WASHINGTON STATE
AUTONOMOUS VEHICLE
WORK GROUP

MEETING SUMMARY

Meeting: Safety Subcommittee
Location: Virtual Meeting - Zoom
Date: May 12, 2021

Attendees:

Name	Organization
Aidan Ali-Sullivan	Waymo
Michelle Avary	World Economic Forum
Shannon Bendiksen	Washington State Patrol (WSP)
Daniela Bremmer	Washington State Department of Transportation (WSDOT)
Debi Besser	Washington Traffic Safety Commission (WTSC)
Kenton Brine	NW Insurance Council
David Carter	US Department of Transportation
Brian Chandler	DKS Associates
Dan Cooke	Washington State Department of Licensing
Chief Steve Crown	Wenatchee Police
Doug Dahl	TransitLab
Dr. Andrew Dannenberg	University of Washington
Mandie Dell	WTSC
Mi Ae Lipe	Driving in the Real World
Brent Ludeman	Waymo
Katie Marshall	Venable, LLP
Kimberly Mathis	Washington State Patrol (WSP)
Kyle Miller	WSDOT
Markell Moffett	WSP USA
Pam Pannkuk	WTSC
Manuela Papadopol	Designated Driver
Danny Shapiro	NVIDIA
Captain Trisena Sharff	Washington State Patrol (WSP)
Lt. Courtney Stewart	Washington State Patrol (WSP)
Hilary Torres	National Highway Traffic Safety Administration (NHTSA)
Shannon Walker	City of Seattle
Alan Werner	Washington Society of Professional Engineers
Bryce Yadon	Futurewise

WELCOME & INTRODUCTIONS

Captain Trisena Scharff & Manuela Papadopol

- Introductions
- Walkthrough agenda

Topic closed.

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AUTONOMOUS VEHICLE POLICY: A DRIVING TEST FOR SELF-DRIVING CARS?

Michelle Avary – Head, Automotive and Autonomous Mobility, World Economic Forum

- World Economic Forum has been going for 50 years, non-profit, stated mission to improve the state of the world
    - More than just convening multi-stakeholder events, hosts different platforms
    - One of the key platforms, the Mobility Platform, has 4 areas
        - Automotive and autonomous mobility
        - Aerospace and drones
        - Aviation, travel and tourism, supply chain and logistics
        - Ensure mobility across segments are safe, clean, and inclusive
- Safe and secure & policy challenges for autonomous vehicles
    - How much automation is really transforming the automotive industry?
    - Mobility as a service, different alternative power trains like electrification
    - Changing the driver – going from the customer driving to an algorithm driving the vehicle – warrants fundamental changes in how we look at the "driver"
    - Benefits?
        - Sociocultural – Reduction in collisions and fatalities, improving mobility for those who need it most
        - Environmental – Improves operational efficiency
        - Economic – New, higher quality jobs
    - Automated driving also creates challenges, especially for regulators and policymakers
        - How do we make sure the vehicles being testing on our roads are safe for citizens, who are becoming test subjects (whether they want to participate or not, e.g. pedestrians)?
        - Types of current regulations that exist for vehicles now, recognizing many are inadequate
        - Huge need for consumer trust
            - Understanding these technologies, why they are rolling out
            - Ensuring consumers and the general public are involved so they don't feel the technology is happening to them but rather they are an active part of the technology rollout and benefits
    - Suitability – Where does it make sense to deploy AVs, do we have suitable roads and infrastructure to support bringing them into what is already a very complicated mobility landscape
- Other questions emerge as regulators scramble to prepare for AVs
    - How do we license a car driven by software?
    - Where should we allow them to operate?
    - How safe is safe enough? How can we measure it?
    - How can we create common requirements between markets?
    - These kinds of questions are addressed by creating specific communities – Regulators, governments at various levels (national, state, municipality), commercial industry, university researchers, subject matter experts, civil society advocates
    - Looking at these questions with a global lens, needs to be scalable

  - Finding common questions being asked
- Comparing the US to other approaches
  - US
    - USDOT and NHTSA at federal level, provide overall framework and guidance
    - Exemptions
    - States responsibility for licensing and permitting
    - Pilots led by industry
  - United Nations Economic Commissions for Europe (UNECE)
    - Requires manufacturers to demonstrate compliance
    - Releasing type approvals – level 3 autonomy expected
    - Working groups coming out with regulations
    - Countries such as Germany expected to release regulations
  - National initiatives
    - Federal government approving if a vehicle is safe to be on the road
      - Let each location decide where it is going to operate
      - At the municipal level, the local jurisdiction can define the exact operational design domain the AV is able to operate in, with priorities (shuttles, augmenting public transportation, moving people)
    - Different way to look at how to regulate and operate
  - UK has taken a leadership in policies
    - Setting overall strategy – want to be leader in C/AV, created a dedicated C/AV agency
      - Setup test bed to create test tracks and areas to operate
      - Build level of expertise inside government
      - Define what UK government want to allow, how to let AVs exist within specific locations
    - Policy roadmap on how to align on different regulations needed
    - Code of practice – Test bed and requirements
      - Vehicle registration
      - Safety driver or teleoperations
      - Public engagement
      - Data recording
      - Publication of a detailed safety case
      - *Created a front door for industry and researchers could walk through to help streamline the regulatory effort*
      - Required UK government to get internal alignment among regulatory agencies – what would the impact of technology be across the nation and in specific localities, how to operate together
      - Internal government work happened before creating the front door for industry
      - Creating a scenario database (being launched by forum) – We know we want AVs to operate safely on streets, what do we need to do?

    - Decide where we want AVs to operate, how to determine safety of the vehicles
    - references of use cases to get a baseline assessment of how vehicles can operate in those scenarios,
    - Gather data from operating AVs to compare against baseline
    - Data is annotated, human readable, and open
    - Can be utilized by regulators
    - How they perform, validate veracity of the claims made by commercial entities
    - Created in partnership with community entities and numerous governments
- Success factors in AV policy
    - Cohesive vision – why do you want this, what benefit does it have, what to emphasize first?
        - Reduction in fatalities and collisions
        - Expanding mobility options for disadvantaged and underserved communities
    - Multi-stakeholder engagement
        - Industry, academia, public, and government
    - Agile regulatory tools – Ensure the regulatory tools can match the pace of how AV technologies are evolving
    - Safe Drive Initiative[1] – well evolved framework, allows us to tackle these kinds of questions
- Dubai is running a mobility challenge – delivery of goods is increasing greatly, exploded due to the pandemic
    - Issues around quality of life – collisions, curb management, traffic flow, timeliness of goods deliveries
    - How could highly automated delivery vehicles operate effectively in Dubai
    - Scoped operational design domain to test for delivery goods
    - What kind of infrastructure is needed to support, such as dedicated lanes, division of lanes between other kinds of traffic, wireless network needs?
    - Utilizing framework to derive scenarios, defining what those scenarios are
        - Will then run baseline of vehicles to see how non-automated vehicles took form
        - Collecting data
        - Then opening mobility challenge
        - Results-oriented, technology-agnostic
    - United Arab Emirates (UAE) and Dubai specifically, testing their AVs against a baseline
        - Includes performance-based tests to confirm if vehicles see what we expect them to see within the specific operational design domain
    - Use framework to evaluate how scenarios performed, how to establish regulatory requirements for licensing and permitting
    - Rolling out Summer 2021, results expected Fall 2021

[1] World Economic Forum – Safe Drive Initiative: https://www.weforum.org/projects/safe-drive-initiative

  - Anticipate results to include a regulatory regime, looking to see where we need to update and augment framework to be more responsive
- Artifacts
  - Scenario based framework for safety assessment
  - Implementation guide for using the framework
  - White paper on best practices
  - White paper on AV governance ecosystem
    - UNECE, Uniform Laboratories (UL), SAE, and other groups have been very involved in creating best practices and regulatory considerations
  - Proposed taxonomy for segmentation of AVs and personal delivery devices (PDDs)
    - Having common language and understanding common definitions are vitally important
    - Mobility solutions – vehicles don't stay put, are going to cross borders, need common language to describe and understand them
- Beginning discussions with Ottawa, CA about applying framework, interacting with pedestrians and bicycles to see if the infrastructure is capable of recognizing them – Expect to begin Summer 2021
- World Economic Forum runs workshops on many relevant topics, such as remote monitoring and teleoperations, simulation design tools, minimum risk maneuvers, public education ideas
- Link to presentation: https://weforum.box.com/s/oapjattyg4q40r3m4w3xj0esr0hznnqy
- Safe Drive Initiative: SafeDI Scenario-Based AV Policy Framework – Technical Implementation Guidance White Paper: http://www3.weforum.org/docs/WEF_Safe_Drive_Initative_SafeDI_Framework_Technical_Implementation_Guidance_2021.pdf
- Safe Drive Initiative – The Autonomous Vehicle Governance Ecosystem: A Guide for Decision-Makers: http://www3.weforum.org/docs/WEF_CP_The_Autonomous_Vehicle_Governance_Ecosystem_2021.pdf

Topic closed.

REPLAYING REAL LIFE: HOW THE WAYMO DRIVER AVOIDS FATAL HUMAN CRASHES

Aidan Ali-Sullivan – Waymo

- Overview of white paper released a month ago, looking at how the Waymo Driver automated driving system (ADS) can and does avoid fatal human crashes
  - Waymo Driver ADS performance in simulated high severity fatal crash scenarios – how they would perform hypothetically in real life situations
  - Waymo driver itself was never involved in fatal crashes – conversation today covers real crashes that were simulated and reenacted with Waymo Driver
- Waymo Safety Research Team created simulated scenarios – All crashes highlighted today resulted in fatalities, something to be mindful of

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- Simulations – Each simulation has an initiator (the vehicle that initiated the crash) and a responder (the other entity interacting with the initiator in the crash (if any))
    - Each simulation (case) replaced the initiator with the Waymo Driver and then the responder with the Waymo Driver to see how it would react to the same situation
    - Case 1: Initiator ran red light, crashed into responder
        - Initiator traveling 107 miles per hour (MPH), intoxicated, ran red light, driver injured
        - Responder traveling 35 MPH, driver fatality, had the right of way
        - Recreated simulated crash provides a digital replica of real-world scenario on streets
        - Waymo Driver replacing Initiator – Vehicle stops at the red light, prevents crash
        - Waymo Driver replacing Responder who has the right of way - Vehicle approaches the traffic light, recognizes the initiator is going to run the red light and slows down, prevents crash
        - Demonstrates progress towards goal of reducing fatalities
    - Case 2: Traveling around a curve, Initiator exits their lane and enters the opposing lane, hits Responder head on
        - Initiator intoxicated, speeding, exits their lane and enters the opposing lane
        - Responder not speeding, in correct lane, hit head on resulting in fatality
        - Waymo Driver replacing Initiator – Vehicle stays in the lane, prevents crash
        - Waymo Driver replacing Responder – Vehicle predicts and perceives Initiator entering its lane of traffic and path of travel, takes an evasive maneuver, slows down and nudges to left side of the lane, prevents crash
    - Case 3: Responder taking unprotected left turn across four lanes of traffic, had right of way, Initiator ran red light
        - Initiator intoxicated, speeding, ran red light
        - Responder accelerated into oncoming traffic (had the right of way)
        - Waymo Driver replacing Initiator – Vehicle obeys the speed light and stops at the stop light, prevents crash
        - Waymo Driver replacing Responder – Perceives Initiator speeding and likely going to run red light, slows down, prevents crash
    - Waymo Driver has the ability to reason and respond, perceive, and save lives
- Results
    - When in the Initiator role, Waymo Driver avoided 100% of crashes
    - When in the Responder role, Waymo Driver avoided or mitigated 100% of crashes
    - 72 different crashes simulated, some only involved one vehicle (drunk driver hits a wall, hits a vulnerable road user but not a vehicle), others involved two vehicles
    - Mitigated crashes – Waymo Driver was 1.3 to 15 times less likely to sustain a serious injury (as long as Waymo Driver wasn't hit from behind)
    - Severity analysis
        - Calculated risk of injury likelihood in original crash

- Varying scenarios: Left turn across path, lateral direction, left turn across path other direction, etc.
- Weren't involved in initiator crashes, operator has ability to mitigate, severity reduced

- As the Responder, even with low likelihood of serious injury, there are still fatalities…cannot remove fatalities completely, but seriously reduces fatalities when Waymo Driver makes evasive maneuvers

  - How it worked
    - As Initiator, conducted 91 simulations, Waymo Driver serving as initiator in 52 crashes, avoided crash completely without needing to take last minute action
      - Obeys traffic signals, yields to right of way, doesn't speed, isn't drunk
    - As Responder, conducted 39 crash simulations, 32 were completely avoided
      - 20 without evasive maneuvers, 12 with evasive maneuvers
      - 12 crashes still had to take evasive maneuvers, still reduced the likelihood of a fatality
    - 20 simulations involved pedestrians or bicycles – Waymo Driver avoided all crashes
      - Able to perceive vulnerable road users even in low light situations
    - Unprotected left turns have a small opportunity to prevent or mitigate crashes, Waymo Drive can still reduce severity
  - Crash 4: Involved a pedestrian crossing street outside the crosswalk
    - Responder – Driving straight in dark conditions, strikes pedestrian
    - Waymo Driver replacing Responder – Vehicle perceives object as a pedestrian, breaks to avoid pedestrian

- Why it matters…
  - Waymo driver is capable of driving safely on its own and respond to other road users' mistakes
  - Human error is a factor of almost 100% of crashes
  - Able to mitigate majority of those, reduces severity and impact of road accidents
  - Going to continue to operate where it is interacting with drivers, humans, etc. with unpredictable behavior – Not expecting 100% AVs
  - Mitigating severity of crashes that it doesn't avoid
    - Can do so in extreme and last-minute situations
    - React and perceive faster than a human
- Key takeaways
  - 84 of 91 simulated crashes were avoided altogether
  - Remaining reduced the likelihood of severity in over half (4 of 7)

  - Crash reconstruction testing – secure publicly available data, acquired from Chandler Police and AZDOT, the service area where Waymo is operating
    - Any crash in Chandler that involved a fatality, Waymo took all the data, looked for accidents that could simulate the Waymo Driver into the Initiator or Responder role (e.g. Did not reconstruct crashes where/how Waymo is not operating, such as a crash involving a big rig on a highway)
    - 3 remaining simulated crashes were struck from behind – Waymo Drive given little to no opportunity to respond
- Waymo blog article on this study: https://blog.waymo.com/2021/03/replaying-real-life.html

Topic closed.

QUESTIONS ON PRESENTATIONS

- Is there a single (or two) biggest challenges that countries have consistently had in implementing effecting AV strategies?
  - World Economic Forum: Internal coordination – Have found true with cities as well as countries
    - Looking internally at all departments and organizations potentially impacting or being impacted by Av technologies – What could that mean? What internal education needs to happen?
      - Example: City of San Francisco – San Francisco Municipal Transportation Agency (SFMTA)
        - Involved parties/topics included cybersecurity group, infrastructure for emergency communications, signaling, who manages curb and access, taxation, parking enforcement that could be impacted by testing and commercialization, and licensing of AVs
        - Held workshops for internal departments, Forum representatives available to answer questions, focused on getting alignment between departments who may not otherwise interact, what are the areas we need to prioritize and get unity on?
  - Public Facing Aspects – Many regulatory agencies don't have a habit or best practice of doing community outreach. How do you communicate externally about a technology that is not widely understood?
    - Arizona a unique use case, where the public can actually see the technology on the roads
    - Need to educate the public before you can get the input needed to inform regulatory standing
    - Dealing with relational databases, scenarios, administering technological tests are all easier than internal coordination, external coordination and outreach
  - Looking at the country standpoint is similar to looking at the US national level – a challenge in the US…coordination and incentives

        - Coordination needed among states and regions
        - What is the incentive for a state to move the needle forward? It is going to be different in California than Arizona than Alabama
- Has the Waymo study and white paper been reviewed by the scientific community?
    - Waymo: Unsure immediately what the level of peer review was on the study
    - **ACTION ITEM:** Waymo to determine if the study was peer reviewed/at what level and will provide to Subcommittee chairs/staff to disseminate
- The Waymo Drive simulations involve driver-initiated causes. Is Waymo running any similar scenario research with non-human-caused sources? Like wildlife, debris in the road, environmental, etc.?
    - Not sure if any of the simulations involved non-human caused sources, e.g. a deer runs into the road or a massive pothole
        - **ACTION ITEM**: Waymo to identify if it does have that type of data and will provide to Subcommittee chairs/staff to disseminate

Topic closed.

PUBLIC COMMENT AND OPEN DISCUSSION

- Public comment
    - *No public comment*
- Open discussion:
    - *No open discussion*

MEETING ADJOURNED

Next AV Safety Subcommittee meeting:
Wednesday, June 9, 2021 @ 10 am

NOTE: The July 14, 2021 Safety Subcommittee meeting will be cancelled due to conflict with the Automated Road Transportation Symposium[2] (formerly AVS)

[2] Automated Road Transportation Symposium: https://trb.secure-platform.com/a/page/arts2021