Opportunities and Challenges for the Interaction Between AVs and Vulnerable Road Users

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Center for Vulnerable Road User Safety (CVRUS)

Our Mission:
Use human factors methods to improve road safety & outreach for people at *higher risk of crash or injury than average drivers* due to their mode of transportation, intrinsic, or extrinsic factors

CVRUS Leadership Team

Jon Antin, Ph.D.
- Center Director
- Senior driver safety, NDR

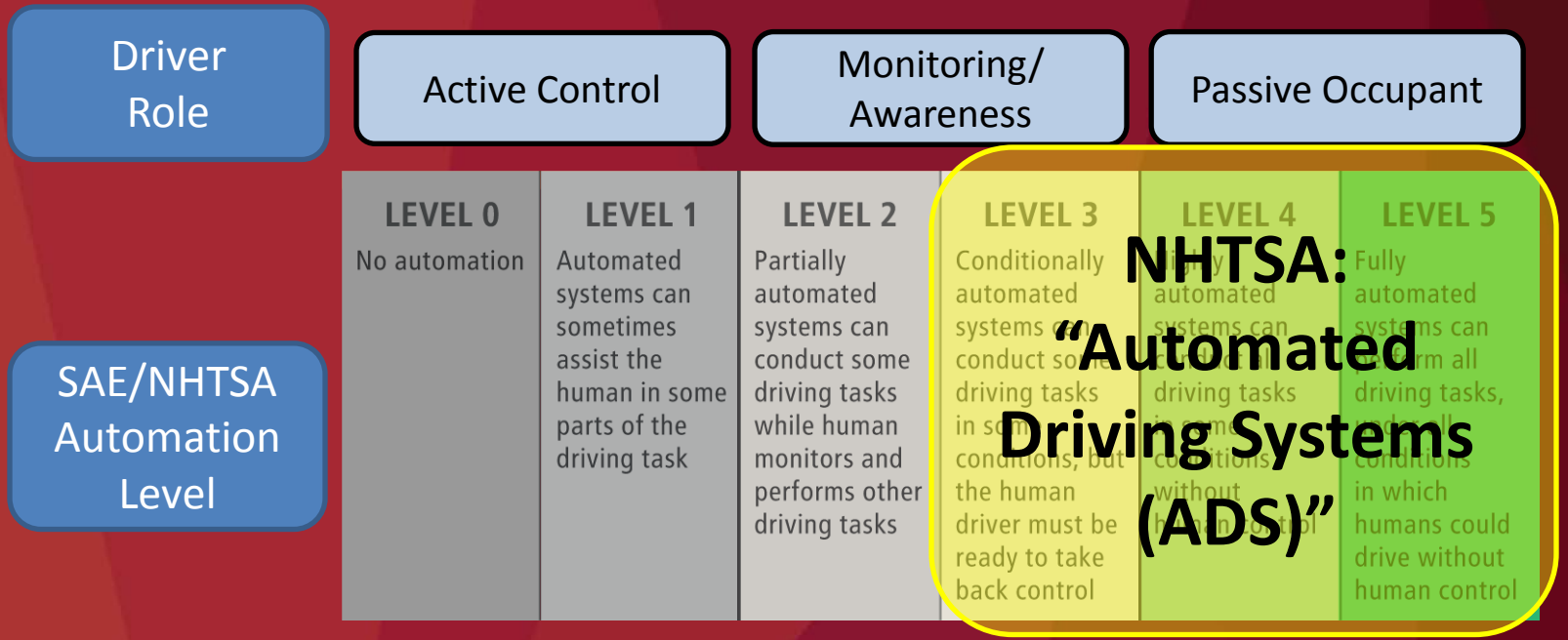
Charlie Klauer, Ph.D.
- Teen driver safety, driver distraction




Ryan Smith, Ph.D.
- Impairment - alcohol, drugs, OTC, marijuana

Justin Owens, Ph.D.
- Ped/bike safety, child safety, PWD, driver distraction & fatigue

What are "Automated Vehicles"?



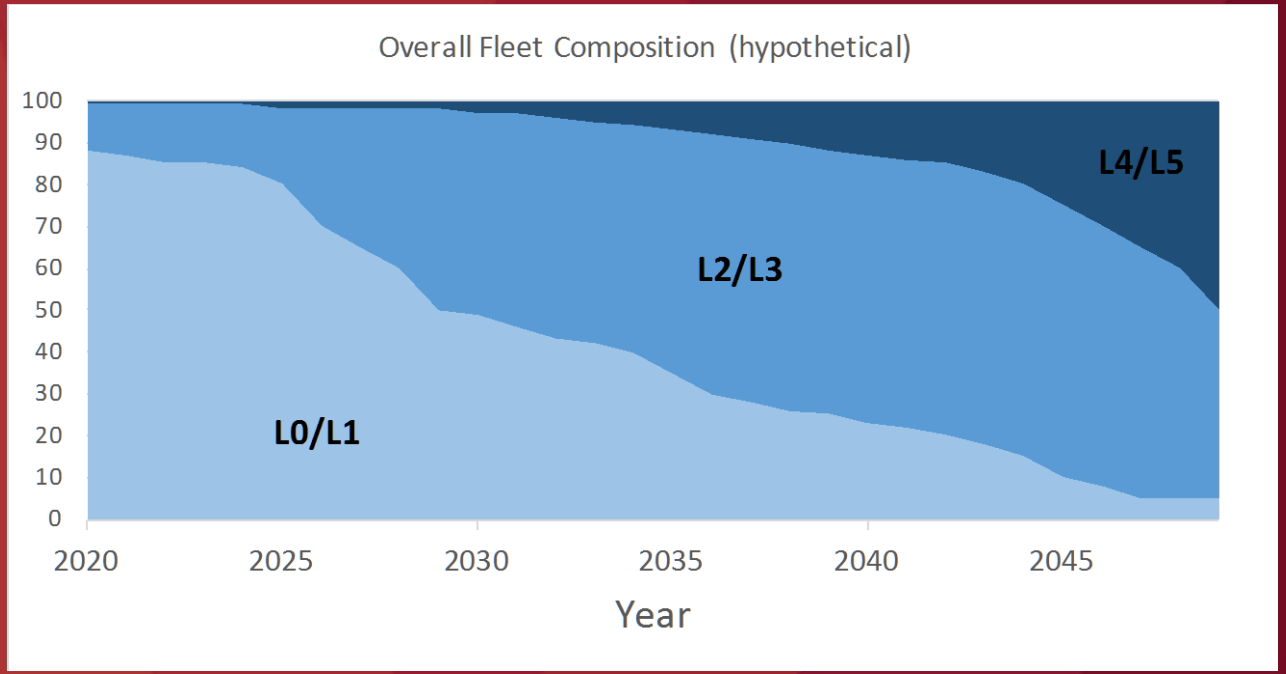
NHTSA/USDOT Guidelines

Automated Driving Systems 2.0: A Vision for Safety

- Published 2017; DOT's current guiding document for ADS
- Provides *voluntary guidance* for manufacturers & *technical assistance to states*
- Pedestrians & cyclists only touched upon:
  - *"[HMI] Considerations should be made for the human driver…and external actors with whom the ADS may have interactions, including…bicyclists and pedestrians."*

https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf

Hypothetical AV Penetration Rate



- Market readiness rate still unclear, but…
- Mixed fleet for decades to come

Automated Driving Systems: Pedestrian Safety Potential

- Improved Perception
- …potentially at night (?)
- …or with occlusion
- No Distraction/ Fatigue/ Emotion
- Faster Reaction Time
- Better Affordances for People w/Disabilities
- Improvements in Efficiency

Challenges for AV/VRU Interactions

- Wide variety of challenges all levels of AV control
  - Some apply in different ways across levels
  - Compounded by operator takeover in L2/3
- Further discussion available in:
  - Sandt, L. & Owens, J.M. (2017). *Discussion Guide for Automated and Connected Vehicles, Pedestrians, and Bicyclists.* Pedestrian and Bicycle Information Center. Chapel Hill, NC

Detecting Pedestrians & Bicyclists

- How does an ADS detect vulnerable road users (VRUs)?
- **Challenges**:
- Multiple technologies (machine vision, Lidar, etc)
- All have $$ and/or tech limitations
- How can ADSs parse & track crowds of VRUs?

How do Pedestrians Identify AVs?

Level 2

www.tesla.com

www.cadillac.com

Level 4

www.easymile.com

www.navya.tech

Level 4/5*

newsroom.uber.com

www.waymo.com

Communication & Negotiation of Intent

- How do vehicles and pedestrians communicate *control* & *intent*?
- Shift from bidirectional human-to-human to user-machine interface

VTTI - Ford

HAL - Duke

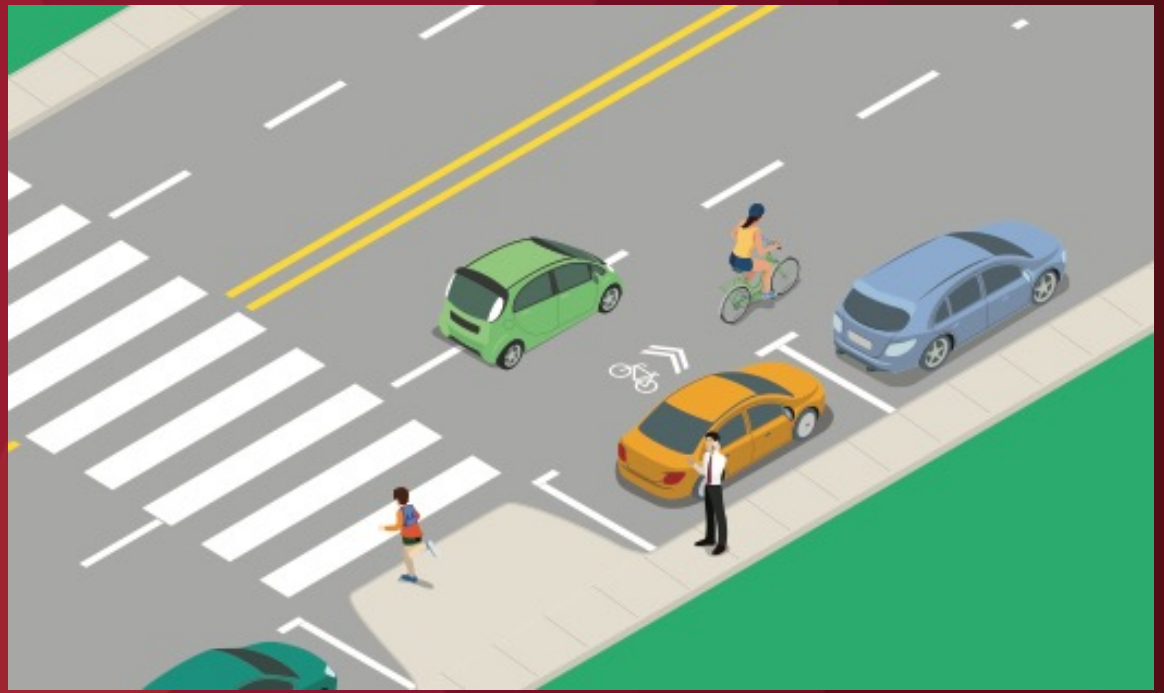
AVIP – RISE Viktoria

Determining Right of Way

- Legal, social & cultural issues
  - Interpretation & respect for local customs and norms?
- Replicate or replace personal communication?

Vehicle Behavior Around Peds & Bikes

- How does an ADS determine when to pass a cyclist/pedestrian in the road?
  - vs. hanging back given roadway parameters
- How does it weigh giving lateral passing distance vs. crossing lane line?



Driver Engagement

- L2/3 – How do interfaces successfully maintain/obtain driver engagement?
  - Especially in unexpected or complex scenarios involving VRUs?
  - Some calls (e.g. NACTO) for restricting use of midlevel automation in city centers.

HF Considerations for VRUs w/Disabilities

- What accommodations can be developed to assist or improve safety?
  - Benefits of connectivity?
  - Extra crossing time
  - Advanced communication
  - Onboarding/offboarding

Equity Considerations

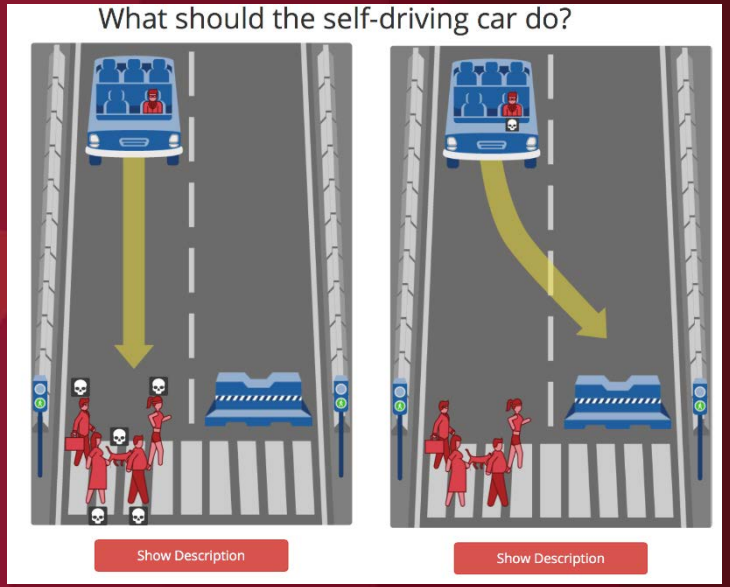
- Universal Design: inclusive of people with disabilities
- Fair distribution of benefits/risk across states, SES, race & gender
- Deployment of new & upgraded infrastructure
  - Connectivity, separated walking areas, etc.

Infrastructure Development

- Designing for *now* vs. *future*
- Predicting future travel patterns
  - Increased/decreased pedestrian traffic
  - Parking vs. return trips
- Separated travel lanes/paths
- What is the *interaction* between design & HF?

Legal/Ethical Questions

- Who to harm?
  - Trolley problem
- Who is liable?
- When can AVs break the law?
  - Major/minor
- Limitations on operational domain?



moralmachine.mit.edu

Summary: A Call for Research

- Even (especially!) with automation, questions about interaction between humans & machines
- Opportunities for improvements over current (fallible) human perception & performance
- Many issues, need engagement from all sides

Thank you!

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