Development of Safety Testing for Automated Driving Systems (ADS) Equipped Vehicles

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Workshop on Consensus Safety Measurement Methodologies for ADS Equipped Vehicles

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The question of “when” ADS technology will be deployed has changed to “where”

• Technically, most companies are just testing, but...

• This testing involves more than engineers monitoring ADS performance and tracking disengagements:

• **Waymo** launched a driverless service in the **Phoenix** area and is testing in **Kirkland, Atlanta, Detroit, Austin** and multiple areas near **Mountain View**.

• **Ford** is testing pizza delivery in **Miami** with additional testing in **Dearborn, Miami, Pittsburgh, DC** and plans for testing in **Austin**.

• **APTIV** and **Lyft** have a partnership “driving” riders in **Las Vegas**

• **Nuro** is delivering groceries in **Scottsdale**.

• **GM** plans to pilot a food delivery service in **San Francisco** this year with testing also taking place in **Warren and Scottsdale**.
Some Milestones in the U.S. Traffic Environment

1885  First seat belt patent is awarded
1901  First statewide traffic laws enacted in Connecticut
1907  First national road inventory published (for 1904)
1910  First drunk driving laws enacted in New York
1911  First documented use of a painted center line used for road surface marking
1920  Four-way, three-color traffic signal tower, installed at an intersection
1934  First motor vehicle crash test
1938-1940  Pedestrian Walk/Don't Walk Signal
1952  First rumble strips implemented in New Jersey
1953  Motorcycle Helmet developed
1966  First Botts' Dots were installed in California
1967  FMVSS No. 209, Seat Belt Assemblies, was the first FMVSS
1968  First seat belt law
1969  First consumer information program: Frontal Impact Testing
2003  National implementation of the Click It or Ticket seat belt enforcement program
2007  Electronic Stability Control (ESC) mandated on passenger and light-duty vehicles
2011  Updates to Child Safety recommendations to be categorized by age rather than type of child seat.
2015  Automated Emergency Braking MOU Signed
2016  Seat belt use achieved an all-time high rate of 90%
2018  National implementation of the Click It or Ticket seat belt enforcement program
2020  5-Star Safety Ratings program
2021  Electronic Stability Control (ESC) mandated on passenger and light-duty vehicles
2025  90% Seat belt use achieved an all-time high rate of 90%
Development of Safety Testing for ADSs

The development of safety testing for ADSs is needed and will not happen overnight

...establishing a thoughtful methodology that allows testing to evolve with the technology will be critical to addressing the complexity of ADSs safety testing.
Development of Safety Testing for ADSs

Testing Framework

Data and Analysis for Framework Implementation

Real-world Deployment Considerations
Development of Safety Testing for ADSs:
Testing Framework

NHTSA’s Testable Cases and Scenarios for Automated Driving Systems created a framework for describing an ADS test scenario; however, more research is needed to identify testable cases and associated test architecture.

Reference:
Development of Safety Testing for ADSs: Data and Analysis for Framework Implementation

Safety testing (specifically identifying test cases) starts with the data and knowledge we have today.

- Naturalistic Driving Data
- U.S. National Accident Data
- Field Operational Data
- Rules of the Road
An industry partnership promoting the development of tools, techniques, and data resources to support the rapid advancement of automated-vehicle deployment for its members.
Development of Safety Testing for ADSs: Real-world Cases, Analytics and Tools

VTTI’s AMP Program is working to support the rapid advancement of ADS deployment.
AMP Near Crash Left Turn Across Path From Opposite Directions Example Case
AMP Near Crash Left Turn Across Path From Opposite Directions Example Case
Development of Safety Testing for ADSs: Data and Analysis for Framework Implementation

The complexity of the ADS and potential test cases may require a multifaceted testing architecture.
Coping with Variability and Uncertainty

Operational design domains can be limited, but most ADSs will still need to operate in highly dynamic domains (e.g., environmental, situational).

No two work zones are the same.

Vulnerable road user interactions add to unpredictability and error severity.

Human drivers, even safe ones, are highly variable.
An innovative approach is needed for the deployment of ADSs. Safety testing alone may not fully ensure safe, robust, and reliable ADS technologies. Some examples for manufacturers to consider include:
Development of Safety Testing for ADSs

All elements needed for the development of ADS safety testing are in place, but they must evolve rapidly and be universally agreed upon.

Progress will occur one element at a time
Advancing Transportation Through Innovation

Thank you
1885: The first seat belt patent is secured by Edward J. Claghorn of New York.

1901: Statewide traffic laws: Connecticut creates the first statewide traffic laws. The new laws limit motor vehicle speed to 12 mph in cities and 15 mph on country roads.

1907: First national road inventory published (for 1904).
https://www.fhwa.dot.gov/publications/publicroads/96spring/p96sp44.cfm

1910: Drunk driving: New York introduces the first drunk driving laws, penalizing drivers for operating a vehicle while under the influence of alcohol.

1911: A painted line along Trenton's River Road in Wayne County, Michigan, is the first documented use of a painted center line used for road surface marking.

In 1920, William Potts designed the first four-way, three-color traffic signal tower, which was installed at the intersection of Woodward and Michigan Avenues in Detroit in October 1920.

1934: General Motors conducts the first vehicle crash test in Milford, Michigan. (Barrier test)
https://www.titlemax.com/resources/a-chronology-of-car-safety/ and other

1938-1940: Pedestrian Walk/Don't Walk Signal installed at intersection
https://www.fhwa.dot.gov/infrastructure/walk.cfm

1939: Buick introduces electric turn signals, replacing hand signals.
https://www.titlemax.com/resources/a-chronology-of-car-safety/

1953: Motorcycle Helmet developed by University of Southern California Professor C.F. Lombard. Designed to absorb the shock of impact. Patent awarded (later?)

1956: The first Botts’ Dots were installed on Interstate 80 around Fairfield and on Highway 99 near Fresno (CalTrans)
https://www.snopes.com/fact-check/botts-dots/

1966: First seat belt law required all vehicles (except buses) to be fitted with seat belts in all designated seating positions.
https://en.wikipedia.org/wiki/Seat_belt_laws_in_the_United_States

1978: Frontal impact testing: The first consumer information program on vehicle safety is established and a 35 mph frontal crash test is administered.

1995: 49 of the 50 states have mandatory seat belt laws.
https://en.wikipedia.org/wiki/Seat_belt_laws_in_the_United_States

2003: The Click It or Ticket seat belt enforcement program goes national, working to increase seat belt use in all 50 states.

2005: .08 BAC Laws: By 2005, all US States, the District of Columbia, and Puerto Rico have enacted .08 per se laws.

2007: Electronic Stability Control (ESC) is mandated on all passenger and light-duty vehicles.

2011: Updates to Child Safety recommendations to be categorized by age rather than type of child seat.

2016: Seat belt use achieved an all-time high rate of 90 percent (DOT HS 812 662)
Ref for blue font items: https://one.nhtsa.gov/nhtsa/timeline/index.html