

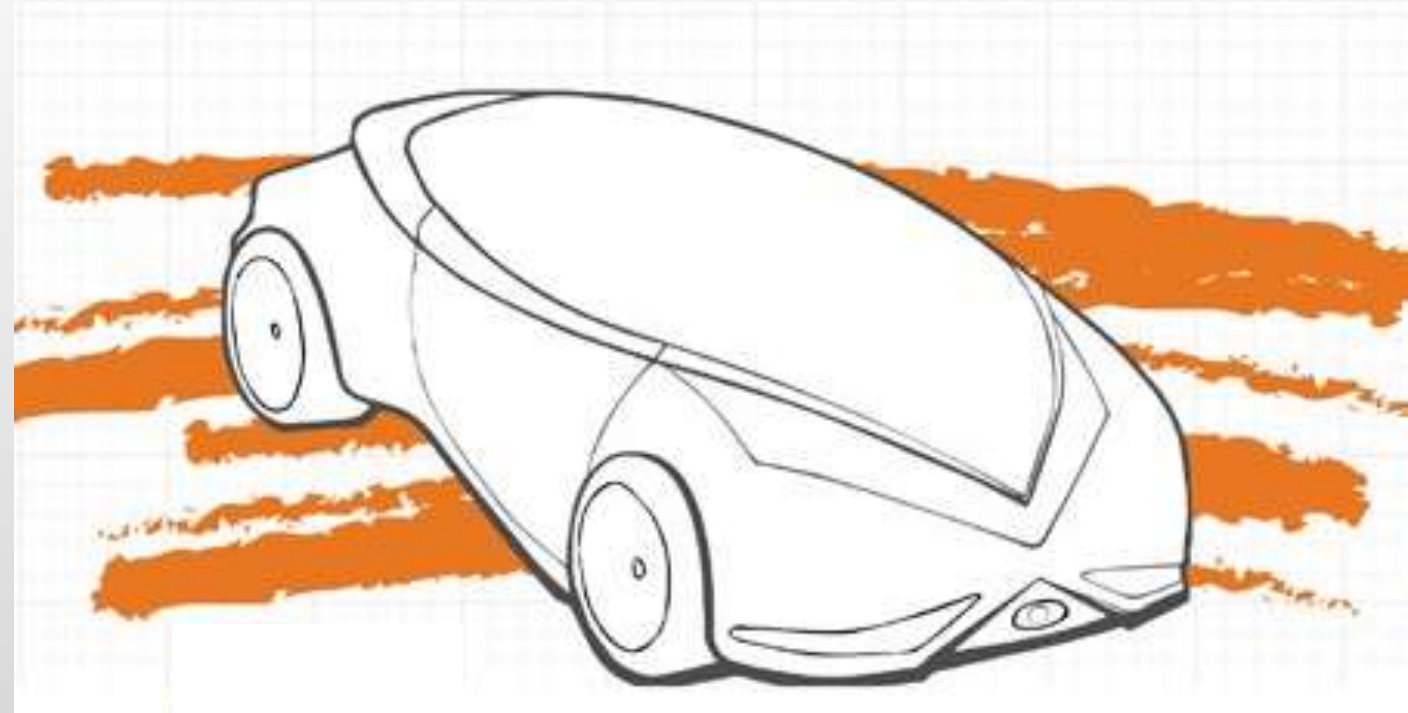
Crash Avoidance Breakout Debrief

Summary of Participant Comments and Discussion

Michelle Chaka
Program Director, VTTI

Stakeholder Meeting: FMVSS Considerations for Automated Driving Systems

DEBRIEF



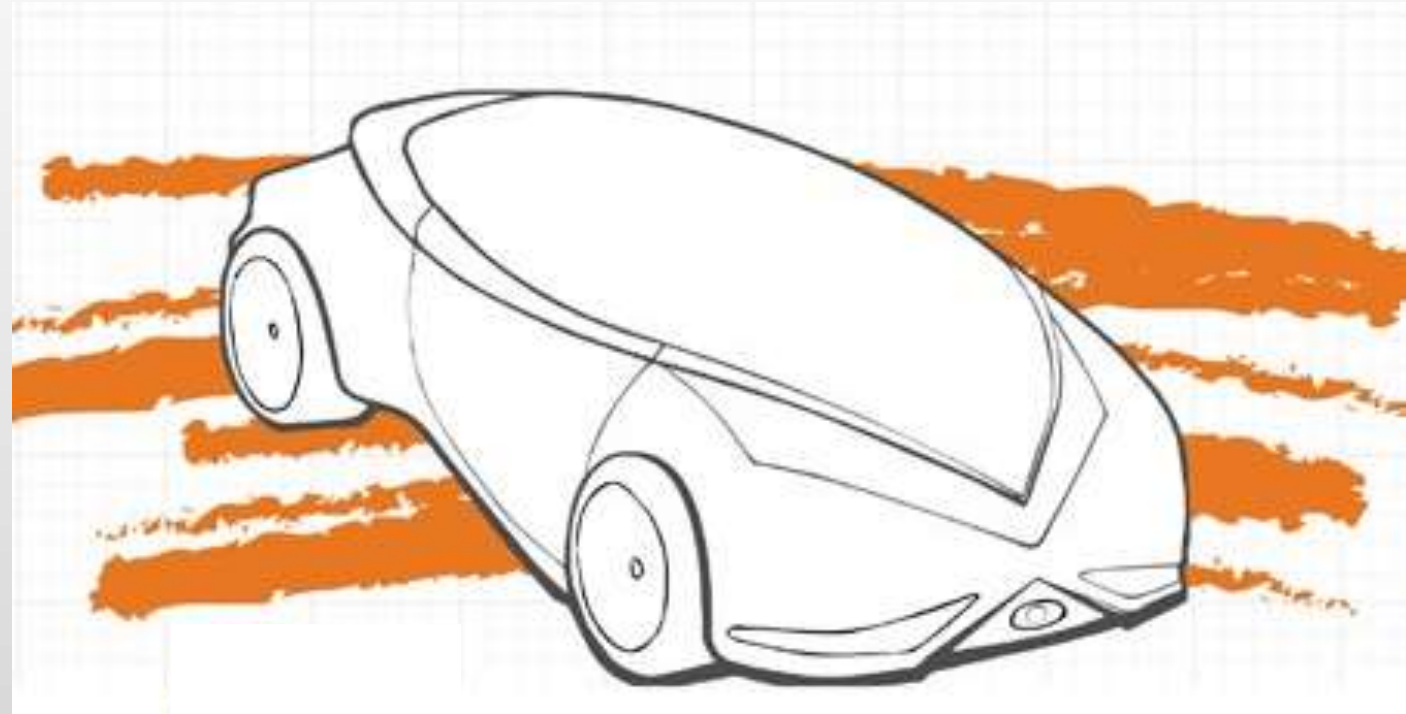
100-Series Breakout Sessions



FMVSS 100-Series: Session Focus

- Driver (Operator)
- Driver Position/Presence
- Service Brake Application
- Shift Position (gear, select, reverse)
- Controls and Displays
- Front/Rear of Vehicle
- Visibility

Panel 1 Driver Session



FMVSS 102, 114, and 118 Translation Discussion



Common Themes Translation Overview

- Theme: Driver
- Challenge: Information and control referenced to driver
- Options
 1. Consider the ADS to be the driver when it is operational
 2. Distinguish human driver and ADS driver
- Theme: Driver Position/Presence
- Challenge: Information and control indicating driver presence and/or position in vehicle.
- Options
 1. Driver designated position
 2. Vehicle doors opening
 3. ADS-DV occupant assumptions



Common Themes Translation Overview

- Theme: Service Brake Application
- Challenge: Specific functionality assumed for human
- Options
 1. Consider the ADS to be the driver when it is operational
 2. Distinguish human driver and ADS driver
 3. Generic means of braking
- Theme: Shift Position (gear, select, reverse)
- Challenge: Specific functionality assumed for human
- Options
 1. Specify a transmission state rather than a gear
 2. For display, the transmission state must be communicated
 3. Generic function

Generic Function Example (FMVSS 102 S3.1.3.1 (c) (2)):

~~driver selects~~ transmission is placed in Reverse



Supporting Definitions Comments

The approach to the driver references is a key to the 100-series translation.

- Driver Definition Options:
 - Option 1: Consider the ADS to be the driver when it is operational.
 - Minimizes potential regulatory text changes
 - Multiple driver meanings may cause confusion/complexity
 - **Concerns when translating directly (e.g., “driver” is used as both an adjective and a noun in the regulations)**
 - Option 2: Distinguish the human driver and the ADS driver.
 - ADS may not always equal the human driver
 - Provides further clarity on the driver reference
 - Consider SAE J3016 terminology
- **Many of the translation options reference “ADS is operational” and may need to be defined.**
- The human driver has roles that go beyond completing the dynamic driving task (DDT) (e.g., supervising window operation).



General Comments

- There is an obvious purpose of FMVSS to protect human life. The safety intent should not be lessened or expanded for ADS-equipped vehicles.
- How the translations apply to an ADS and how to demonstrate that in a Test Procedure is the key question.
- Many of the FMVSS inform the driver (e.g., low tire pressure, low fuel).
- Fallibility of the human driver is the focus of many of the FMVSS. These may not translate to an ADS.



General Comments (Cont.)

- The translation options begin to thread the needle and address the barriers while maintaining the safety intent of the standards.
- This is not the end-all-be-all or last step of this task. There may be areas where more/new standards are needed.
- FMVSS are based on an established safety need. NHTSA has enforcement to address unreasonable safety risks.



Translation Specific Comments

FMVSS 102:

- Discussion focused on the standard's requirements to reduce likelihood of shifting errors.
- While it may not be necessary, the ADS could shift to neutral first when shifting from forward to reverse.
- Even with an ADS, the system and passengers should be informed of the shift status.
- The shift display is to support the human driver and translating to occupants expands beyond the established safety need.



Translation Specific Comments

FMVSS 114:

- Discussion focused on the standard's brake shift interlock with competing views.
 - Brake shift interlock should be maintained with an ADS-DV.
 - Brake shift interlock are not applicable to an ADS-DV.



Translation Specific Comments

FMVSS 118:

- Discussion focused on the circumstances that allow closure without meeting the S5 automatic reversal systems requirements.
- There are no barriers to deploying ADS vehicles. Adding all doors and meeting S5 is not equivalent to the current standard and would impose additional restrictions.
- When everyone is a passenger, automatic reversal systems should be required.
- S5 automatic reversal systems are difficult to meet.



Observation Comments

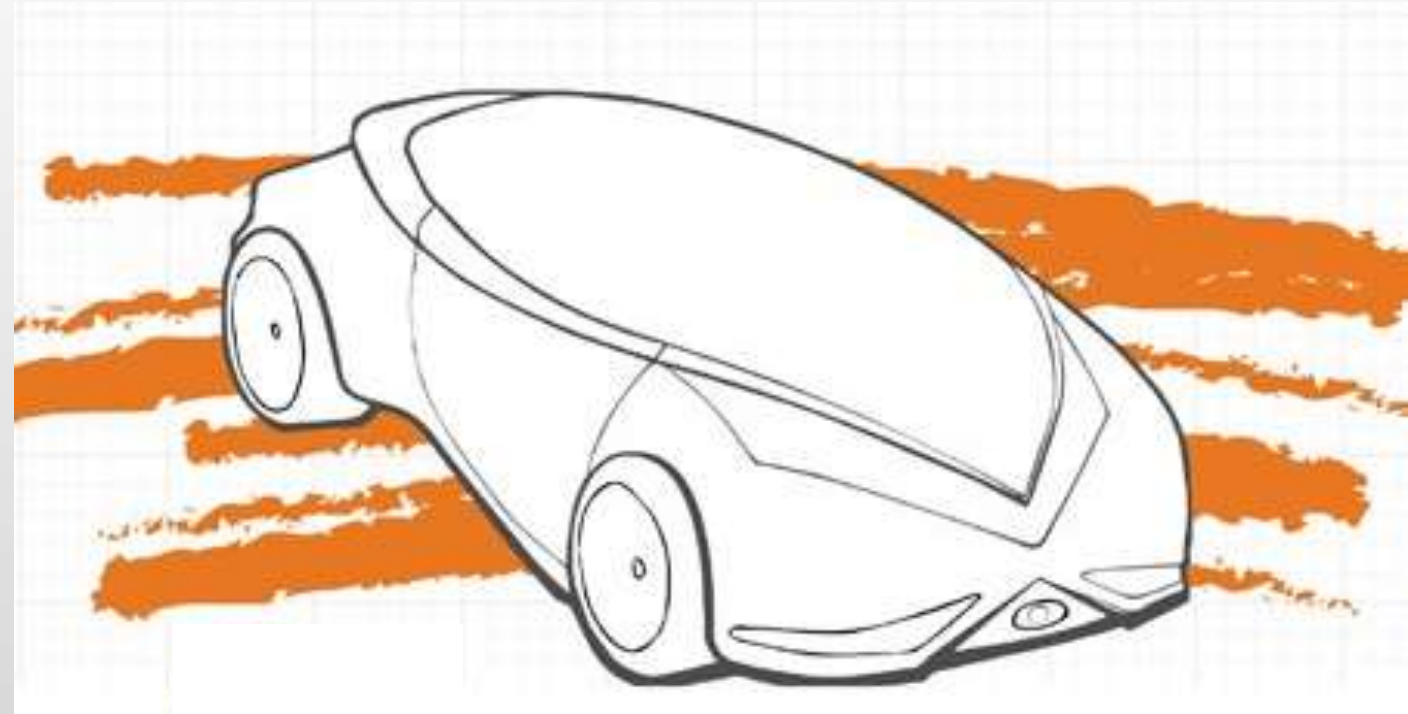
- Apprehensive about the rush to automation. There should still be someone in charge.
- The ADS Brain should be discussed in parallel. It is tough to do this without considering the brain.
- More research is needed to understand what information should be provided to the occupants.
- FMCSA may have connected standards that are impacted by the potential ADS-DV FMVSS modifications.
- L2 and L3 standard development is also needed.
- Remote driver should be considered.



Observation Comments (Cont.)

- It is easy to get focused on the unconventional design. There needs to be work on the near-term challenges and barriers.
- FMVSS 135 is a significant barrier to certifying ADS-DVs and needs **to be moved up in the project's priority.**

Panel 2 Controls and Displays Session



FMVSS 101 and 138 Translation Discussion





Common Themes Translation Overview

- Theme: Controls and Displays
- Challenge: Provide information to a human in a manner that can be perceived and understood. ADS differs from a human driver.
- Options
 1. Clarify the requirements which may specific to human driver (e.g., conventional identifiers).
 2. If the vehicle is not required to be fitted with a control/display, the specific identifiers do not apply, including manual driven vehicles and ADS-DVs.
 3. Mandated control, telltale, and/or indicator translations are captured within the standard that mandates them.



General Comments

- Telltales need to take into consideration the particular use-case(s) when they are needed for safety reasons.
- FMVSS 101 is an **“if fitted”** requirement.
- The standardization required in FMVSS 101 is specific to the **needs of a licensed human driver’s recognition and attention.**
- FMVSS 183 TPMS icons could be problematic if not understood. The user might be a person without vehicle experience (e.g., child, elderly, impaired).



Translation Specific Comments

FMVSS 101

- The purpose of the standards is to provide information to an entity that could act on it, not necessarily the driver.

FMVSS 138

- **Language is important in S3 option 2 (box below) “and” may need to be reviewed further.**

FMVSS S3 Option 2

Illuminates a low tire pressure warning telltale to the driver and communicates a low tire pressure condition to an ADS if operational.

Consider the following approaches for “and”: ADS-DV should be OR; Dual Use Vehicles AND. Another method would be to separate into two sentences.

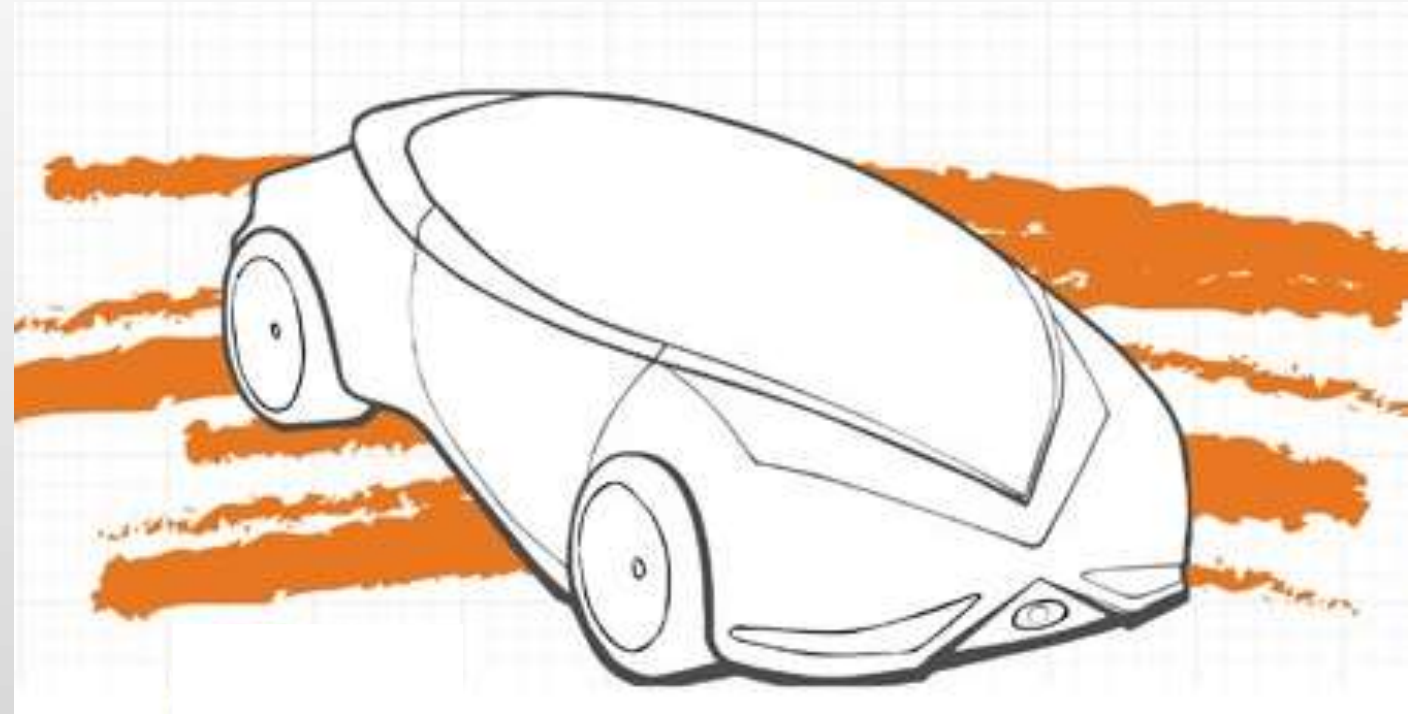


Observation Comments

- Research needed to identify which type of information is safety relevant for an occupant (taking into consideration user characteristics) versus what could be considered in order to increase user acceptance and comfort.
- Consider if standardization of symbols is needed for occupants.
- ISO/SAE commonization are in-place today and evolving. Manufacturers typically apply these practices.

Panel 3

Front/Rear of the Vehicle Session



FMVSS 108 and 141 Translation Discussion





Common Themes Translation Overview

- Theme: Front/Rear of the Vehicle
- Challenge: Front and rear of the vehicle is assumed in the standards. Bi-directional vehicles no longer have a traditional front and rear. These vehicles will still need to communicate to other roadway and non-roadway users their travel directions/intentions.
- Options
 1. Define front and rear of vehicle in the context of travel direction.
 2. Define bi-directional functionality and clarify requirements in both directions.



General Comments

- In a mixed-fleet environment, we must continue to provide conspicuity, identification of vehicle direction, turn intent and signalization.
- Malfunctions must be communicated to the ADS.
- Unification of the current state requirements for activation of lighting systems (distance for turn signals, high beams, etc.) must be addressed.
- Some systems may become redundant or their test requirements might change base on the ADS performance characteristics.
- Competing views on bi-directional ADS translation needs:
 - Bi-directionality is not near-term. The more critical issues are the redundant controls and telltales currently required in the standard. Also significant challenge for 200-series.
 - 100-series regulations do not need modifications for bi-directional functionality. There are no significant barriers.



Translation Specific Comments

FMVSS 108:

- Reflex reflectors may be the main bi-directional limitation.
- Provide the same functionality in the ADS as provided by manual controls.



Translation Specific Comments

FMVSS 141:

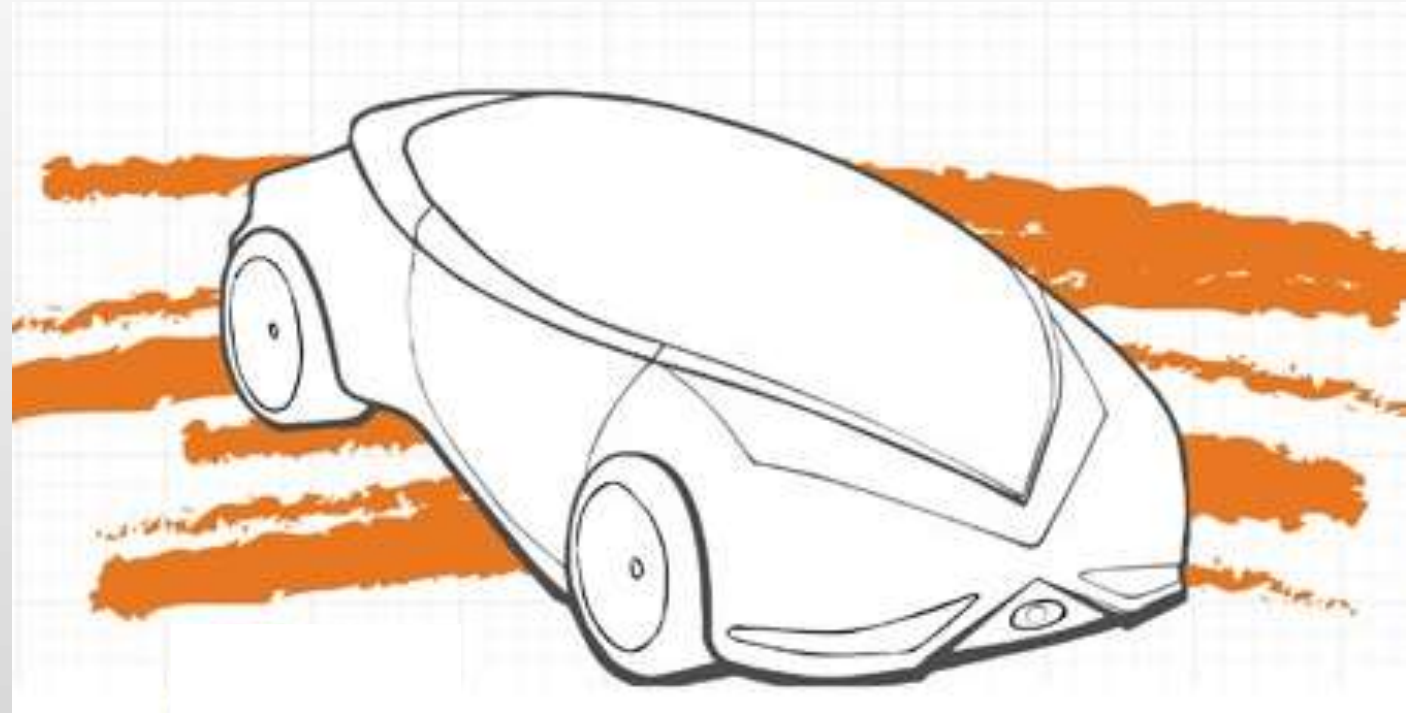
- Language changes are required to remove driver and passenger side references.
- Translation is straightforward but accounting for test procedure requirements relative to ADS-DVs is the significant challenge.



Observations

- FMVSS 108 does not limit the use of other external signaling to provide other functionality. There may be a need for standardization, research and future rulemaking.
- SAE/ISO external communication standardization activity is on-going in parallel to this translation activity.
- Some thought is required for use cases when the user would override the system.

Panel 4 Visibility Session



FMVSS 103, 104, 111, and 113 Translation Discussion



Common Themes Translation Overview

Theme: Visibility

Challenge: The standards which cover driver visibility were developed specifically to support the human driver. These standards may not be needed in order for the ADS-DV to maintain driving visibility.

Options:

1. Clarify the requirements which may be specific for human driver operation.
2. Translate requirements which may be appropriate for ADS-DVs and human drivers.



General Comments

- **ADSs don't rely on a single sensor as a human does to “see.”** An ADS has redundancies in sensors so an obstruction in one doesn't necessarily imply failure of the system.
- With an ADS, the system should not operate if it cannot perceive it's environment (unlike humans may do with a windshield with frost).
- Visibility (103, 104, and 111) standards are specific to human drivers. Additional or new visibility standards may need to be developed for ADSs but these should follow the normal process (research, comment, etc.).



Translation Specific Comments

FMVSS 103/104:

- Forward visibility requirements through the windshield are specific to human drivers.
- Additional considerations, such as occupants seeing outside the vehicle to exit and first responders being able to see into the vehicle, are beyond the current safety intent.

FMVSS 113:

- All front opening hoods that may obstruct sensor detection should have a secondary latch system.
- Secondary latch is not a barrier.



Translation Specific Comments

FMVSS 111:

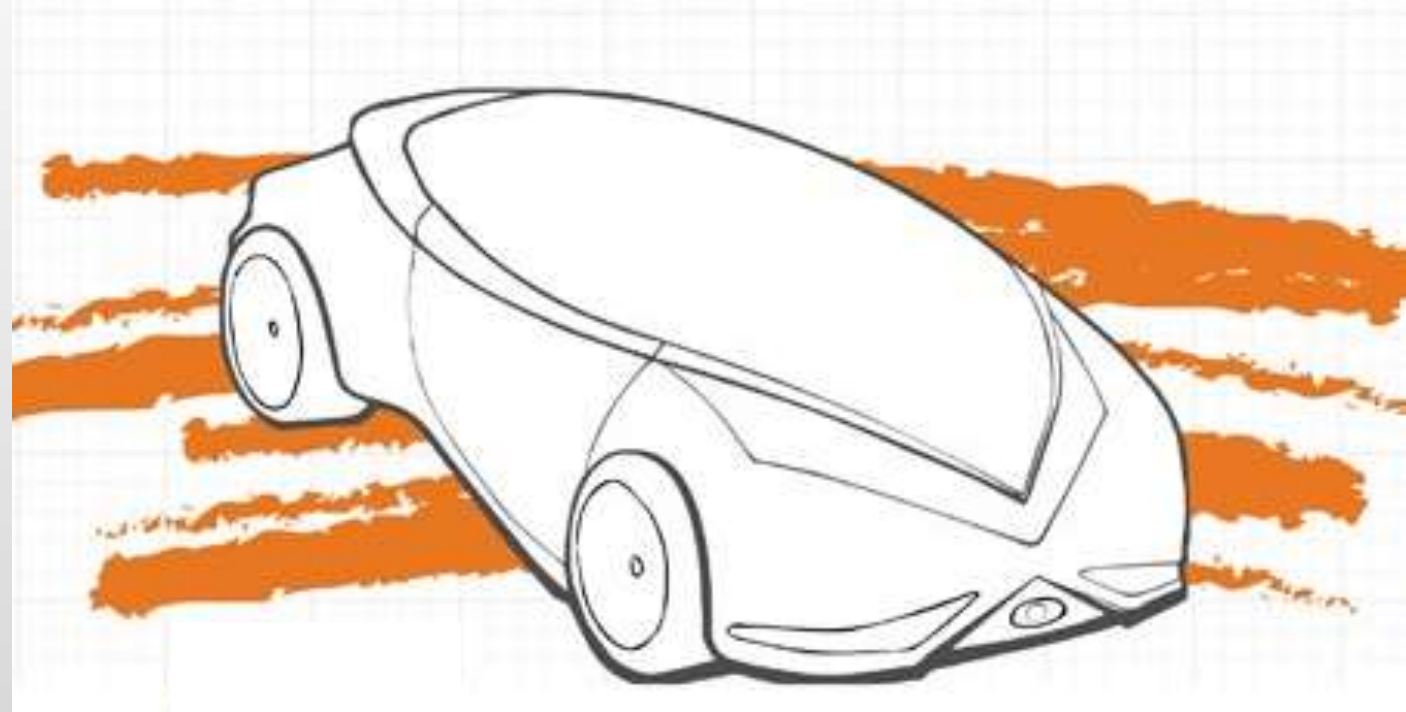
- Field of view (FOV) information should be communicated to ADS to maintain the minimum visibility zones for human drivers and ADS systems.
- ADS system may be able to easily see the targets but this would not necessarily translate to the minimum requirements for ADS to reverse safely.
- Current ADS multi-sensors approach is undefined to develop specific ADS FOV requirements.
- Given the Congressional mandate and important safety intent, FMVSS 111 should be translated as at least a starting point.



Observations

- Future research is needed to determine if new standards for ADS sensors relating to the defrosting and defogging and wiping and washing are needed.
- Is there a new safety rationale for defrosting and defogging and wiping and washing (e.g., stepping out of the vehicle)?
- ADS will also need to have rear and side visibility.
- There should be a demonstrated safety need and a way to determine how it is going to be demonstrated.
- The standards need to be performance based.
- Customer satisfaction is a big driver in the marketplace and shouldn't need to be regulated.

**Thank You
for Your
Participation**



100-Series Breakout Sessions



Crashworthiness and Occupant Protection Breakout Debrief

Summary of Participant Comments and Discussion

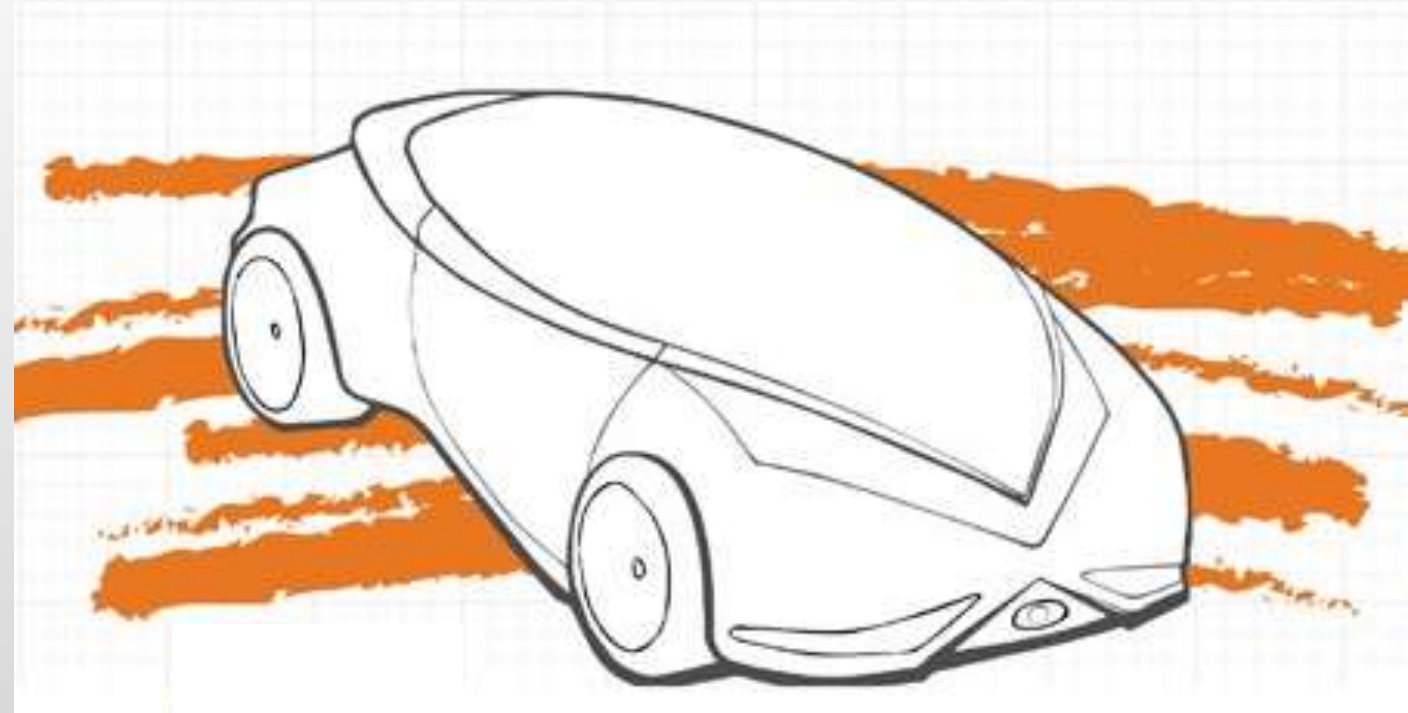
Clay Gabler

**Samuel Herrick Professor of Engineering
Chair, Biomedical Engineering Graduate Program
VTI**



Stakeholder Meeting: FMVSS Considerations for Automated Driving Systems

DEBRIEF



200-Series Breakout Sessions



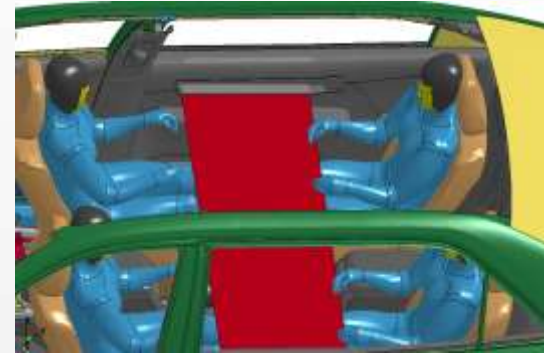
FMVSS 200-Series: Session Focus

- Driver Reference
- Driver/Passenger Seating Position(s)
- Equipment to Be Tested May Not Be Present
- Telltales
- FMVSS Front Row Bias
- Front/Rear of Vehicle
- Dummy Positioning

Conventional vs. Unconventional Seating



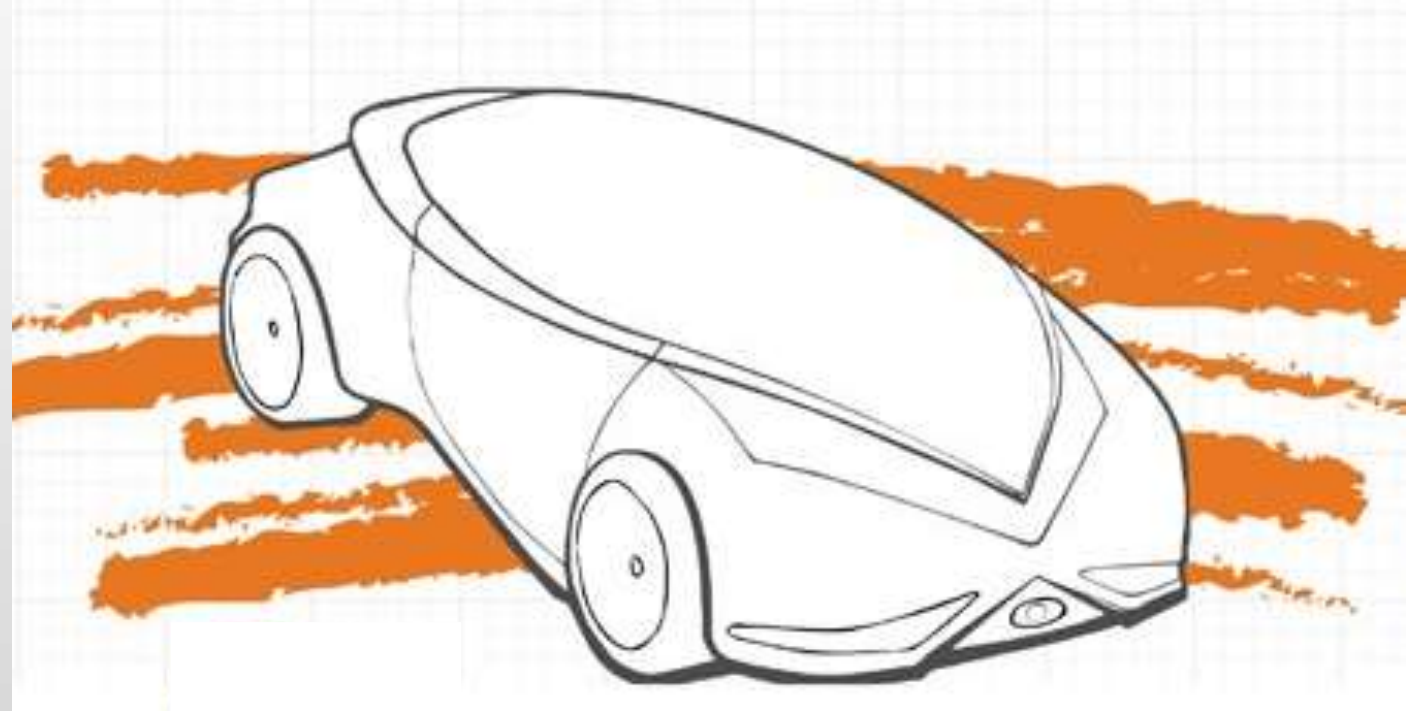
Phase 1:
Conventional
Seating



Phase 2:
Unconventional
Seating

Panel 1

- **Driver**
- **Driver DSP**
- **Equipment
Not available**



FMVSS 208, 203, and 204 Translation Discussion



Candidate Definitions (Part 571.3)

- Driver
- Driver Designated Seating Position
- Passenger Designated Seating Position
- Manual Driving Control
- Steering Control
- Steering Control System (Energy Absorbing System)



Driver Designated Seating Position (DSP)

- Candidate definition option for Driver DSP option greatly simplifies translations.
- Driver DSP not required.
- If present, occupant protection standards would apply.



General Comments

- Consensus that Phase 1 (conventional seating) should be considered first.
- Candidate Driver Designated Seating Position definition was well-received. Simple translations are better.
- Google interpretation of Driver needs to be revisited. Does not map well onto 200-series.



Research and Translation Priorities

- Focus on removing barriers in the short term.
- Research should be started in parallel for follow-on translations:
 - Phase 1: Conventional Seating (extend 208 to rear seats)
 - Phase 2: Carriage Seating
 - Phase 3: Side facing seating (may take up to a decade)



Questions / Observations

- **Would emergency stop button make occupants “drivers”?**
 - No – require control real-time, sustained, manual manipulation.
- **Could 214 be translated today for rear-facing occupants?**
 - Possibly, but would need dummy positioning defined.



Questions / Observations

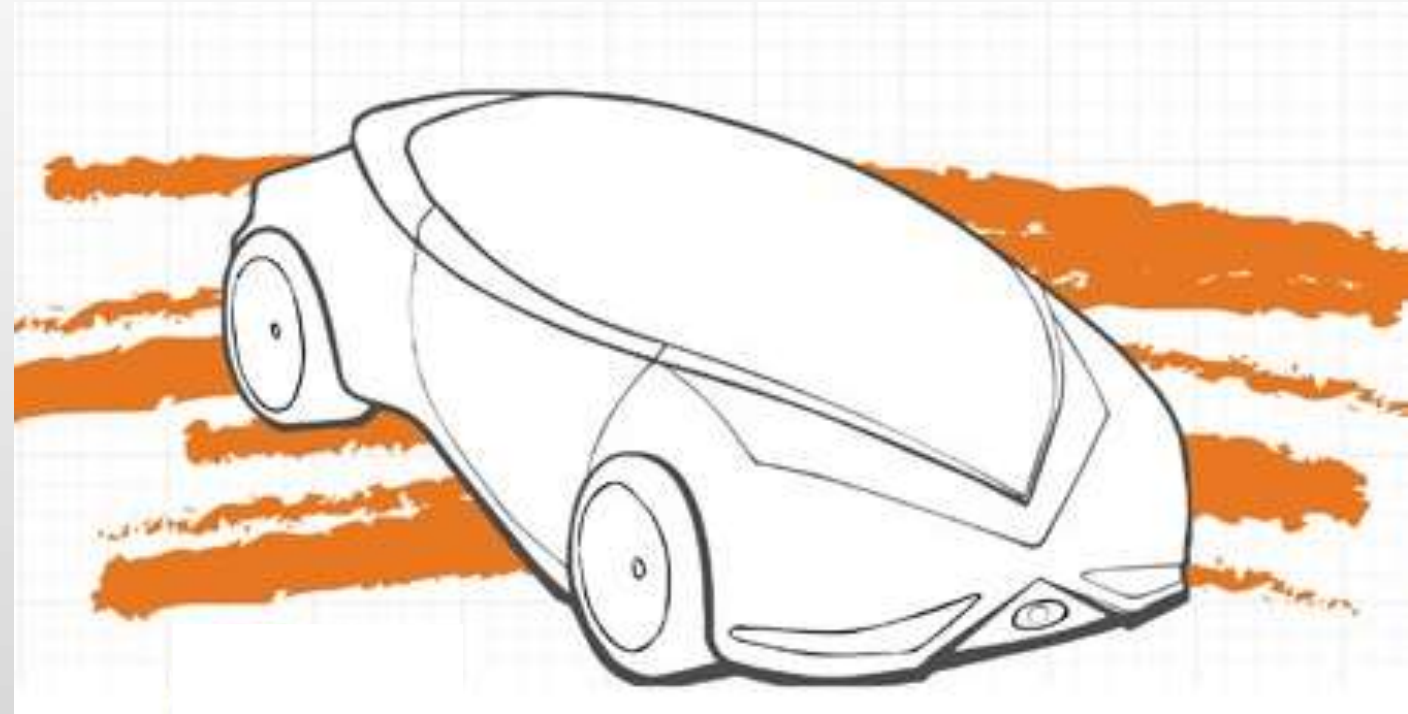
- How will translations be used by NHTSA?
- Will translations identify research needs? Yes
- Could simulation models help in certification? Need for model validation.
- Are there efforts underway to develop Global Technical Regulation (GTRs) for AVs? Not to our knowledge.



Questions / Observations

- Are multi-mode systems being considered? Stowable controls, limp-home mode? Lots of discussion, but not in scope.
- Would game-boy type controls make an occupant a driver? Only if control throughout the Dynamic Driving Task.
- Can we do away and eliminate Designated Seating Positions (DSPs) and simply protect all occupants regardless of position? Might be possible in future 10-15 years from now.

Panel 2 Debrief: Teltales



FMVSS 206 and 208 Translation Discussion





Crosscutting Theme: Telltales

- FMVSS 206 requires a door closure warning system for vehicle doors. The door closure warning system shall be located where it can be clearly seen by the driver.
- FMVSS 208 requires a seat-belt reminder warning for driver.
- Neither FMVSS specifies how warning should be communicated to an ADS, or what actions the ADS should take in this event.



Telltales: 206 Translation Considerations

- FMVSS 206 translations only warn vehicle occupant of unlatched doors.
- Is the implicit assumption that driver is responsible for latching the doors? What if there is no driver?
- Should ADS-DV be notified? If so, what actions should ADS-DV action take?
- How should telltales be communicated to persons with a visual or hearing impairment?



General Comments

- Strong differences of opinion on telltales.
- Are telltales just to make driver aware, or is there the expectation of safety?
- Position 1: Just make the driver aware of an issue.
- Position 2: Intent of warning is not simply to make driver aware of issue, but to take action on the warning.



Questions/Observations

- There is need for someone to be designated as the responsible **occupant (i.e., the “operator”)**.
- Part of the reason for telltales is assumption human driver is taking action/making decisions. Human driver responsible for deciding what to do. ADS should be responsible.
- If ADS operated with doors open, would ADS be considered negligent?
- Instead of seatbelt reminders, should we just have seatbelt interlocks?



Questions/Observations

- Can we use FMVSS to provide equal access for people with disabilities? Can we improve access for people with impairments?
- Opportunity to improve mobility, but there are challenges.
- Already have automated transportation systems (e.g., People-Mover) that provide guidance. Have vehicles that people step into and out of, children, people with disabilities, etc.



Questions/Observations

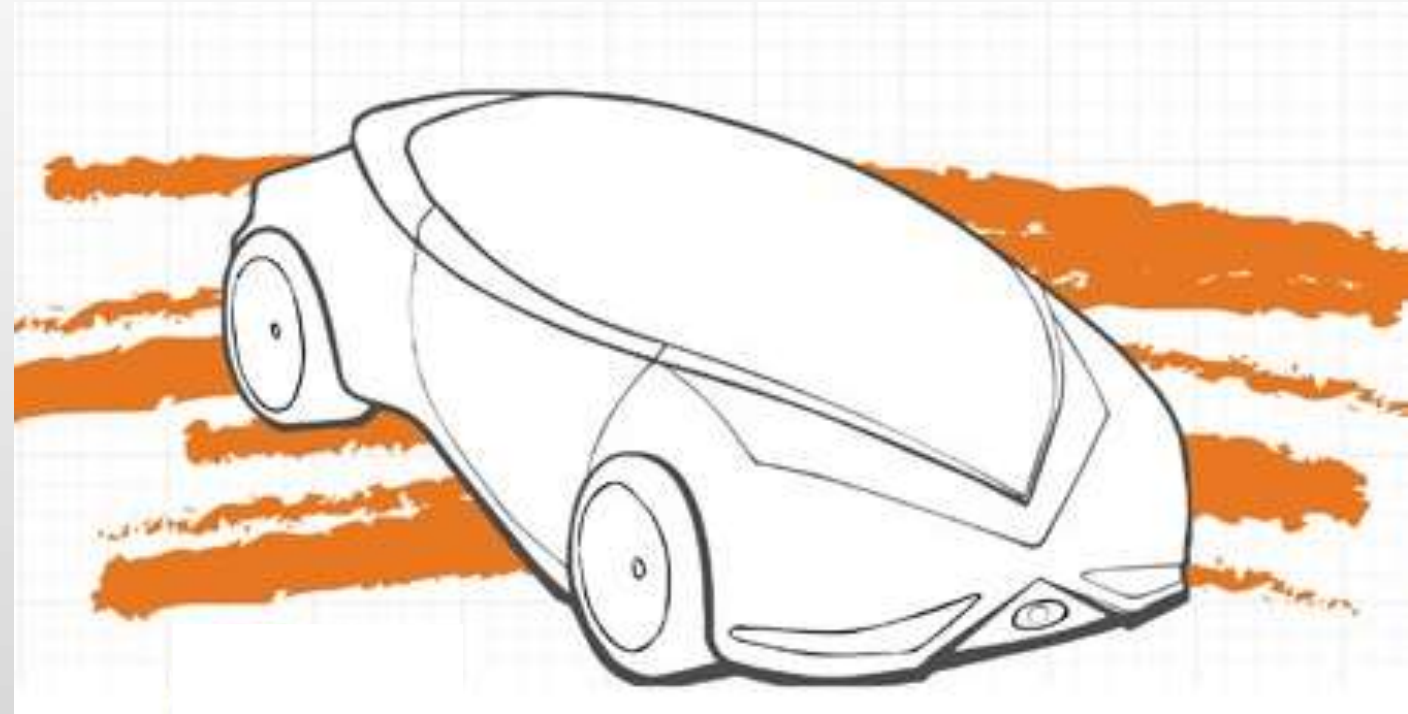
- How do we improve telltales for people with disabilities, impairments?
 - Haptics — but also need to teach drivers what that means.
 - More accessible iPhone apps
 - With Internet of Things (IoT) there are significant opportunities. Area where significant research could be conducted.
 - Potentially tailor the warning to the person and their particular disability



Questions/Observations

- Do consumers have higher expectation for safety with ADSs?
- Instead of seatbelt reminders, should we just have seatbelt interlocks?
- Why don't OEMs voluntarily install seat belt interlocks?

Panel 3 Debrief: Front Seat Bias



FMVSS 201 and 208 Translation Discussion

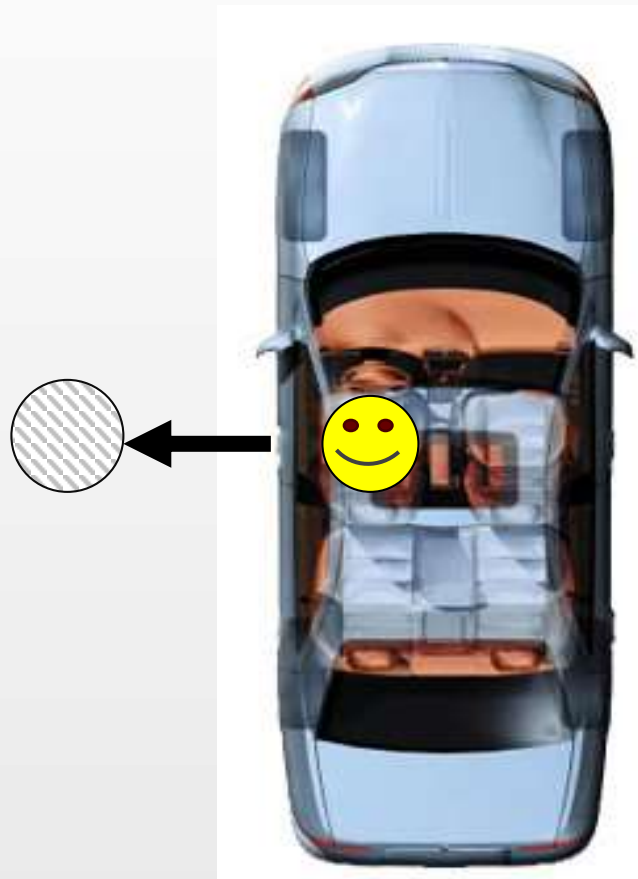


Front Seat Bias Background

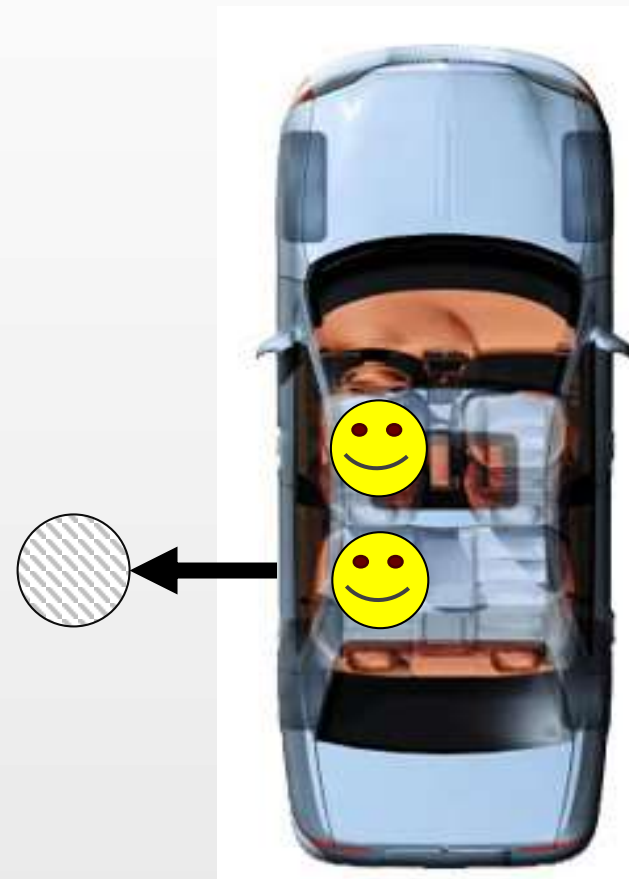
- Several 200-series crash tests assess occupant protection for the front seat occupants only.
- All telltales present information to the human driver.
- Current vehicles – All current vehicles have a front seat driver. Few occupants sit in the rear seat.
- ADS-DV – If there is not a driving seating position, where will occupants sit? Will they expect equal protection?



FMVSS 201 / 214 Vehicle-Pole Test Option

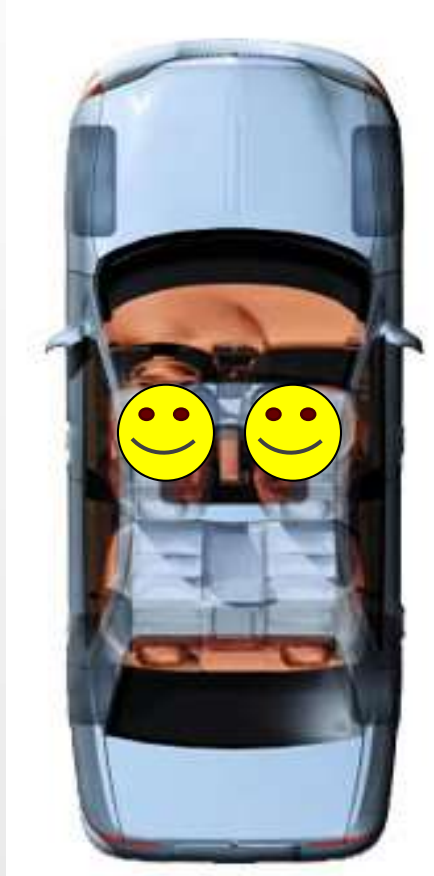


FMVSS 201
(Current Test)

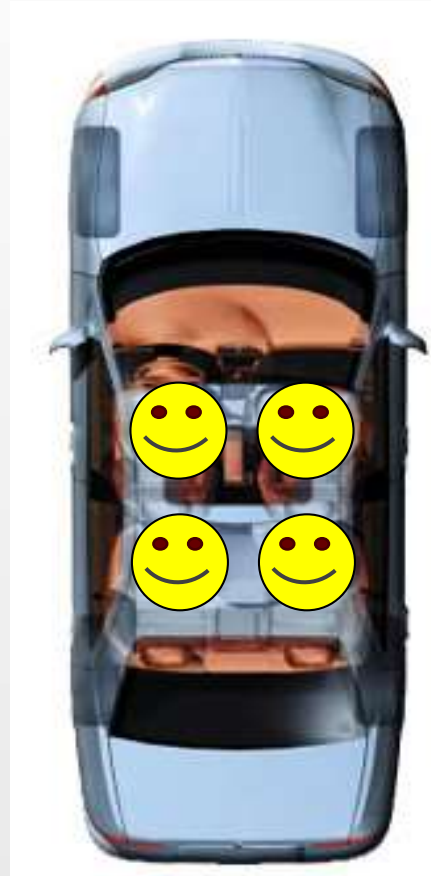


FMVSS 201
(Additional Test)

FMVSS 208 Frontal Crash Test – Option



FMVSS 208
(Current)



FMVSS 208
(Option)



General Comments

- Where will occupants elect to sit in an ADS-DV?
- Seating preference may change in ADSs with lack of driving controls.
- This gap in knowledge (where occupants will choose to sit) should be explored in order to prioritize occupant protections at each designated seating position.



General Comments

- Current trend:
 - Adults in front seats
 - Children in rear seats
- Seats are “optimized” to meet these occupancy preferences.
- While it may be straightforward and acceptable to apply current approaches to the right (passenger) front seat to the left (driver) front seat, the same cannot so easily be said for applying front seat approaches to the rear seats.



Questions / Observations

- Are translations considering persons in wheelchairs?
Translations not going backwards, but not adding anything.
- Will FMVSS use average sized crash dummies or others assuming some people are larger/smaller?
- Could ADS-DV be an opportunity for advanced adaptive seats — i.e., seats tailored to size, gender, injury tolerance?



Questions / Observations

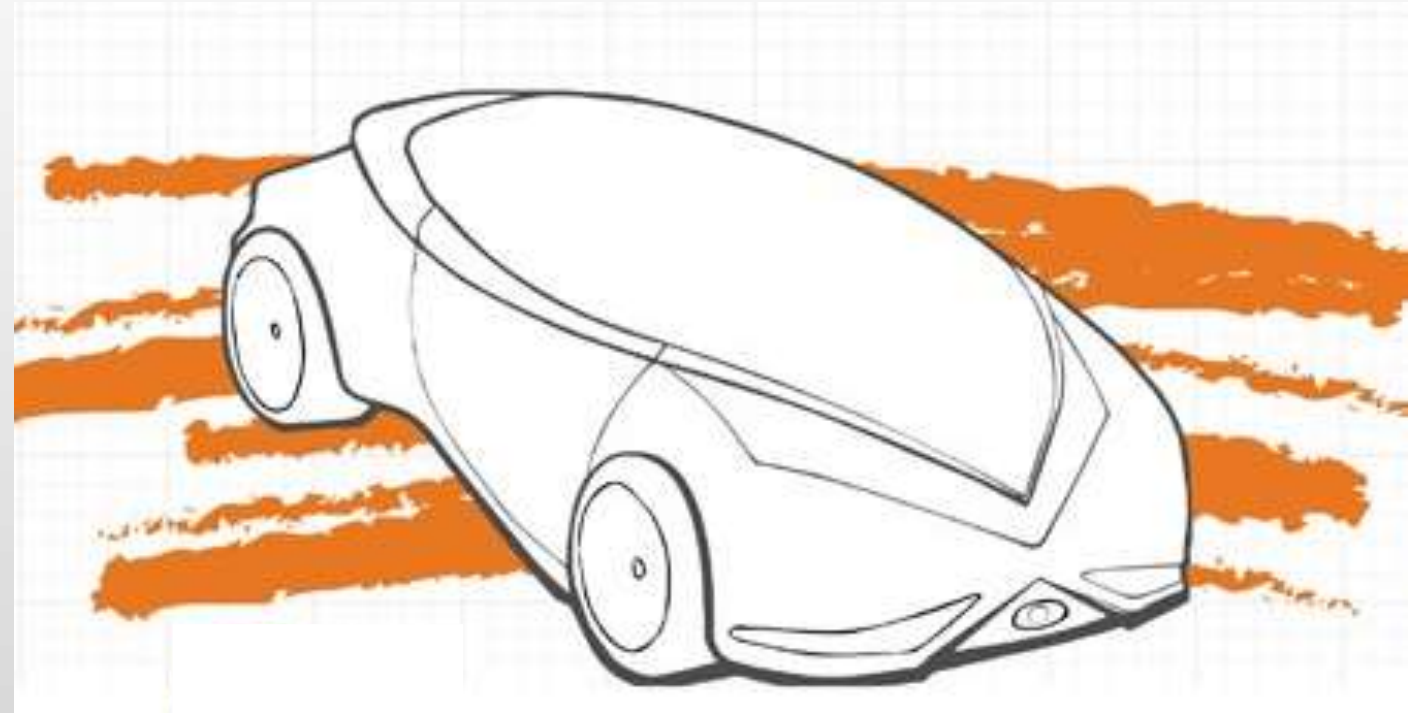
- Can simulations be used for certification?
 - OEMs can use simulations at their discretion, but NHTSA will continue to use testing.
 - OEMs well versed in simulating crash conditions.



What is the role of simulation?

- Existing dummies likely unsuitable for evaluating unconventional seating.
- Simulations using human body models can provide direction for needed dummy improvements.
- Simulations can be used to evaluate potential test conditions for vehicles with unconventional seating configurations.
- Limitations – Need to validate human body models.

Panel 4 Debrief: Front / Rear Dummy Positioning



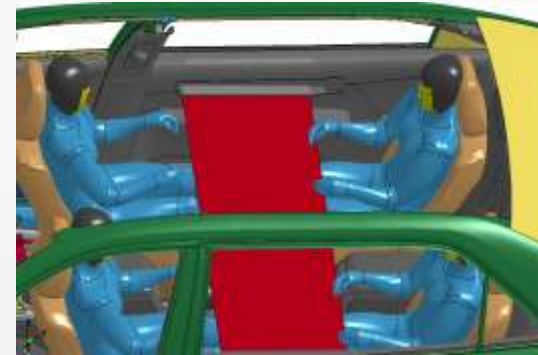
FMVSS 208 Translation Discussion



Forward vs. Rear-facing Seating



Phase 1:
Conventional Seating



Phase 2:
Unconventional Seating



Discussion

- Candidate definitions from front/rear of vehicle.
- Dummy positioning for conventional seating — mirror passenger procedures to driver.
- Dummy positioning for unconventional seating — challenging and will require research.



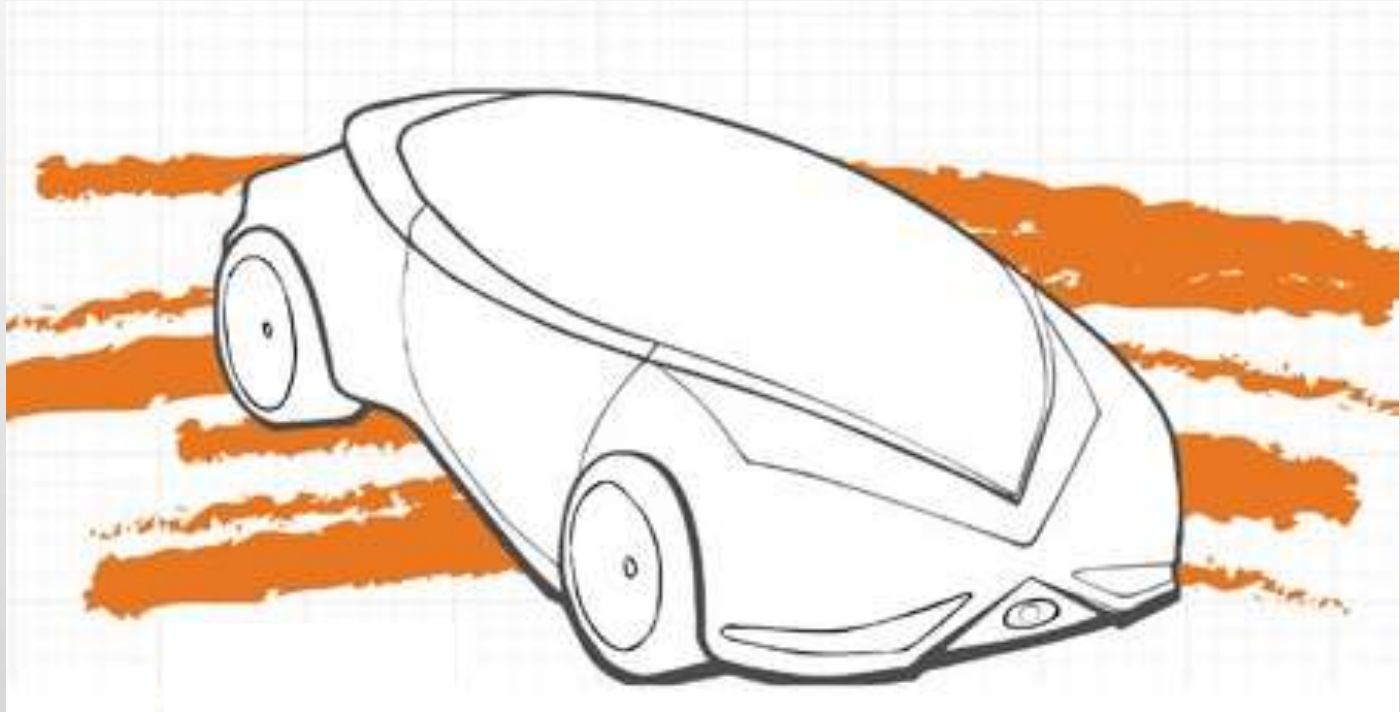
Dummy Positioning in Unconventional Seating Arrangements

- No existing positioning procedures for rear-facing seats.
- Possibly adapt FMVSS 214 rear seating procedure.
- Existing landmarks (e.g., A-pillar for front seat occupants) may no longer be relevant.
- Phase 2 research topic.



Panel 4

Looking Ahead Phase 2: Forward/Rear References





General Comments

- Is rear-facing seating actually wanted by consumers? Might be attractive to families on long trips.
- Should we trust rotating seats? Would they be reliable?
- Motion sickness in rear-facing seats.
- What about a 10-lb backpack sitting on the floor in carriage seating? Unrestrained luggage would become a projectile.
- Europe does not allow side-facing seats. Anything more than about 10 degrees rotation not allowed.



General Comments

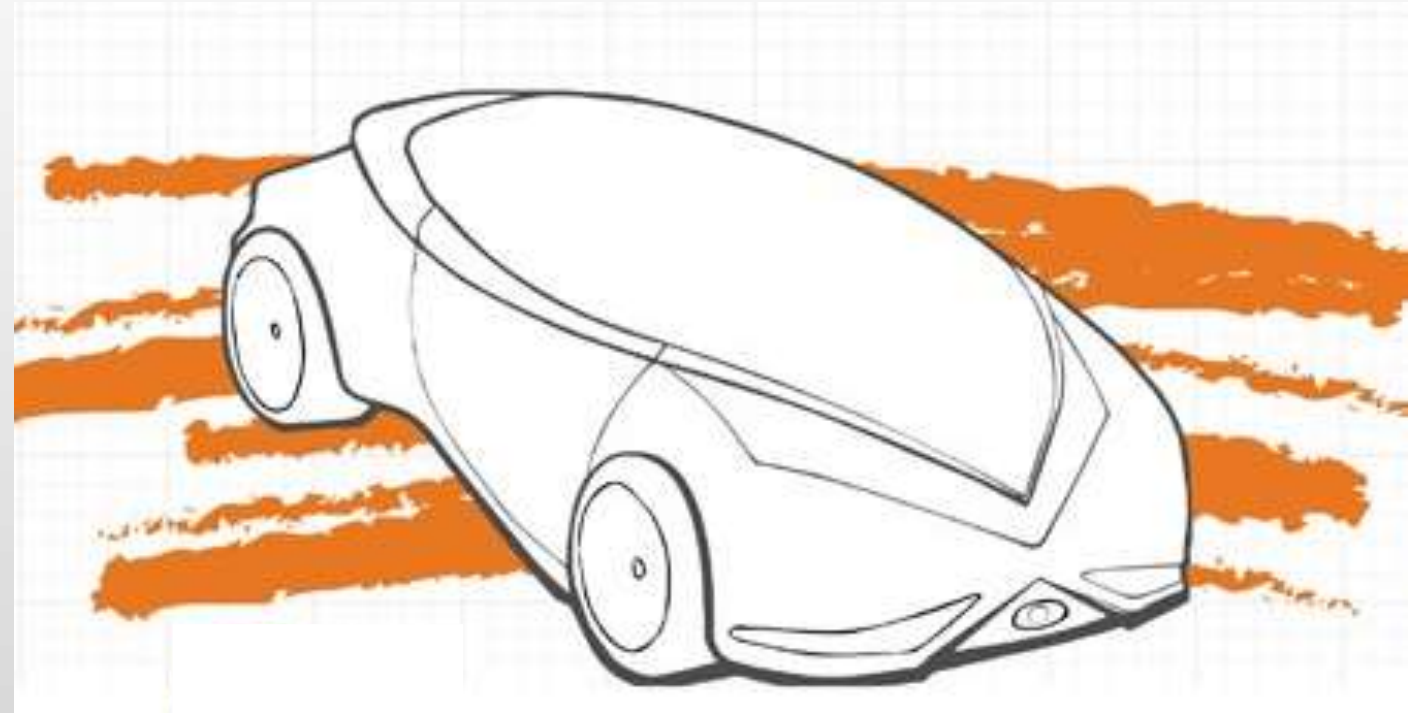
- Do we have the right tools to assess unconventional seating?
 - Human body models?
 - Dummies?
 - Validation for dummies?
- Research should begin now.
- SAE Task Force looking into this issue.



Questions / Observations

- How to handle rear-facing child seats in rear-facing seats (would be facing forward in ADSs)?
- Would bidirectional vehicles require infrastructure changes or driver education?
- Will airbags be required in the rear?
- How to handle unbelted occupants in carriage seating?

**Thank You
for Your
Participation**



200-Series Breakout Sessions



Thank You!

- Ellen Lee, COR (TO)
 - E-mail: ellen.lee@dot.gov
 - Phone: 202-366-1435
- Myra Blanco
PI/Project Manager
 - E-mail: mblanco@vtti.vt.edu
 - Phone: 540-231-1551

