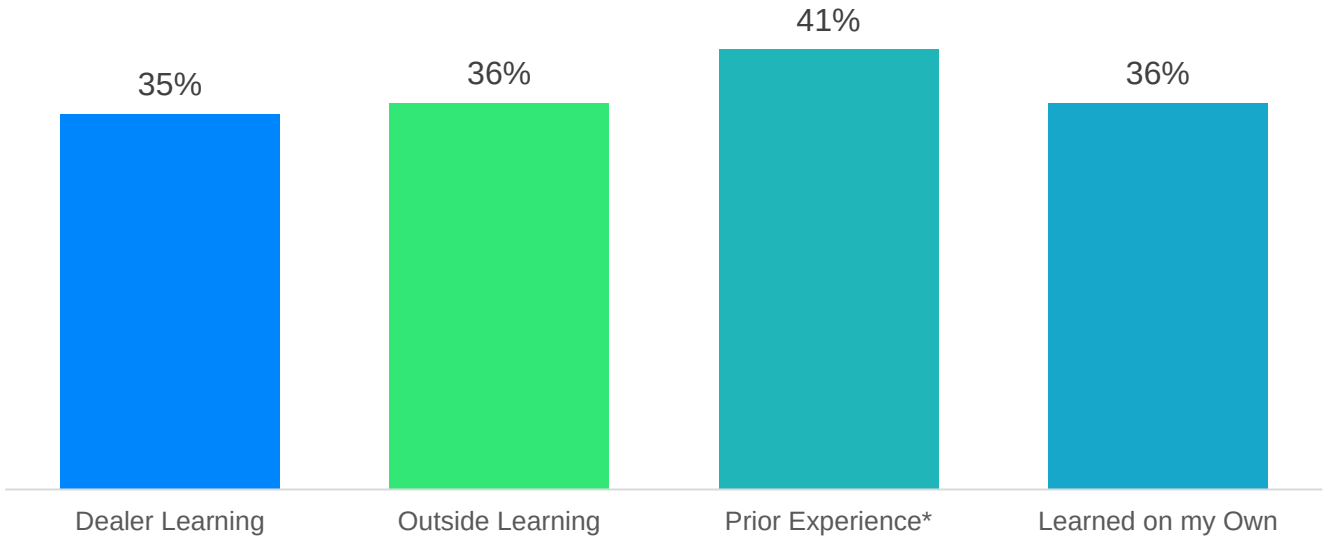
KEY FINDING

11. Content and depth play a critical role in effectively educating consumers and dealers on the Active Driving Assistance feature

Minimal differences appear in the comparison of the degree of knowledge about the feature by how the owner learned about it, indicating that the educational content being provided is not sufficient for complete user understanding.

Collaboration across the auto industry, dealers, insurance, and state DOTs would transform the industry and consumer education.

Average % Correct: Pre-Video
Total Sample By How Learned



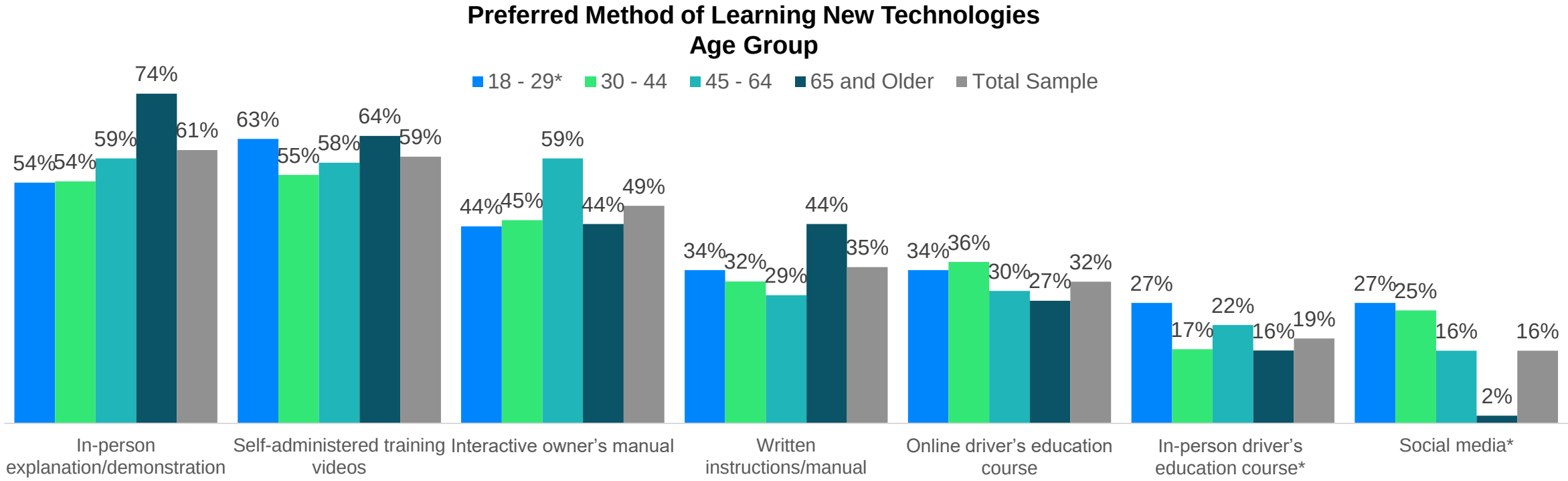
*Small Sample

KEY FINDING

12. An opportunity exists for in-person training or self-administered training videos

Owners express the desire to learn about new technologies through a variety of methods and prefer in-person explanations/demonstrations or self-administered training videos. Owners expect to be educated about new technologies through their dealer or vehicle manufacturer. However, these methods have not been effective.

Those who had difficultly learning from the video training are more likely to look to the DOT or an Insurance Provider to educate them and are more open to formal education learning methods.



*Small Sample

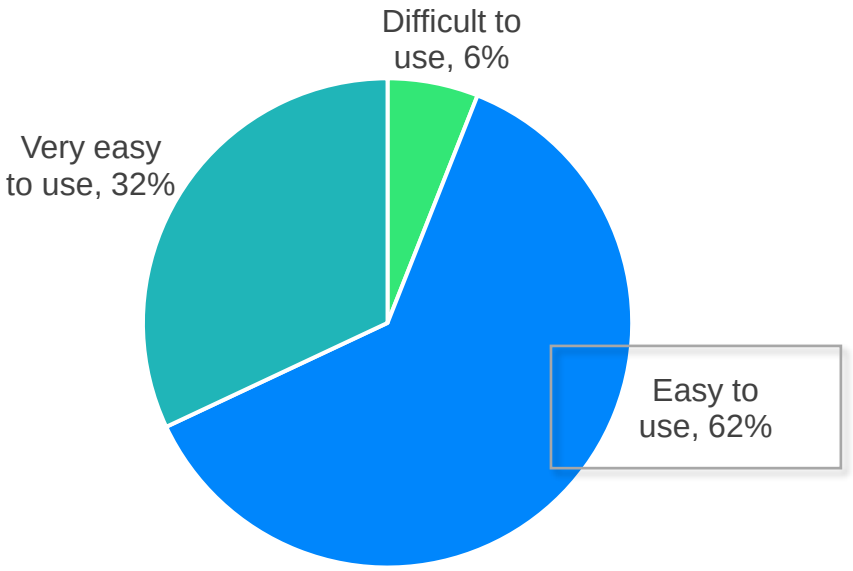
J.D. POWER

KEY FINDING

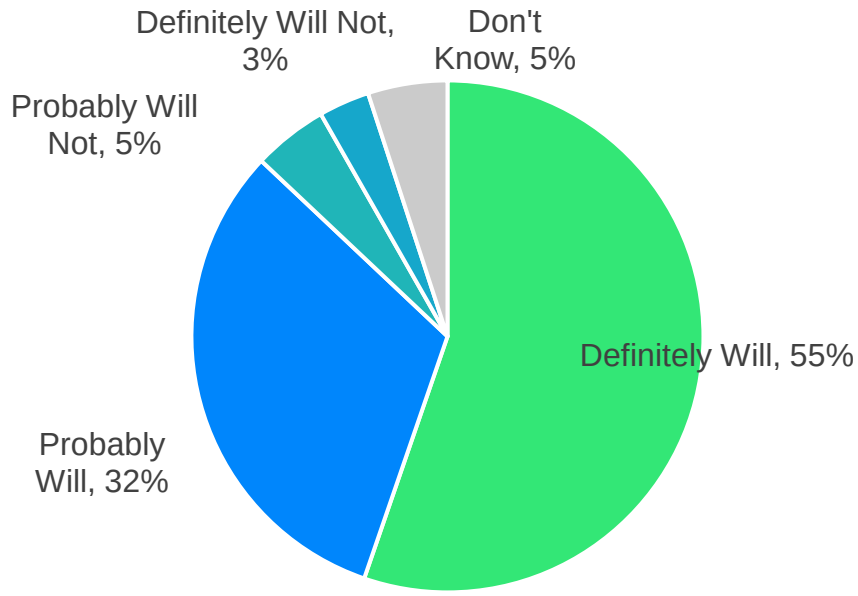
13. Mandatory educational training may be necessary to elevate the knowledge-base of the Active Driving Assistance feature, which is clearly needed to reduce risk (1 of 2)

With almost 90% of owners wanting this feature again and prior experience having a limited impact on knowledge, requiring training may be the best path forward to ensure proper use of the Active Driving Assistance technology.

Active Driving Assistance – Ease of Use
Total Sample



Future Intent: Want Active Driving Assistance Again on Next Vehicle
Total Sample

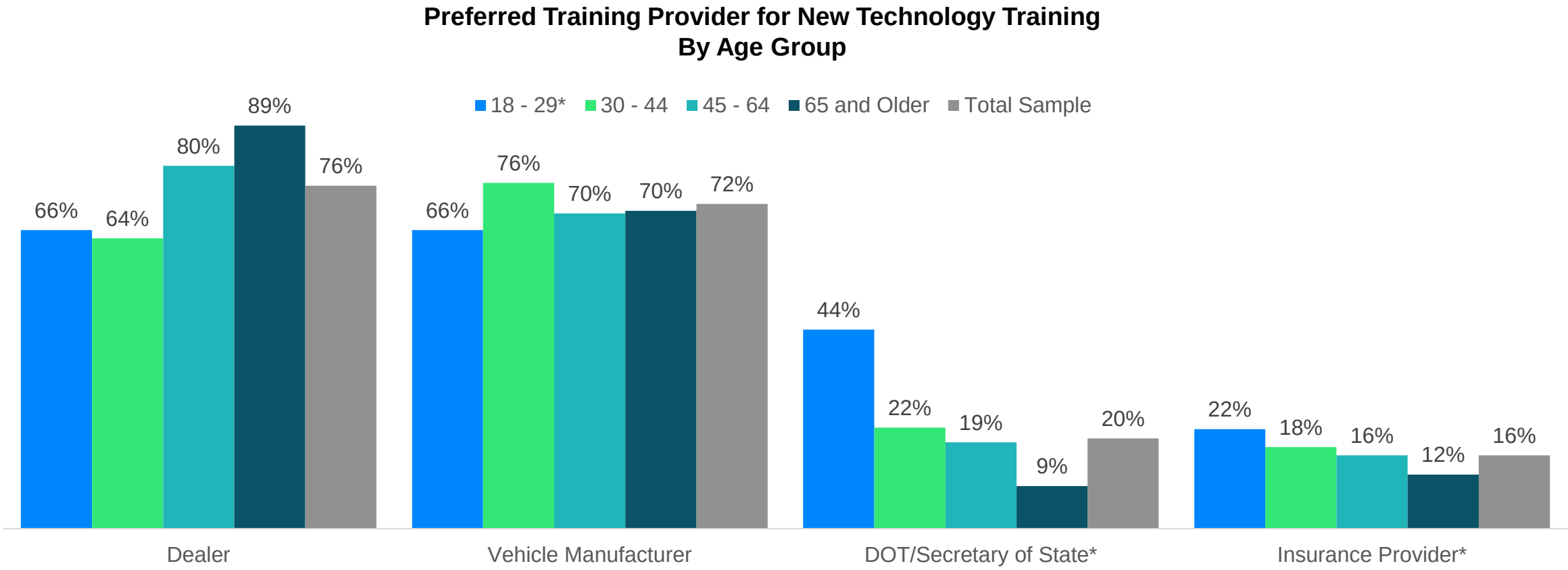


*Small Sample

KEY FINDING

13. Mandatory educational training may be necessary to elevate the knowledge-base of the Active Driving Assistance feature, which is clearly needed to reduce risk (2 of 2)

If not mandatory, then a variety of training methods need to be offered to meet varying needs of consumers by age and gender. Perhaps, some reward-type system (e.g., insurance discount, subscription service discount) could also be used to encourage training.



*Small Sample

J.D. POWER

RECOMMENDATIONS

Recommendations

1

Collaborative Training Content

OEMs must provide critical content to operate their ADAS technologies and elevate driver knowledge of activation, current state, understanding status images, feature reactions, limitations, and settings

2

Increase Training for Dealer Staff

Must ensure dealers are properly trained on complex ADAS features. Leverage the existing dealer relationship to serve as qualified sources for critical information and conduits for proven learning sources

3

Increase Variety of Training Methods

There is an opportunity for industry and government stakeholders to create learning methods that leverage consumer preferences for in-person and self-administered learning experiences

4

DOT Mandated Education

Initial efforts can focus on new and more complex ADAS features. Mandating training ensures all consumers are trained – especially those who overestimate their knowledge. Prior feature experience does not remove the need for training

Contact

For further information, please contact:

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Senior Manager, Auto Benchmarking

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CTDOT/TETC AV Lane Marking Evaluation Study Report

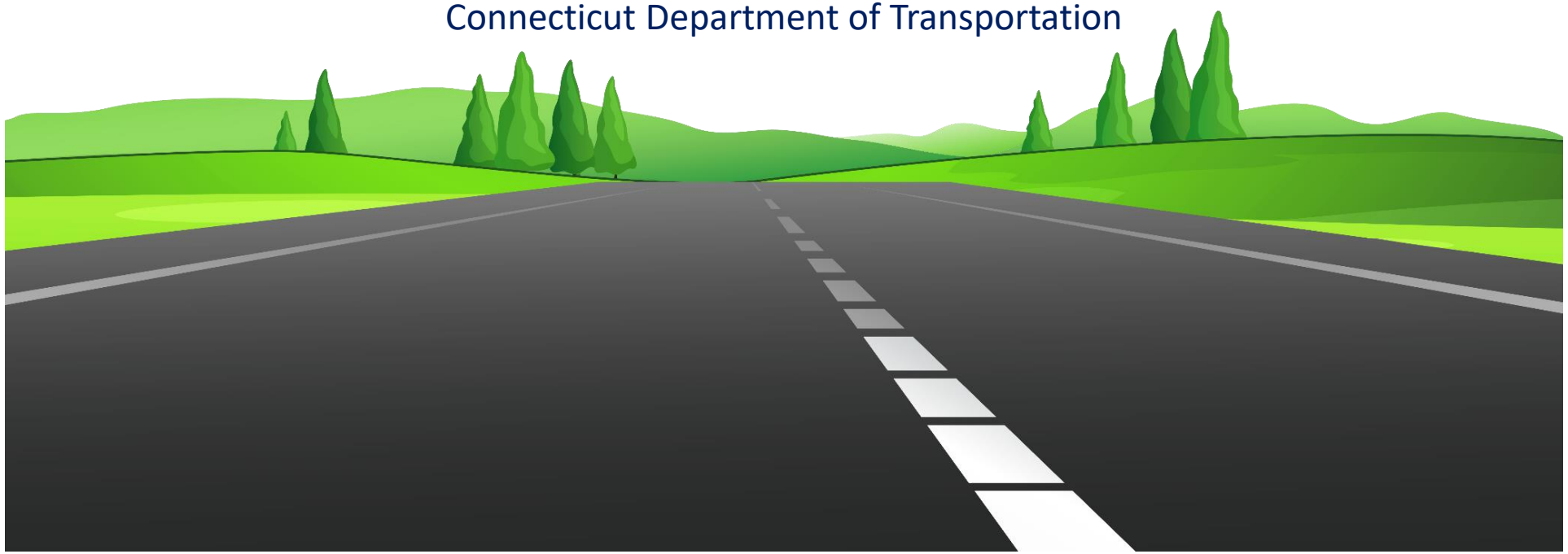
Peter Calcaterra, Transportation Supervising Planner,
Bureau of Public Transportation
Connecticut DOT

Eric Jackson, Executive Director
CT Transportation Institute
University of Connecticut

Shaon Mohammed,
Associate Research Scientist
University of Connecticut

Advanced Driver Assistance Systems (ADAS) Pavement Marking Evaluation in Connecticut

Peter Calcaterra
Transportation Supervising Planner
Lead for Connected and Automated Vehicles (CAV)
Connecticut Department of Transportation



U.S. Department of Transportation Federal Highway Administration

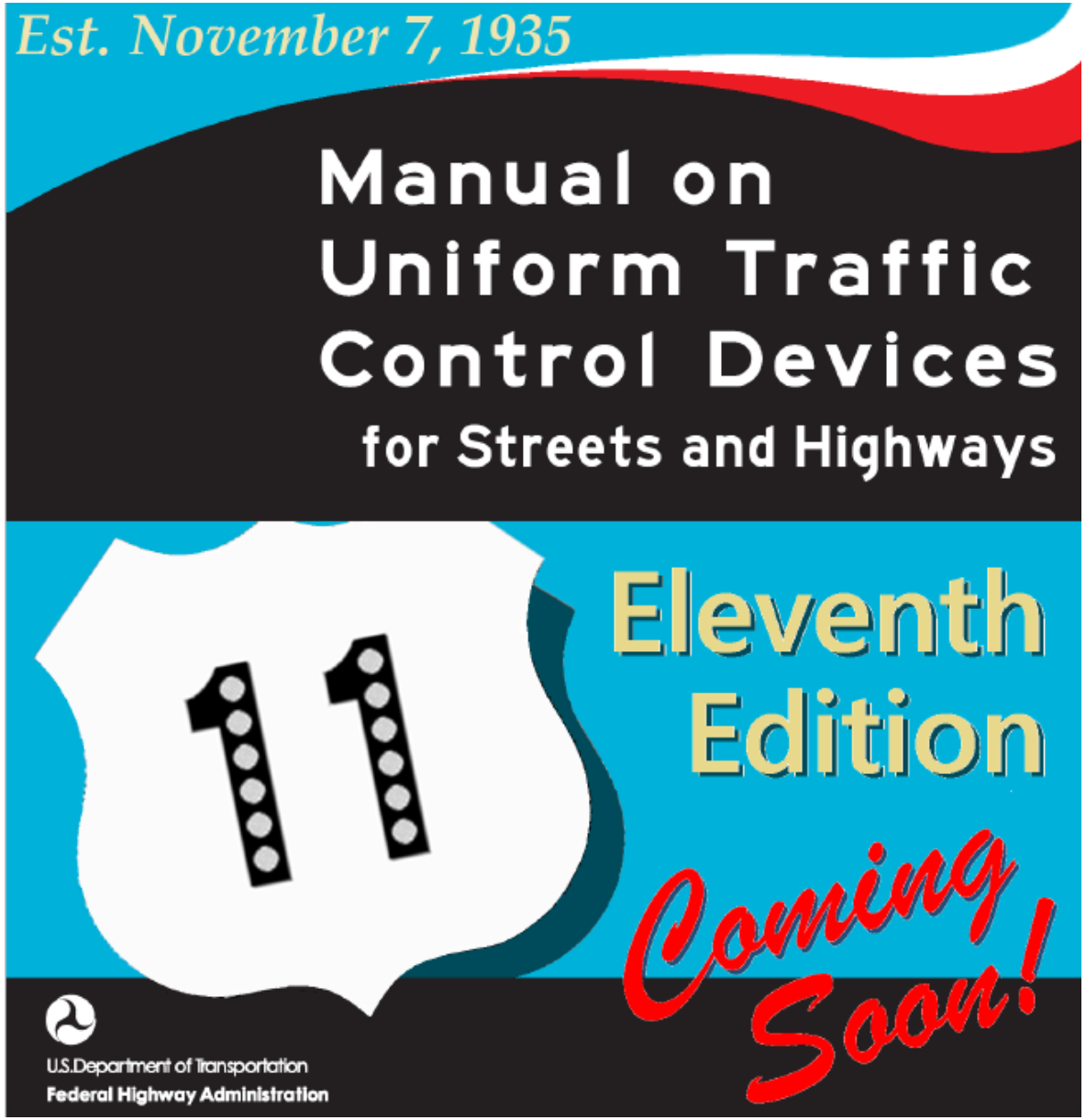
THE EASTERN TRANSPORTATION COALITION

CONNECTICUT DEPARTMENT OF TRANSPORTATION

UCONN

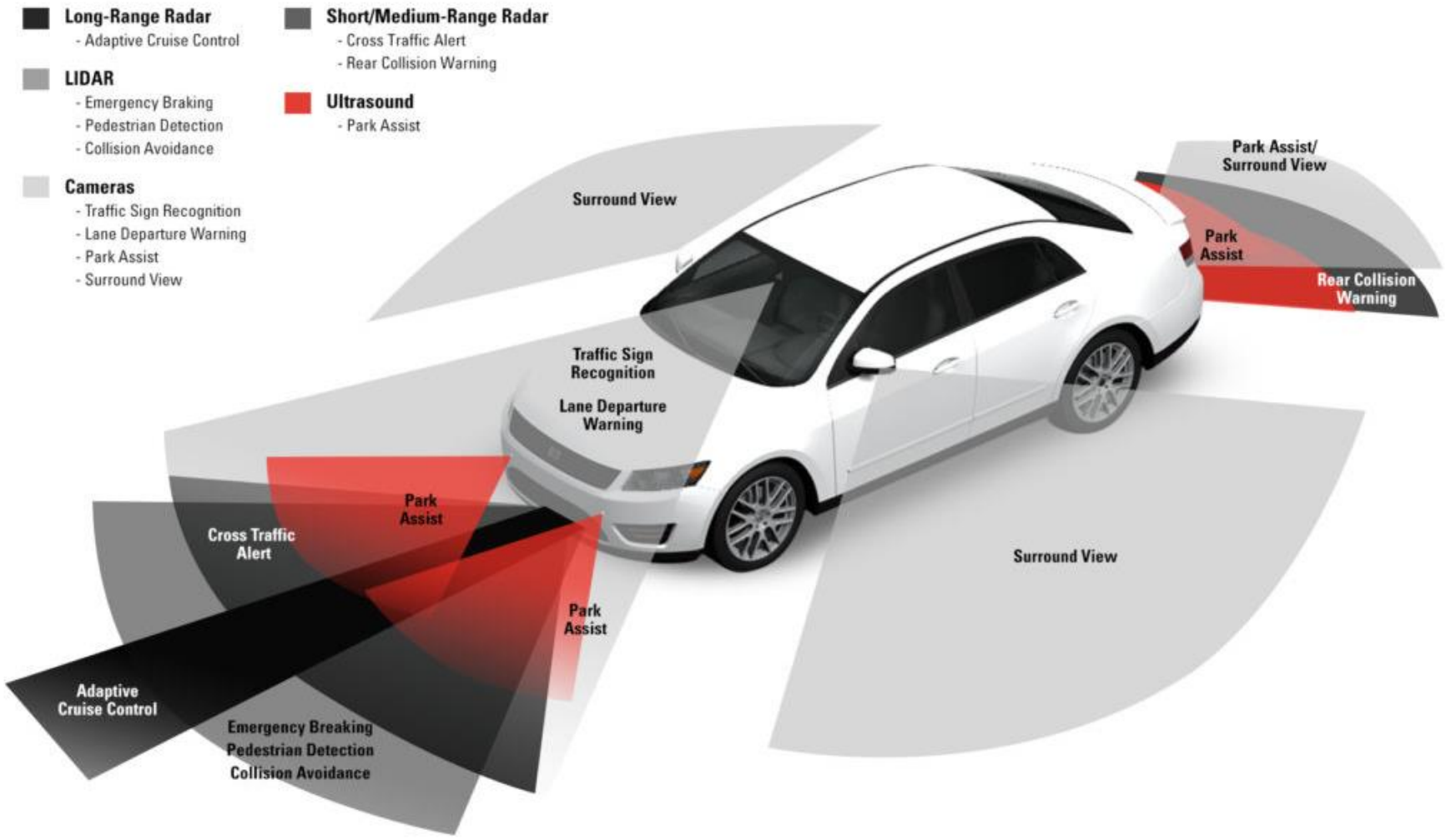
CR Consumer Reports

New Proposed Federal MUTCD Requirements



- **6” wide longitudinal markings on all roads 40+ mph**
- **6” wide edge lines on all other roads**
- **6” dotted edge line extensions along all entrance and exit ramps, all auxiliary lanes, and all tapers where a deceleration or auxiliary lane is added**
- **50 mcd/m2/lx under dry conditions for longitudinal markings on roadways with speed limits of 35+ mph**
- Chevron markings in the neutral areas of exit gores to distinguish them from travel lanes.
- Continuous markings at the beginning of work zones and in all lane transitions
- Raised pavement markers only as a supplement to, rather than as a substitute for, markings
- Uniform contrast markings on light-colored pavements to create greater contrast
- Broken lines of at least 10ft in length with a max gap of 30ft.
- Avoidance of decorative elements in crosswalks.

Increasing Percentage of New Cars Sold with ADAS



Graphic Source: http://roboticsandautomationnews.com/2017/07/01/adas-features-of-advanced-driver-assistance-systems/13194/

What Pavement Markings & Characteristics Matter for ADAS?

- Width
- Retroreflectivity
- Color
- Markings Age / Condition
- Type
- Paint Type or Material
- Contrast
- Recessed or Surface Applied
- Weather Conditions
- Geometry
- Topography
- Lighting & Time of Day
- Traffic Volume and Speeds

Research Opportunity!

THE EASTERN TRANSPORTATION COALITION

TETC Funding
& CR Oversight

CR Consumer Reports

Consumer Vehicle
Data Collection

Partnership

CONNECTICUT DEPARTMENT OF TRANSPORTATION

U.S. Department of Transportation
Federal Highway Administration

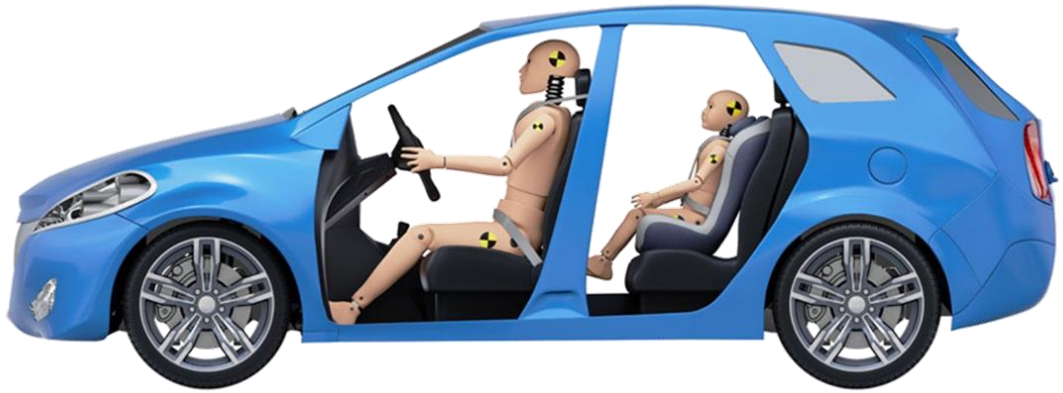
CTDOT & FHWA SPR Funding
& UCONN Oversight

UCONN

Study Area Design and Coordination,
Baseline Data Collection, Data Storage,
Data Analysis, and Reporting

Advanced Driver Assistance Systems (ADAS) Pavement Marking Evaluation in Connecticut

Connecticut Transportation Safety Research Center
University of Connecticut



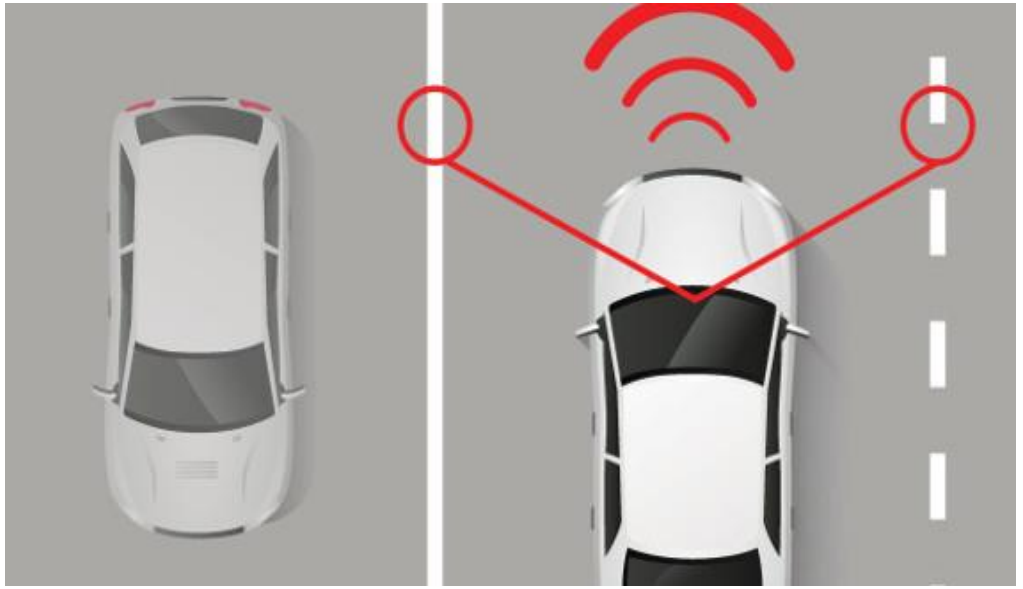
Connecticut Transportation Safety Research Center

THE EASTERN TRANSPORTATION COALITION

UCONN SCHOOL OF ENGINEERING
CONNECTICUT TRANSPORTATION INSTITUTE

Motivation

- Manufacturers have begun incorporating new ADAS in their vehicles to improve vehicle safety
- Longitudinal pavement markings are the primary roadway asset that ADAS sensors look to for reference



- ❑ Can we rely on the existing roadway markings to guide the new cars of today as well as the cars of the future?
- ❑ What are the minimum longitudinal marking requirements for driver assistance technologies to be successful in improving roadway performance and safety?

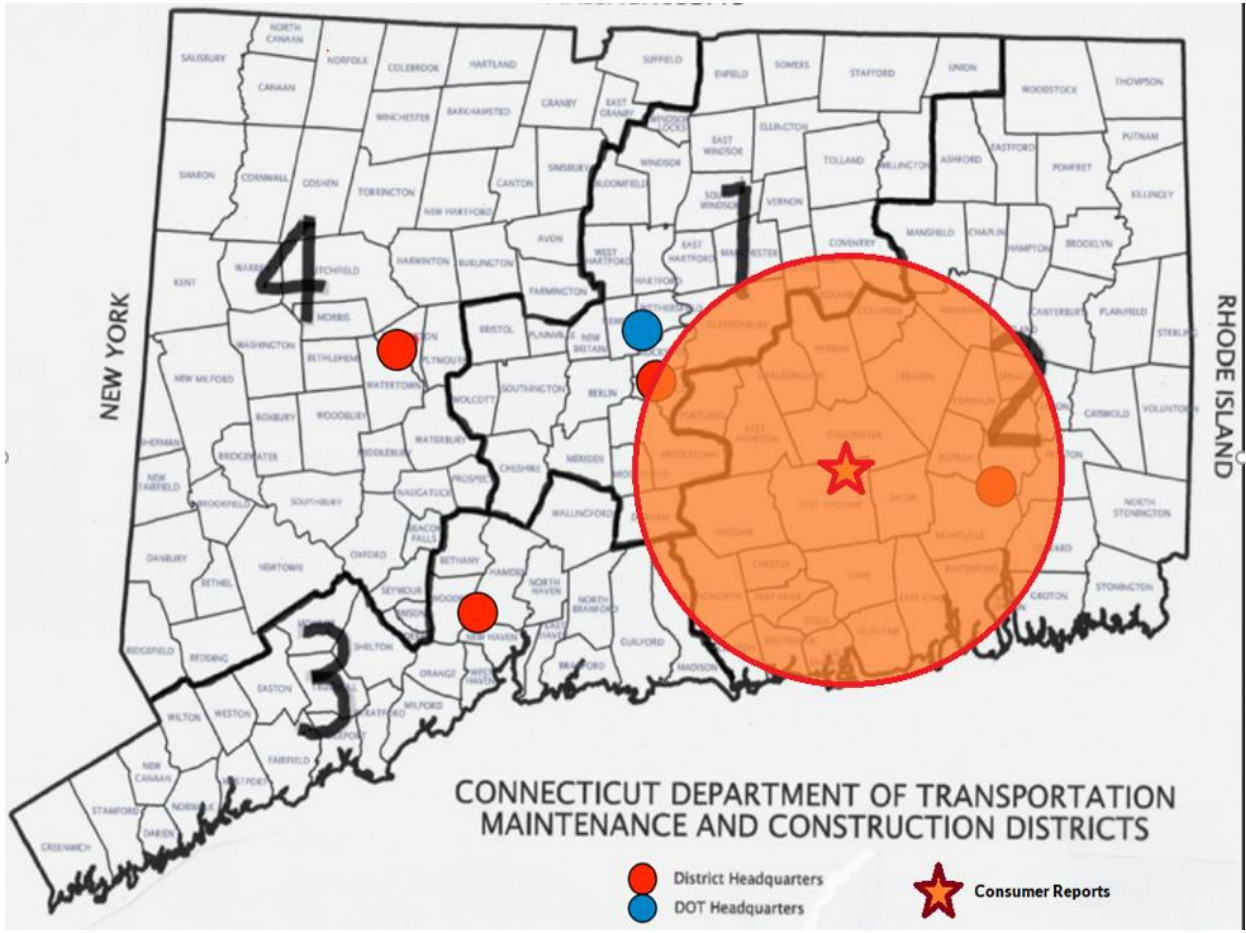
Objectives

- Evaluate the **effect of pavement marking** characteristics such as color, retroreflectivity, and lane marking width **on machine vision detection**

- Explore the machine vision lane marking **detection accuracy** under **different lighting conditions** and vehicle operational characteristics such as vehicle **speed**

- Explore the **differences across different makes, models**, and technologies used to detect lane marking while a vehicle is in operation under machine vision

Study Area



Study Partners and Tasks

- ✓ **Task 1: Literature Review**
- ✓ **Task 2: Study Design**
- ✓ **Task 3: Baseline Analysis of Study Area**
- ✓ **Task 4: Preliminary ADAS Base Data Collection**
- ✓ **Task 5: Full Scale Data Collection**
- ✓ **Task 6: Process and Archive Field Testing Data**
- ✓ **Task 7: Analyze Field Testing Data & Final Report**

Study Design

- Old vs. New –
  - Run Vehicles Pre & Post Line Stripe Improvement
- Day and Night
- 6 inch VS 4 inch
- Epoxy VS Water-based and Wet Reflective

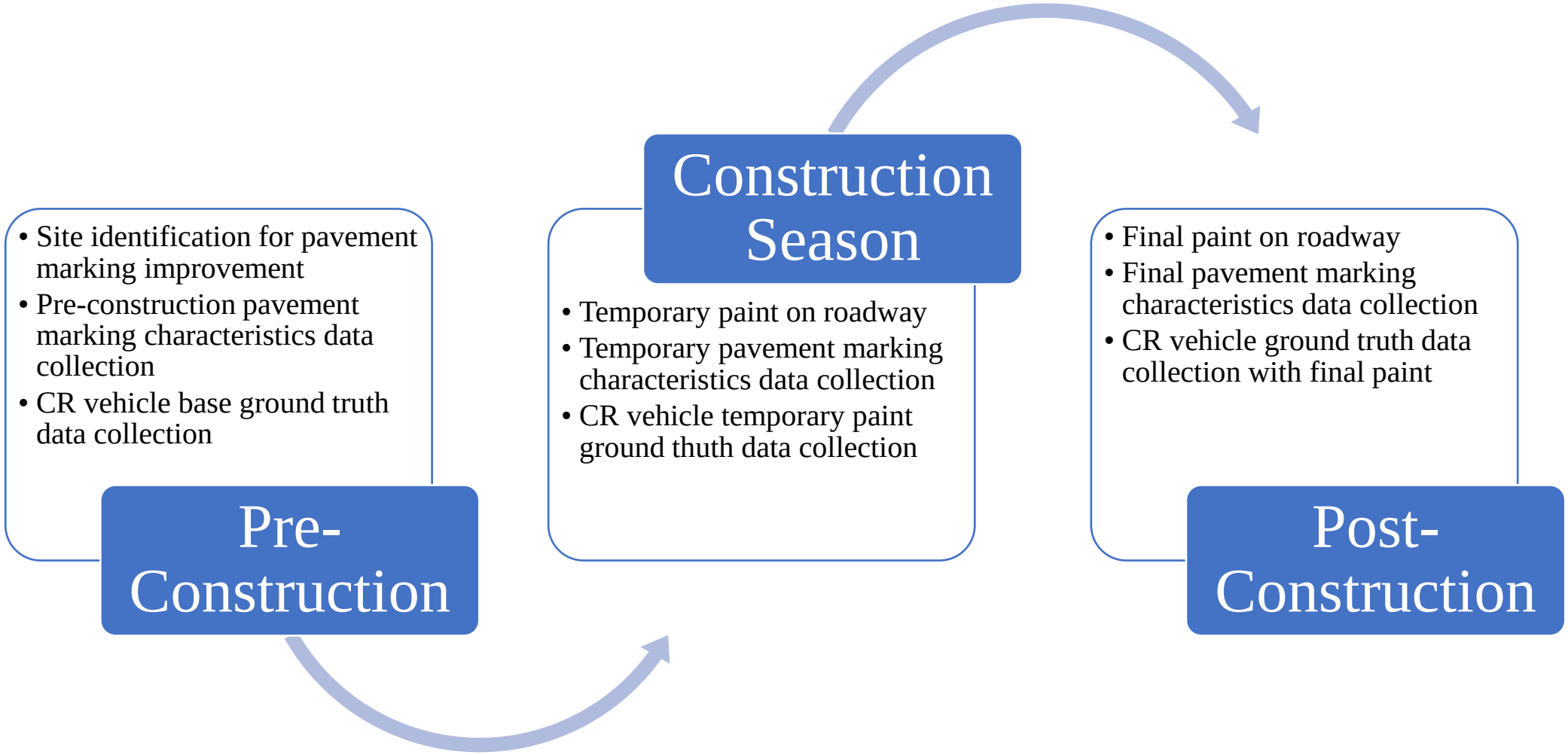
- Laserlux® G7 Mobile Retroreflectometer
- Data Items: Retroreflectivity, Width, Color, Contrast

Camera 4

Camera 2 Camera 1 Camera 3

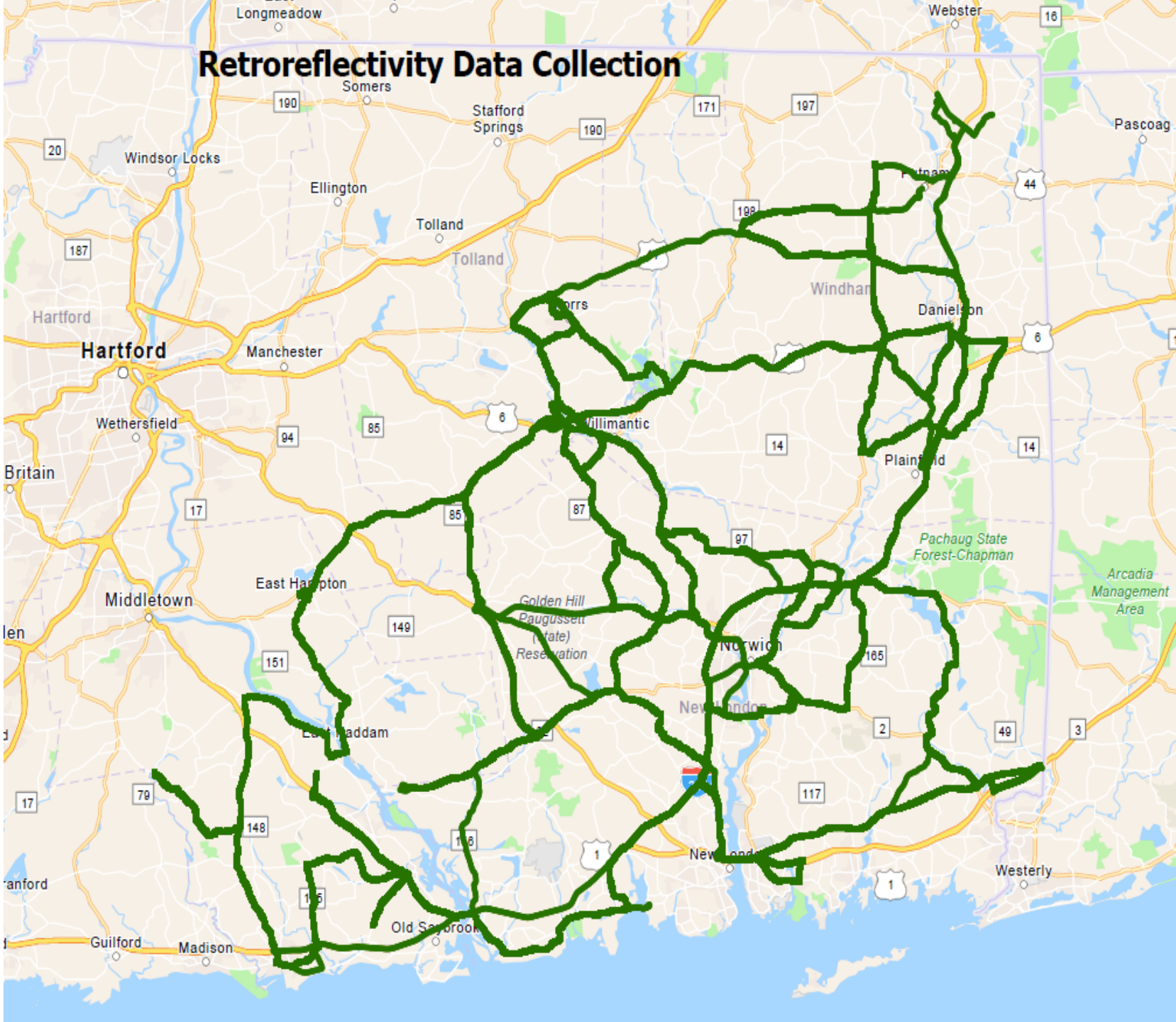
- 4-Camera setup
- Racelogic Video VBOX Pro 20Hz
- VBVD10P 580TVL Camera NTSC Assembly

Data Collection



Retro Data Collection

- Centerline and Edge line data were collected separately
- Only for the rightmost lane
  - **1,245 miles of Centerline**
  - **1,174 miles of Edge line**



Retroreflectivity Visulization Tool

Centerlines Dashboard | Edgelines Dashboard

Connecticut Transportation Safety Research Center (CTSRC)

Town
No category selected

Route
No category selected

Date
No date selected

Milepoint
0 - 500

Line Color
No category selected

Stripe Type
No category selected

Edgeline Groups
High, Medium, Low

Retroreflectivity Groupings
No category selected

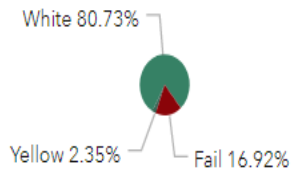
Edgeline Retroreflectivity
Set the filters in the menu above to change the widgets on the screen

Count of Retroreflectivity Readings

16.5k

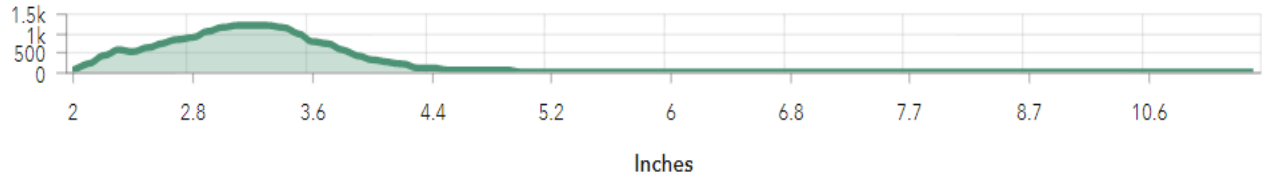
Minimum	Average	Maximum
52.3 mcd/m2/lux	215.5 mcd/m2/lux	1.3k mcd/m2/lux

Edgeline Color

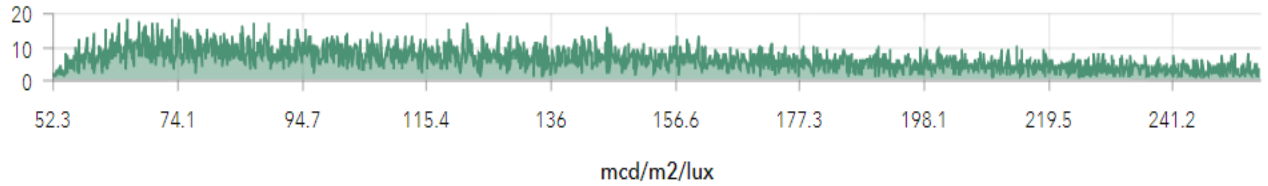


Edgeline Color

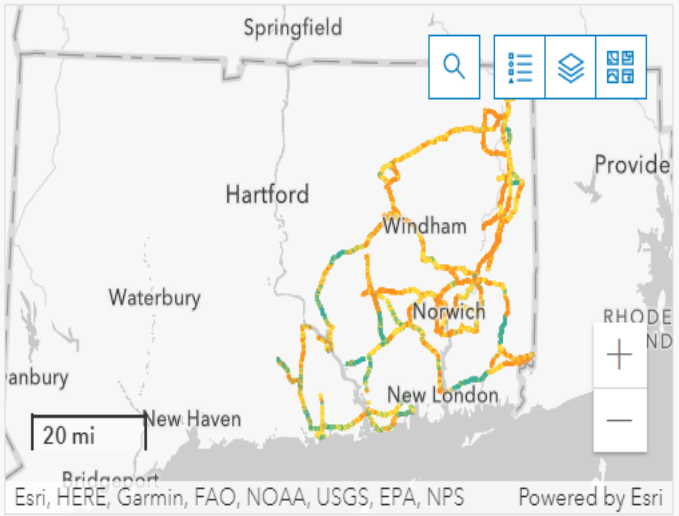
Edgeline Width



Edgeline Retroreflectivity



Width and Reflectivity | Retroreflectivity Categories | Retroreflectivity and Line Color by Milepoint



Date	Route	Mile Point	Town	Stripe Type	Retro Left ...	Retro Left ...	Retro Left ...
1/28/2023	44-E	76.21	MANSFIELD	Single_Solid	180.00	White	3.70
1/28/2023	44-E	76.15	MANSFIELD	Single_Solid	172.70	White	4.10
1/28/2023	44-E	76.10	MANSFIELD	Single_Solid	174.90	White	4.00
1/28/2023	44-E	76.05	MANSFIELD	Single_Solid	145.20	White	3.80
1/28/2023	44-E	75.91	MANSFIELD	Single_Solid	188.50	White	4.10
1/28/2023	44-E	75.82	MANSFIELD	Single_Solid	149.70	White	3.70

Retroreflectivity Visulization Tool

Centerlines Dashboard | Edgelines Dashboard

Connecticut Transportation Safety Research Center

Town
No category selected

Route
No category selected

Date
No date selected

Milepoint
0 - 500

Line Color
No category selected

Stripe Type
No category selected

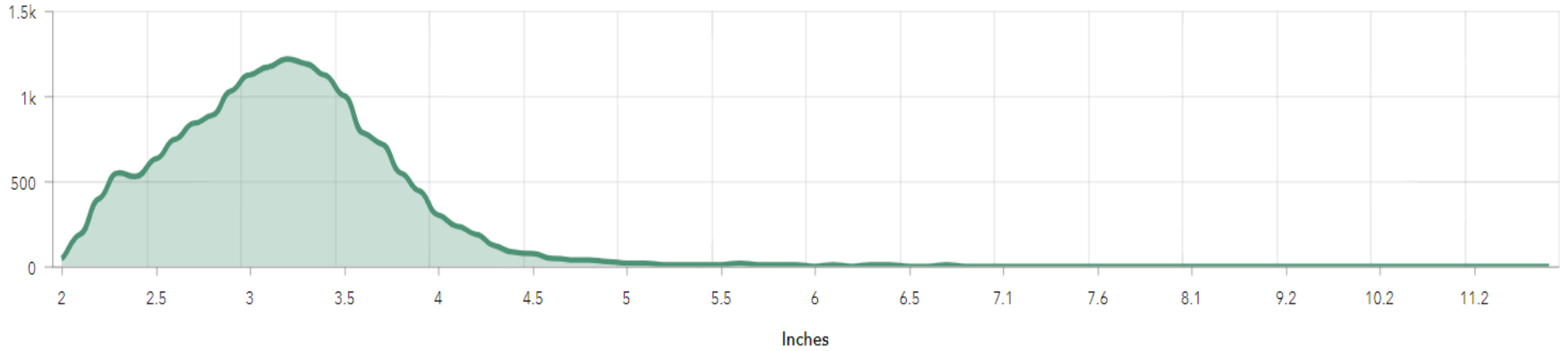
Edgeline Groups
High, Medium, Low

Retroreflectivity Groupings
No category selected

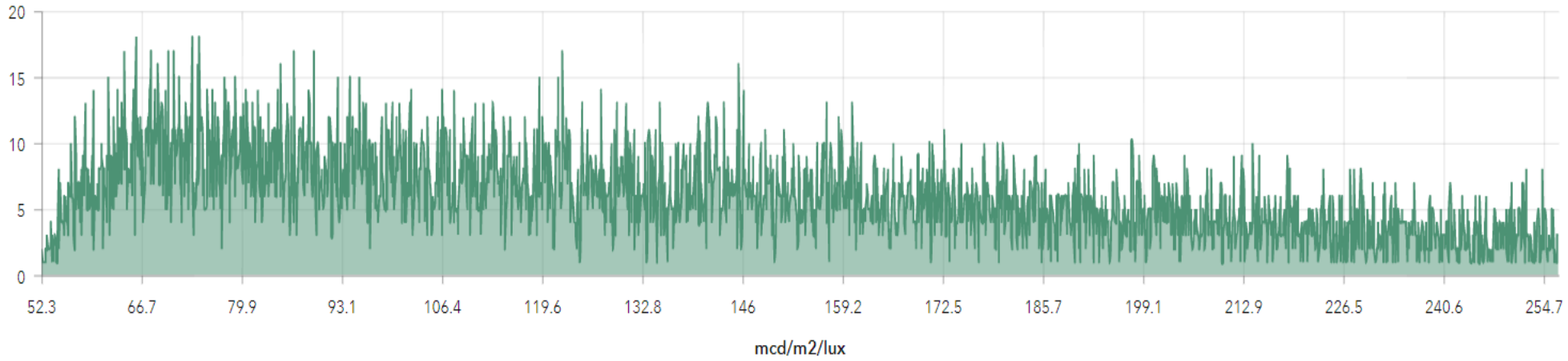
Edgeline Retroreflectivity

Set the filters in the menu above to change the widgets on the screen

Edgeline Width



Edgeline Retroreflectivity



Width and Reflectivity | Retroreflectivity Categories | Retroreflectivity and Line Color by Milepoint

Retroreflectivity Visulization Tool

Centerlines Dashboard | Edgelines Dashboard

Connecticut Transportation Safety Research Center

Town
No category selected

Route
11-N

Date
1/1/2022 - 1/1/2023

Milepoint
0 - 500

Line Color
No category selected

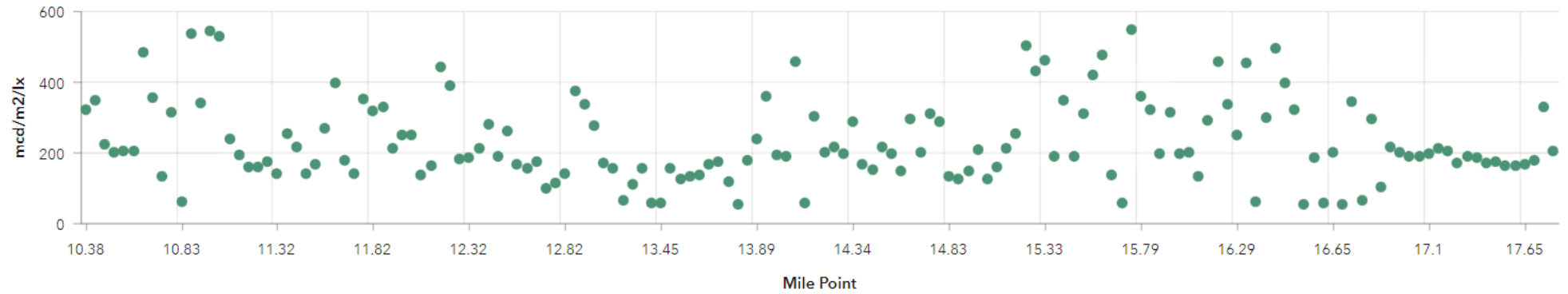
Stripe Type
No category selected

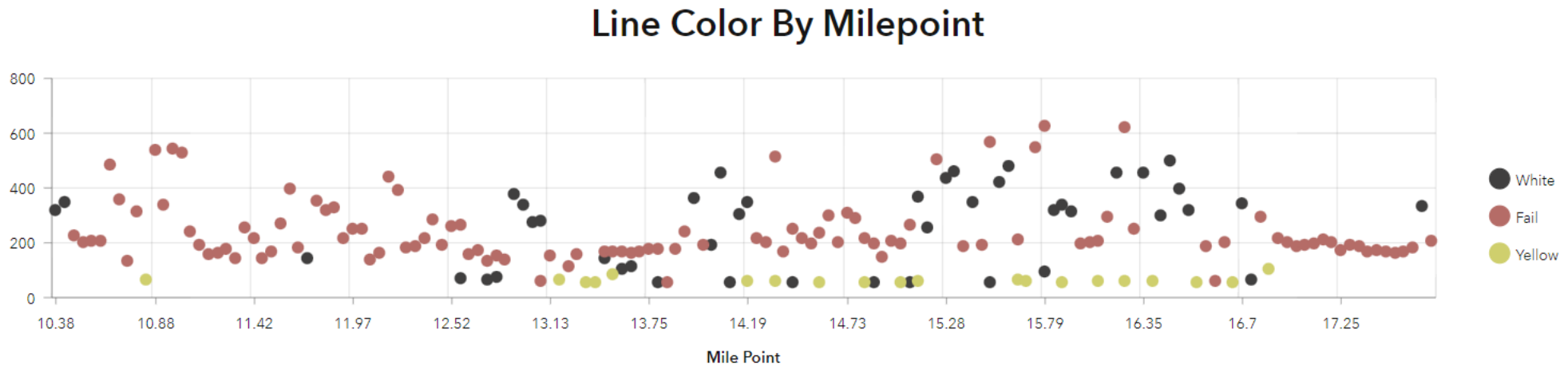
Edgeline Groups
High, Medium, Low

Retroreflectivity Groupings
No category selected

Edgeline Retroreflectivity

Set the filters in the menu above to change the widgets on the screen





Width and Reflectivity | Retroreflectivity Categories | Retroreflectivity and Line Color by Milepoint

Pre-Construction – Rt. 11 North

Retroreflectivity Visulization Tool

Centerlines Dashboard | Edgelines Dashboard

Connecticut Transportation Safety Research Center (CTSRC)

Town
No category selected

Route
11-N

Date
1/1/2023 - 3/1/2023

Milepoint
0 - 500

Line Color
No category selected

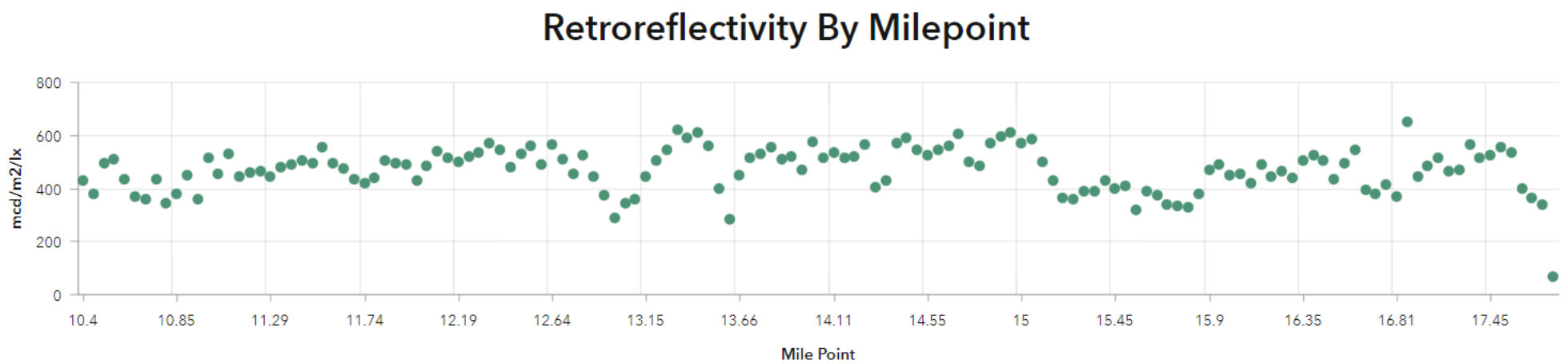
Stripe Type
No category selected

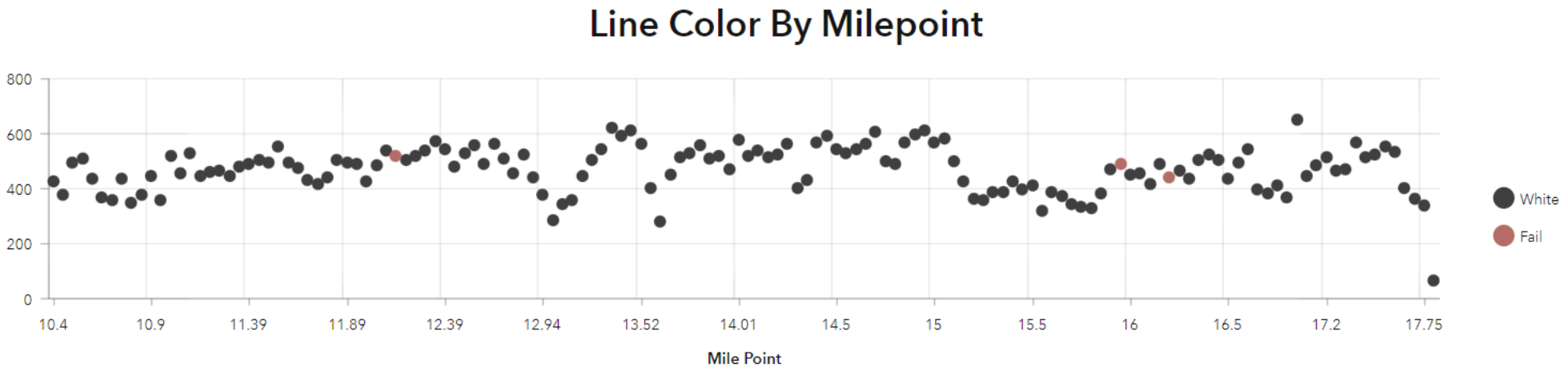
Edgeline Groups
High, Medium, Low

Retroreflectivity Groupings
No category selected

Edgeline Retroreflectivity

Set the filters in the menu above to change the widgets on the screen





Width and Reflectivity | Retroreflectivity Categories | Retroreflectivity and Line Color by Milepoint

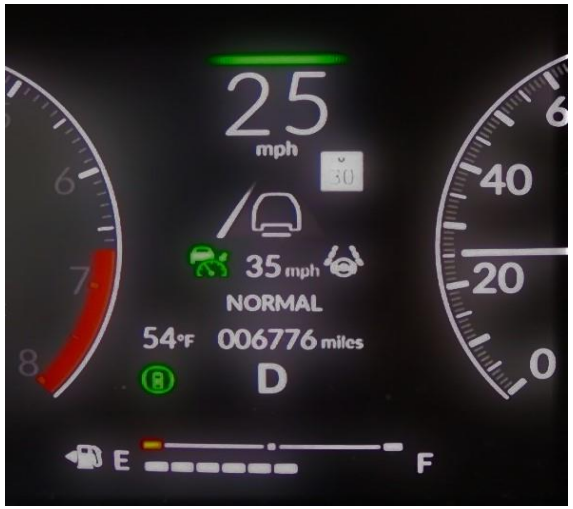
Post Construction – Rt. 11 North

Study Vehicles

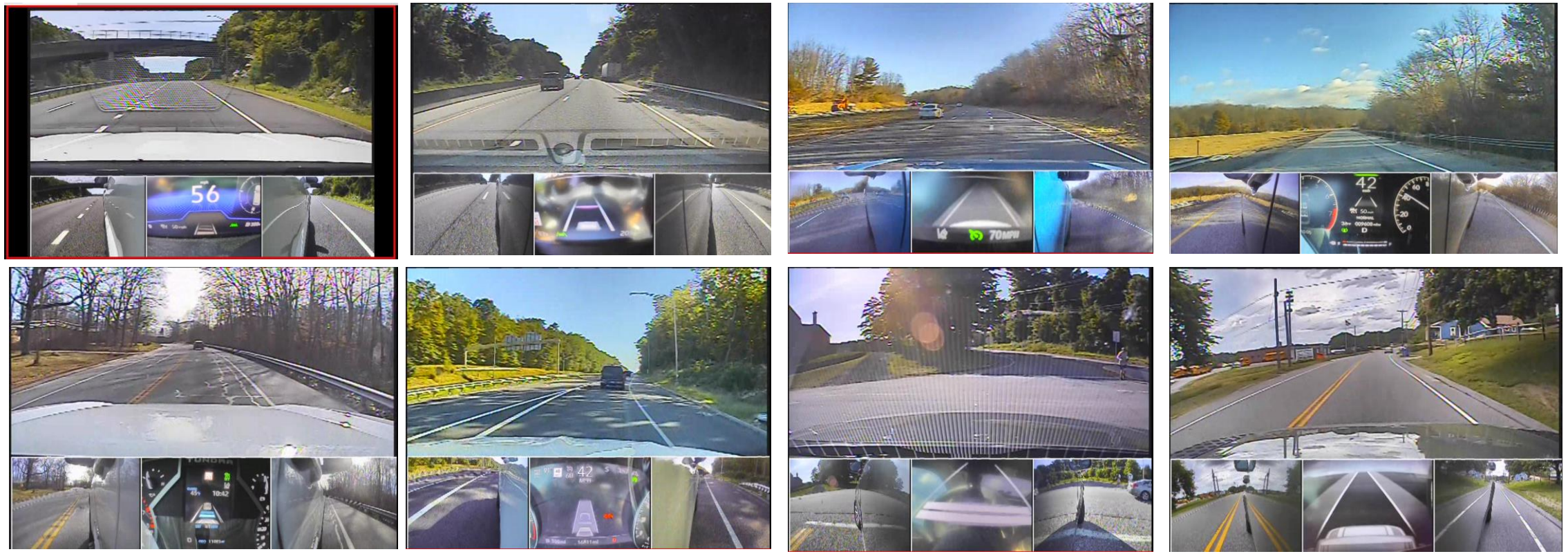
- Variety of Machine Vision Vendors “Under The Hood”
- 8 Vehicles: Different Makes and Models
  - Half are the “Most Common” Vehicles on the Market Today with This Technology onboard.
- Tesla & Super Cruise Not Included

Designation	Model Year	Description	Drivetrain	ADAS Detection Feature
Vehicle 1	2022	Sedan	FWD	Lane Keeping Assist System (LKAS)
Vehicle 2	2021	SUV	AWD	Lane Keep Assist (LKA)
Vehicle 3	2020	SUV	4WD	Lane Keep Assist (LKA)
Vehicle 4	2022	SUV	4x4	Active Lane Management System (ALMS)
Vehicle 5	2022	Crew Cab, Truck	4x4	Lane Tracing Assist (LTA)
Vehicle 6	2022	Crew Cab, Truck	AWD	Lane Keeping System (LKS)
Vehicle 7	2022	SUV	AWD	Lane Keeping Assist
Vehicle 8	2022	Minivan	FWD	Lane Keeping Assist & Lane following Assist.

Observations



Variation in Dashboard Indications



- Each system is different
- Indication types varies significantly

CTSRC
Connecticut Transportation Safety Research Center

VBOX: A data logger that links videos with GPS coordinates

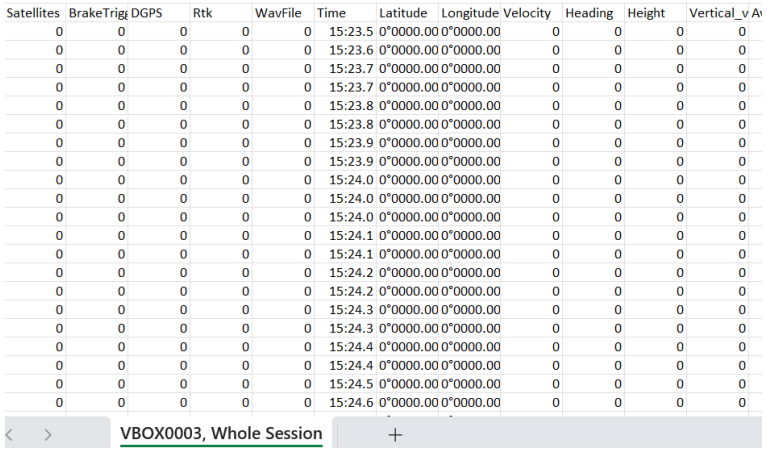
Excel Data File with GPS coordinates

Satellites	BrakeTrigg	DGPS	Rtk	WavFile	Time	Latitude	Longitude	Velocity	Heading	Height	Vertical_v	AviFileInd	AviSyncTir	dgps_stati	ComboG	Distance	ElapsedTir	Combined	LateralAcc	LongitudinalAcceleration
8	0	0	0	0	05:43.4	41°0047.7	71°0055.0	5.212	11.74	44.25	1.037	7	-1	1.00E+00	5.65E-02	0.001	0	0.131	-0.055	0.119
8	0	0	0	0	05:43.4	41°0047.7	71°0055.0	5.422	12.77	44.24	1.037	7	-1	1.00E+00	8.85E-02	0.075	0.05	0.131	-0.055	0.119
8	0	0	0	0	05:43.5	41°0047.7	71°0055.0	5.516	12.28	44.23	1.166	7	-1	1.00E+00	7.07E-02	0.151	0.1	0.06	0.027	0.053
8	0	0	0	0	05:43.5	41°0047.7	71°0055.0	5.527	11.36	44.22	1.426	7	166	1.00E+00	3.90E-02	0.228	0.15	0.051	0.05	0.006
8	0	0	0	0	05:43.6	41°0047.7	71°0055.0	5.794	11.93	44.22	1.296	7	200	1.00E+00	9.49E-02	0.307	0.2	0.155	-0.033	0.151
8	0	0	0	0	05:43.6	41°0047.7	71°0055.0	5.746	13.14	44.22	1.166	7	266	1.00E+00	3.68E-02	0.387	0.25	0.074	-0.069	-0.027
8	0	0	0	0	05:43.7	41°0047.7	71°0055.0	6.047	13.56	44.21	1.166	7	300	1.00E+00	1.04E-01	0.469	0.3	0.172	-0.025	0.171
8	0	0	0	0	05:43.7	41°0047.7	71°0055.0	6.144	12.75	44.2	1.426	7	367	1.00E+00	7.87E-02	0.553	0.35	0.074	0.049	0.055
8	0	0	0	0	05:43.7	41°0047.7	71°0055.0	6.232	14.08	44.2	1.296	7	400	1.00E+00	6.71E-02	0.639	0.4	0.096	-0.082	0.05
8	0	0	0	0	05:43.8	41°0047.7	71°0055.0	6.369	13.75	44.18	1.555	7	467	1.00E+00	7.16E-02	0.727	0.45	0.08	0.021	0.078
8	0	0	0	0	05:43.9	41°0047.7	71°0055.0	6.507	14.11	44.18	1.555	7	500	1.00E+00	7.57E-02	0.816	0.5	0.082	-0.023	0.078
8	0	0	0	0	05:43.9	41°0047.7	71°0055.0	6.686	15.48	44.18	1.426	7	567	1.00E+00	9.28E-02	0.908	0.55	0.136	-0.091	0.101
8	0	0	0	0	05:44.0	41°0047.7	71°0055.0	7.039	15.45	44.17	1.555	7	600	1.00E+00	1.46E-01	1.003	0.6	0.2	0.002	0.2
8	0	0	0	0	05:44.0	41°0047.7	71°0055.0	7.036	17.57	44.16	1.814	7	667	1.00E+00	8.56E-02	1.101	0.65	0.147	-0.147	-0.002
8	0	0	0	0	05:44.1	41°0047.7	71°0055.0	7.196	17.83	44.15	1.814	7	700	1.00E+00	9.11E-02	1.2	0.7	0.093	-0.018	0.091
8	0	0	0	0	05:44.1	41°0047.7	71°0055.0	7.326	19.04	44.14	1.944	7	767	1.00E+00	9.27E-02	1.3	0.75	0.114	-0.088	0.074
8	0	0	0	0	05:44.2	41°0047.7	71°0055.0	7.842	20.06	44.13	2.074	7	800	1.00E+00	1.93E-01	1.406	0.8	0.303	-0.079	0.292
8	0	0	0	0	05:44.2	41°0047.7	71°0055.0	8.032	20.76	44.13	1.944	7	867	1.00E+00	1.57E-01	1.516	0.85	0.121	-0.056	0.108
8	0	0	0	0	05:44.3	41°0047.7	71°0055.0	8.258	22.13	44.11	2.203	7	900	1.00E+00	1.53E-01	1.629	0.9	0.17	-0.112	0.128
8	0	0	0	0	05:44.3	41°0047.7	71°0055.0	8.477	23.15	44.11	2.203	7	967	1.00E+00	1.49E-01	1.745	0.95	0.151	-0.085	0.124
8	0	0	0	0	05:44.3	41°0047.7	71°0055.0	8.75	25.06	44.1	2.333	7	1001	1.00E+00	1.68E-01	1.865	1	0.226	-0.165	0.155
8	0	0	0	0	05:44.4	41°0047.7	71°0055.0	9.066	26.23	44.09	2.333	7	1067	1.00E+00	1.86E-01	1.989	1.05	0.207	-0.105	0.179
8	0	0	0	0	05:44.4	41°0047.7	71°0055.0	9.201	28.72	44.09	2.074	7	1101	1.00E+00	1.69E-01	2.116	1.1	0.239	-0.227	0.076
8	0	0	0	0	05:44.5	41°0047.7	71°0055.0	9.552	29.91	44.08	2.203	7	1167	1.00E+00	1.98E-01	2.246	1.15	0.228	-0.112	0.199
8	0	0	0	0	05:44.6	41°0047.7	71°0055.0	9.925	31.23	44.08	1.944	7	1201	1.00E+00	2.21E-01	2.381	1.2	0.248	-0.13	0.211
8	0	0	0	0	05:44.6	41°0047.7	71°0055.0	9.92	32.47	44.08	1.685	7	1267	1.00E+00	1.51E-01	2.519	1.25	0.122	-0.122	-0.003
8	0	0	0	0	05:44.7	41°0047.7	71°0055.0	10.241	33.61	44.07	1.685	7	1301	1.00E+00	1.82E-01	2.659	1.3	0.215	-0.115	0.182
8	0	0	0	0	05:44.7	41°0047.7	71°0055.0	10.519	33.76	44.07	1.555	7	1368	1.00E+00	1.77E-01	2.803	1.35	0.158	-0.016	0.157
8	0	0	0	0	05:44.8	41°0047.7	71°0055.0	10.57	34.88	44.06	1.555	7	1401	1.00E+00	1.35E-01	2.95	1.4	0.121	-0.117	0.029
8	0	0	0	0	05:44.8	41°0047.7	71°0055.0	10.623	34.24	44.06	1.685	7	1468	1.00E+00	9.04E-02	3.097	1.45	0.074	0.067	0.03
8	0	0	0	0	05:44.9	41°0047.7	71°0055.0	10.902	34.39	44.06	1.685	7	1501	1.00E+00	1.23E-01	3.246	1.5	0.159	-0.016	0.158
8	0	0	0	0	05:44.9	41°0047.7	71°0055.0	11.23	34.55	44.06	1.555	7	1568	1.00E+00	1.55E-01	3.4	1.55	0.187	-0.018	0.186
8	0	0	0	0	05:45.0	41°0047.7	71°0055.0	11.588	35.57	44.05	1.814	7	1601	1.00E+00	1.86E-01	3.558	1.6	0.234	-0.117	0.203
8	0	0	0	0	05:45.0	41°0047.7	71°0055.0	11.583	37.03	44.07	1.555	7	1668	1.00E+00	1.20E-01	3.719	1.65	0.167	-0.167	-0.003
8	0	0	0	0	05:45.1	41°0047.7	71°0055.0	11.927	38.23	44.07	1.426	7	1701	1.00E+00	1.70E-01	3.883	1.7	0.241	-0.142	0.195
8	0	0	0	0	05:45.1	41°0047.7	71°0055.0	12.27	39.3	44.07	1.296	7	1768	1.00E+00	1.96E-01	4.051	1.75	0.234	-0.13	0.194
8	0	0	0	0	05:45.1	41°0047.7	71°0055.0	12.408	40.88	44.07	1.296	7	1801	1.00E+00	1.72E-01	4.222	1.8	0.209	-0.194	0.078
8	0	0	0	0	05:45.2	41°0047.7	71°0055.0	12.769	41.57	44.06	1.555	7	1868	1.00E+00	1.99E-01	4.397	1.85	0.222	-0.087	0.205
8	0	0	0	0	05:45.3	41°0047.7	71°0055.0	13.186	43.21	44.06	1.814	7	1935	1.00E+00	2.41E-01	4.577	1.9	0.319	-0.214	0.236
8	0	0	0	0	05:45.3	41°0047.7	71°0055.0	13.58	44.98	44.06	1.814	7	1968	1.00E+00	2.62E-01	4.763	1.95	0.326	-0.238	0.223
8	0	0	0	0	05:45.4	41°0047.7	71°0055.0	13.927	46.31	44.06	1.685	7	2002	1.00E+00	2.60E-01	4.954	2	0.269	-0.183	0.197
8	0	0	0	0	05:45.4	41°0047.7	71°0055.0	14.376	47.84	44.06	1.814	7	2068	1.00E+00	2.86E-01	5.15	2.05	0.335	-0.217	0.254
8	0	0	0	0	05:45.5	41°0047.7	71°0055.0	14.664	48.95	44.05	1.944	7	2102	1.00E+00	2.59E-01	5.352	2.1	0.229	-0.161	0.163
8	0	0	0	0	05:45.5	41°0047.7	71°0055.0	14.95	50.52	44.05	2.074	7	2168	1.00E+00	2.55E-01	5.558	2.15	0.283	-0.232	0.162
8	0	0	0	0	05:45.6	41°0047.7	71°0055.0	15.258	51.39	44.05	2.074	7	2202	1.00E+00	2.47E-01	5.768	2.2	0.218	-0.131	0.174

Data Analysis Process:
Review the dashboard video from the VBOX file and add a flag in the Excel Data file when lane marking is not detected

Data Issues

- Real-world data collection can be affected by several factors
  - Traffic factors, Contextual factors, Equipment used, # of sites
- Collected ground truth data was affected by
  - Video quality (glare, camera position)
  - GPS error
  - File naming scheme
  - Variation is dashboard indications across vehicles
  - Painting schedule



Satellites	BrakeTrigg	DGPS	Rtk	WavFile	Time	Latitude	Longitude	Velocity	Heading	Height	Vertical_v	A
0	0	0	0	0	15:23.5	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:23.6	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:23.7	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:23.7	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:23.8	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:23.8	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:23.9	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:23.9	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.0	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.0	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.0	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.1	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.1	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.2	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.2	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.3	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.3	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.4	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.4	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.5	0°0000.00	0°0000.00	0	0	0	0	
0	0	0	0	0	15:24.6	0°0000.00	0°0000.00	0	0	0	0	

VBOX0003, Whole Session

Last Marking Date

RouteId	Town(s)	Project Type	BGN MILES	END MILES	LOG LENGTH	Termini	Date of Last Permanent Marking
6-E	Brooklyn/ Killingly	VIP	109.43	110.9	1.47	.06 Miles West of East jct. Brickyard Rd. to Start o/p Quinebaug River	11/20/2022
11-N	SALEM	Ultra-Thin	10.38	17.8	7.42	SR-82 to SR-2	11/7/2023
11-S	SALEM	Ultra-Thin	10.38	17.8	7.42	SR-82 to SR-2	11/7/2023
12-N	Plainfield	VIP	23.44	26.29	2.85	Griswold TL to OP Mill Brook	6/5/2023
12-N	Killingly/ Putnam	VIP	39.81	44.65	4.84	Town Farm Road #2 to Heritage Road	12/1/2022
12-N	Plainfield	VIP	27.91	32.13	4.22	N. Jct Rte 14A Academy Hill Road to Rte 205 n/b Wauregan Road	11/28/2022
14-E	Plainfield	VIP	13.46	16.99	3.53	W. JCT RT. 14A TO 12	5/31/2023
82-E	SALEM	Chip-Seal	17.6	20.2	2.6	.03 MI E/O END ROUNDABOUT (NEW LONDON RD) TO RTE 354 (EB) (OLD COLCHESTER RD)	8/18/2022
163-N	MONTVILLE/ BOZRAH	VIP	7.46	12.56	5.1	RT. 82 TO SR-2 BOZRAH ST. EXT.	6/8/2023
164-N	Preston/ Griswold	VIP	0	7.83	7.83	Rte 2 Norwich Westerly Road to end of Route 164	12/9/2022
165-E	Norwich/ Preston	VIP	0	5.16	5.16	Rt 2 to Rt 164	6/7/2023
2A-E	Montville/ Preston	VIP	4.37	7.05	2.68	BGN OP I-395 TO RTE 12 (INCLUDE RAMPS)	9/30/2022
2A-E	Preston	VIP	7.35	9.91	2.56	Route 12 Military Hwy to End of Route 2A	9/29/2022
607-E	Killingly	VIP	0	2.54	2.54	RT. 12 TO SOUTH FRONTAGE RD.	11/21/2022
6-E	KILLINGLY	Trad. Epoxy	111.32	113.62	2.3	RT. 12 TO SR. 607 (Brickyard Rd)	Done by Another Contractor
12-N	NORWICH/ LISBON	Trad. Epoxy	15.2	19.55	4.35	RT. 97 TO NB. ACCESS TO I395	Done by Another Conractor

Vehicle ID	Day/Night	2022						2023
		June	July	Aug	Sep	Oct	Dec	Jan
Vehicle 1	Day	157.95	0	0	350.07	0	228.3	0
	Night	57.32	0	0	282	0	298	0
Vehicle 2	Day	76.3	0	142.67	0	1000.63*	123.85	0
	Night	56.9	0	134.13	0	146.3	0	0
Vehicle 3	Day	93.2	0	0	0	0	0	0
	Night	46.33	0	0	0	1715.33*	0	109.92
Vehicle 4	Day	135.33	0	0	0	0	0	0
	Night	138.25	0	0	0	279.95	0	0
Vehicle 5	Day	52.13	0	165.88	319.22	0	0	210.58
	Night	63.25	0	144.93	311.53	0	0	226.73
Vehicle 6	Day	0	0	0	159.08	0	0	1095.68*
	Night	0	0	0	0	0	0	224.2
Vehicle 7	Day	81.35	0	0	0	276.43	0	0
	Night	0	57.98	0	0	129.27	0	0
Vehicle 8	Day	0	246.5	141.22	150.4	138.42	0	217.93
	Night	0	156.72	131.85	148.65	121.3	0	235.3

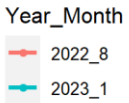
Legend:	0	51-100	101-150	151-200	201-250	251-300	>301

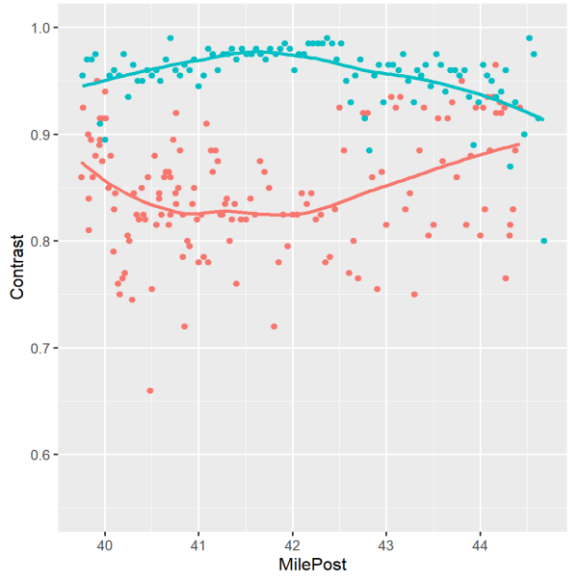
Note: Values with "*" exclude files that cannot be processed in the Circuit Tool

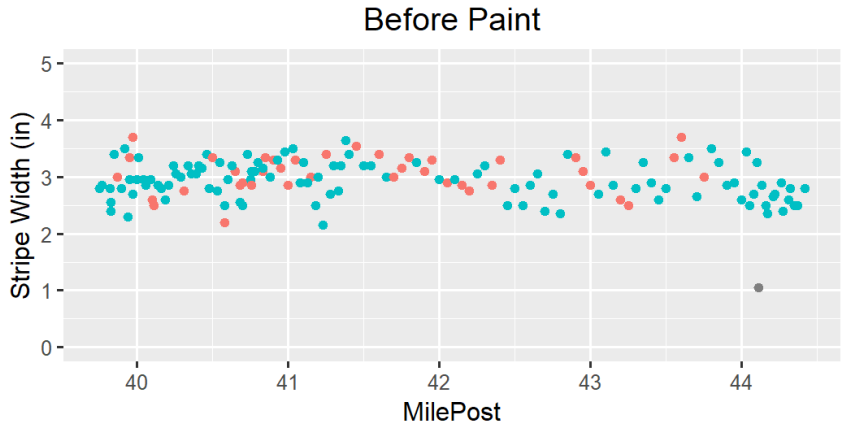
Data Distribution

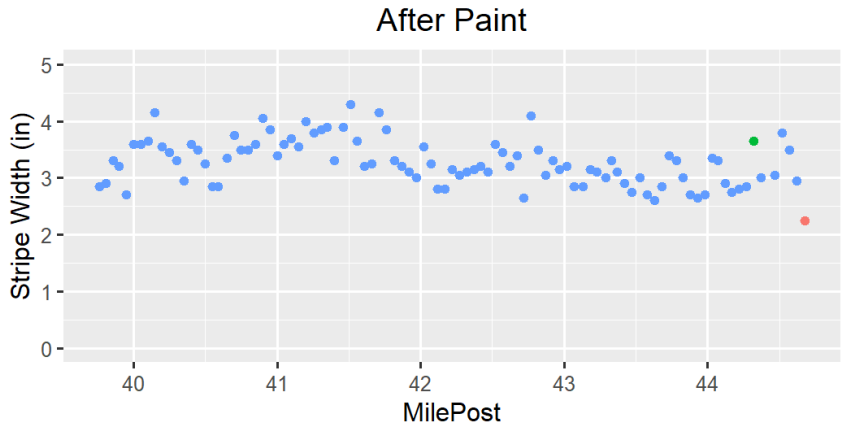
SiteID	Period	Day/ Night	Vehicle 1				Vehicle 2				Vehicle 3				Vehicle 4				Vehicle 5			
			Date	Count	%-LM	%-RM	Date	Count	%-LM	%-RM	Date	Count	%-LM	%-RM	Date	Count	%-LM	%-RM	Date	Count	%-LM	%-RM
12N_VIP 1128	Before	Day					6/21/22	4940	10.12	9.92	6/7/22	5697	51.61	46.16	6/9/22	5743	3.83	3.83				
		Night	6/29/22	5482	0	0	6/23/22	5376	0	0					6/9/22	5556	3.78	4.14	6/20/22	5671	16.40	8.29
	During	Day	9/14/22	2974	4.37	0													9/24/22	2119	8.97	0
		Night	9/15/22	3607	0	0	10/20/22	3577	0	0									9/23/22	1841	0	0
	After	Day	12/19/22	5451	0	0	12/5/22	5297	12.27	10.38	1/24/23	3640	0	0					1/11/23	5623	0	27.39
		Night	12/8/22	5946	0	0													1/17/23	5312	0	5.84
12N_VIP 1201	Before	Day	6/24/22	6410	14.20	2.96	6/21/22	6235	114.03	123.66	6/7/22	6719	215.36	134.39	6/9/22	6863	2.04	3.93				
		Night	6/29/22	6362	0	0	6/23/22	6897	81.77	88.59					6/9/22	6628	4.07	3.92	6/20/22	6772	90.52	61.72
	During	Day	9/14/22	3869	0	0													9/24/22	3992	0	0
		Night	9/15/22	4903	0	15.91	10/20/22	7065	0	9.34									9/23/22	6866	10.34	9.18
	After	Day	12/19/22	6860	0	0	12/5/22	3386	48.73	48.73									1/17/23	7403	68.62	110.23
		Night	12/8/22	6628	0	0					1/24/23	668	28.44	28.44					1/11/23	7511	36.35	31.29
164N_VIP 1209	Before	Day	6/24/22	9999	0	0	6/21/22	1842	13.57	14.66					6/9/22	10416	6.72	6.43	6/17/22	8179	15.53	14.55
		Night													6/9/22	10135	0	0.79	6/20/22	5691	2.81	5.62
	During	Day	9/30/22	8324	0	0	8/25/22	7898	0	0									9/27/22	9723	15.02	25.71
		Night	9/29/22	7612	0	0	8/25/22	10765	0	0									9/27/22	6844	7.89	60.78
	After	Day	12/19/22	11360	0	0					1/18/23	6858	122.34	125.40					1/11/23	10726	13.52	54.82
		Night	12/30/22	10888	0	0					1/24/23	6460	75.08	70.43					1/17/23	11382	10.28	8.43
2AE_VIP 0930	Before	Day	6/2/22	6274	0	3.51	6/21/22	2784	93.39	100.57	6/6/22	3414	146.46	172.52	6/8/22	3217	43.83	43.83	6/17/22	2667	61.49	86.24
			6/24/22	3512	0	0													8/16/22	3448	160.67	67.00
		Night									6/6/22	3599	135.87	134.76	6/8/22	3480	6.32	6.32	6/20/22	3281	84.43	68.27
																			8/16/22	3012	47.81	48.47
	During	Day	9/30/22	3182	0	3.46													9/27/22	3258	109.88	113.26
		Night	9/29/22	3593	0.83	7.51	8/25/22	3509	31.92	31.92									9/27/22	2781	0	69.76
	After	Day	12/19/22	3311	21.44	2.42					1/18/23	613	107.67	83.20					1/17/23	3104	39.63	134.99
		Night	12/30/22	3515	68.28	3.13					1/24/23	3299	210.97	138.22					1/11/23	3329	126.76	64.88

Data Analysis



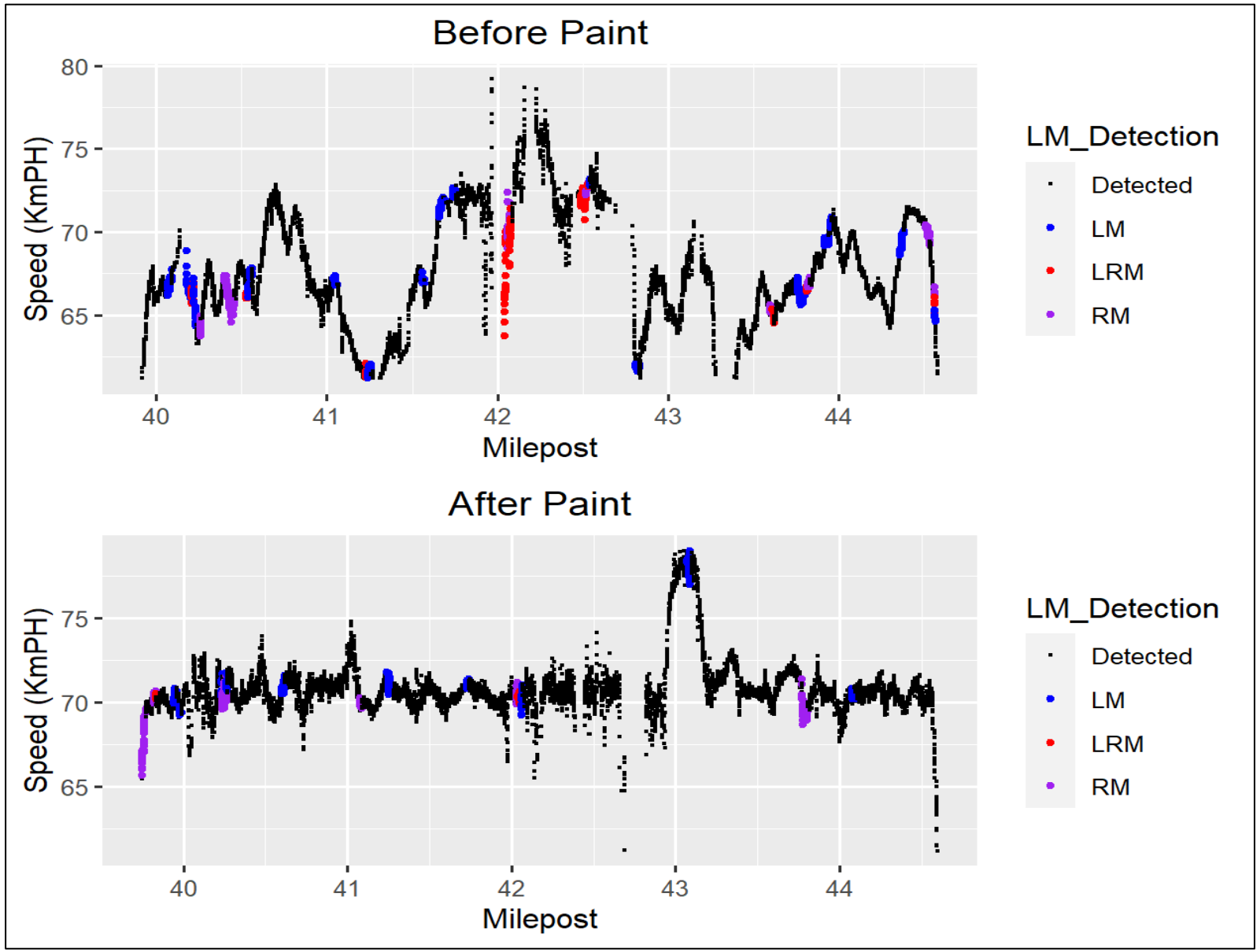






Improved pavement marking conditions after paint

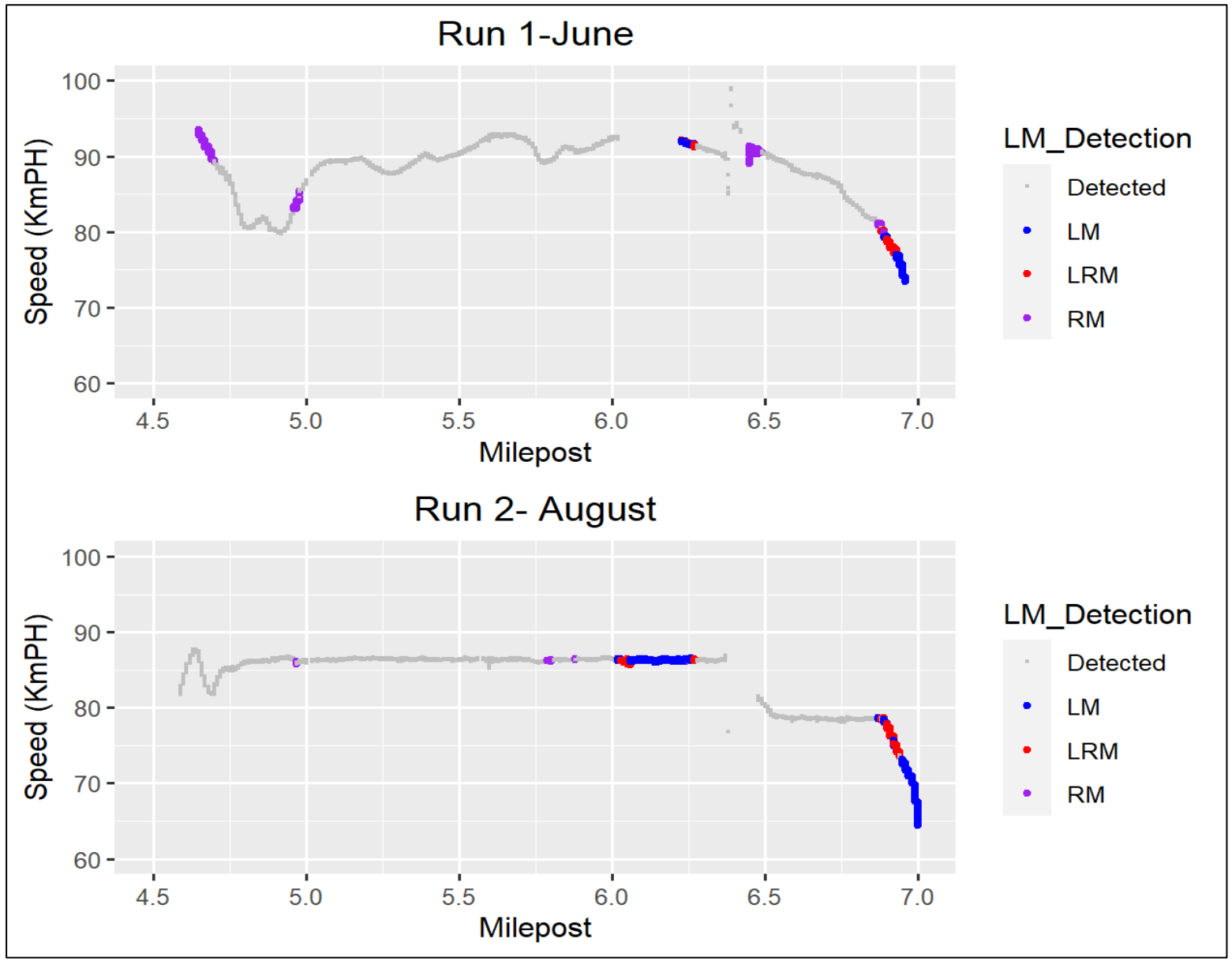
Data Analysis: Before vs After



Takeaways

- Failed to detect lane markings
  - In both high and low speed
  - In after condition with improved markings

Data Analysis: Comparing Same Condition

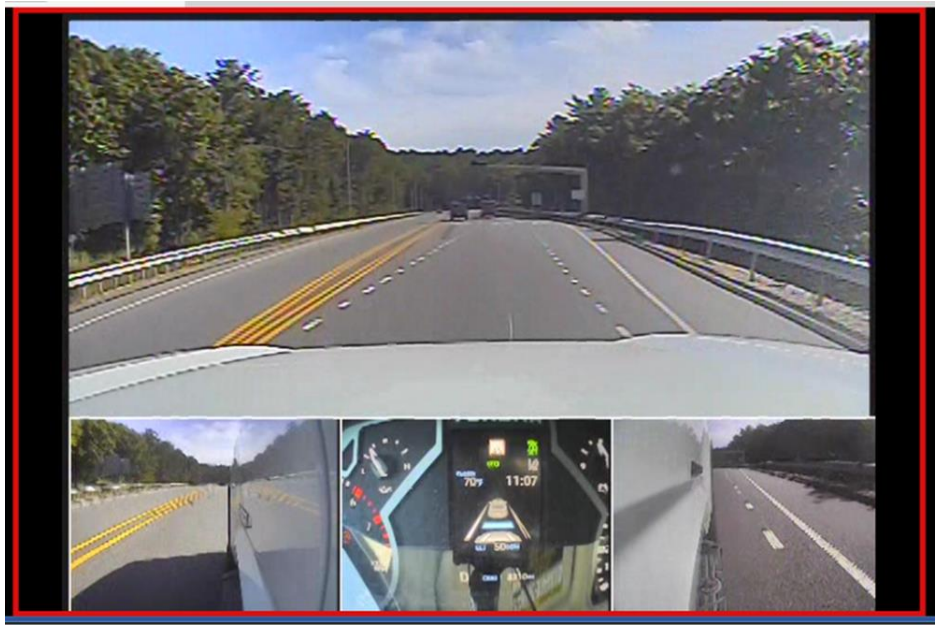


Takeaways

- Not consistent detection on the same site using the same vehicle
- Failed to detect lane markings in both high and low speed

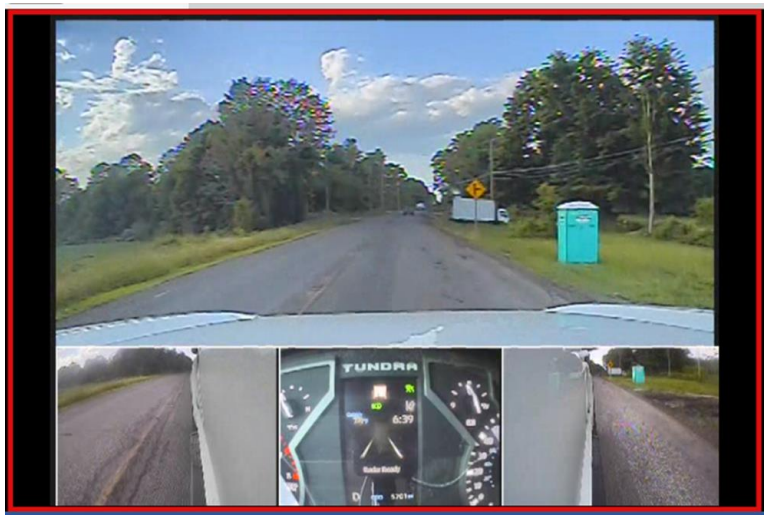
Special Events

Changes in Lane Marking Types



Wide Lanes

Raised Curb



Conclusions

- No apparent relationship between pavement marking characteristics and pavement marking detection capability of ADAS.
  - ADAS detected lane markings with **retroreflectivity <100 mcd/m2/lux**.
  - ADAS was able to detect **lane stripe width ≈ 3 inches**.
  - Similar trend was observed with pavement marking color and contrast.
- The “None Detected” events were not associated with vehicle speed.
- Special scenarios were identified where ADAS failed to detect lane markings
  - Changes in lane marking type and color
  - Wide lane
  - Object on the road

Recommendations

- Lessons learned on real-world ADAS data collection
- Design future studies
  - Design defined data collection procedure
  - Data accuracy check
  - Multiple runs on the same location with varying speeds, and pavement marking characteristics
- Careful study site selection
- Define an appropriate data archiving procedure

Questions?

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Q&A and Discussion

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CONNECTING FOR SOLUTIONS

THANK YOU

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