What Do Production ADAS and ADS Systems Tell Us about the Migration to Collaborative Driving?

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The History of Driverless is Nearly a Century Old

**MILESTONES**

1926  First experiment with remote control

1950s  GM investments in the topic

1980s  Several prototype concepts

2009  Google launched its self-driving car program

Next?

In the **10 years** since, billions of dollars of investment...
Some possibilities view points on objectives (use cases) of autonomy include:

- Vehicles and vehicle systems that encompasses aspects of hands-free driving?
- Autonomous mobility on demand services (without safety drivers) in a neighborhood or city?
- A mobility ecosystem that provides seamless intermodal connectivity?
- A mobility solution that meets a target safety threshold?

WHAT IS THE “DRIVERS” ROLE
A Need for a Global Movement Away from SAE 3016?

Driving & Riding may be the only terminology consumers understand without significant education.

The Advanced Vehicle Technology Consortium

**Originators:** MIT AgeLab, Touchstone Evaluations & Agero

**Founding Members:** Aptiv, Liberty Mutual, Jaguar Land Rover, Veoneer & Toyota

**Current Members:** Agero, Aptiv, Jaguar Land Rover, Veoneer, Toyota, Consumer Reports, Progressive, Insurance Institute for Highway Safety, Google, JD Power, Volvo Cars, Audi / AID, Lear, Travelers, Affectiva, Zenuity, The LAB (GIE PSA Renault Groupes) & TBD

**Other Supporters:** TravelCenters of America

**Focus:** To collect and analyze cutting edge data that objectively characterizes the behavioral and safety benefit of advanced driver assistance systems, higher levels of automation, and other in-vehicle technologies under real-use conditions

**To develop:** An understanding of system performance and how drivers adapt to, use (or do not use), and behave with advanced vehicle technologies
Autopilot and Inattention

--- epoch constants ---
epoch_type: tesla_toc_dis
is_day: 1
vehicle_speed_mph: None
speed_limit_mph: None
toc_vehicle_speed_mph: 62.5
toc_speed_limit_mph: 45

--- important variables ---
autopilot_state: 3
secs_to_toc_dis: -5.0
speed_mph: 66.1
speed_limit_mph: 45

--- other constants ---
autopilot_hands_on_state: 1
autopilot_stalk: 64
acc_enable_speed: 13.6
acc_hold_state: 0
acc_state: 4
steering_control_type: 1
auto_lane_change_state: 7
autopilot_knob: 66
brake_pedal: 0
brake_pedal_state: 0
pedal_pos_percent: 0.0
steering_haptic_request: 0

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Super Cruise First Use

Trust Builds Quickly With Well Developed L2
L1 plays a role both as a state and as apart of a transition path to L2.

Proportion of transitions between levels of automation

The “Blue State”
The “Red State”
ATTENTION CHANGES WITH L1

Automation (ACC) Increases Monitoring “Costs”

Glances to the instrument cluster increase in frequency during ACC use relative to manual driving.
Increased System Use Amplifies Glace Effects

Minimal PA use in version A.

Increased PA use in version B associated with increased glance to the instrument cluster and interior relative to manual driving.
Drivers Have a Role in the Success of Automation

- Automation enabled vehicle systems have delivered improved safety (e.g., ESC, AEB)
- Driver attention (and related awareness) may be at a historic low
- Increased automation needs to be coupled with increased comfort, mobility and safety, but will require new roles for the “driver”
  - Collaboration
  - Monitoring
  - Readiness to take-over
- New HMIs are needed to monitor, manage and motivate drivers as an integrated component of the system
Can a driver maintain sustained attention in this model? – NO!
Two-way Collaboration may be a More Realistic Model for Success

MUTUAL SUPPORT
Will the driver be more comfortable, more trusting, and more successful if they have support in fulfilling their role?
We may need to consider a functional view of driver attention that focuses on a holistic (system wide) view of the net impact of all sources of demand (primary and secondary, under all automation levels, and the role of operating context) on safety.

**In practical terms, perhaps we can not solve the drowsy, distraction and technology influx epidemic without a broader consideration of driver attention management.**


The concept of an ‘attentional buffer’ can be used to describe both visual allocation and attention.

Depth of buffer reflects sampling rate required to keep vehicle in lane (every 1.8-2s; cf. Senders, 1967) – potential changes with automation etc.

Driver’s focus away from road - awareness of road situation declining

Driver needed to look back at the road and attend to it in order to refresh their awareness of the road situation.

Figure adapted from Kircher & Ahlstrom (2009), See Seppelt et al. (2017) for additional details.
Advances in HMI Will be Critical to Supporting Drivers & Riders

Increases in automation will increase information needs:
• New visual displays to communicate mode awareness and enhance the operational relevance of information
• Expanded infotainment and comfort offerings
• More effective multi-modal interfaces to support context aware communication and the management of driver state
• Innovative eHMI to communicate expectations and potentially salient advertisement space

The integration of communication, infotainment, and safety systems through synergistic HMIs is critical to an automated, electrified and connected mobility system.
THE FUTURE MAY BE AUTONOMOUS, BUT...

Significant Changes will Take Decades and Increased Industry Initiative

• Higher level automated vehicles will emerge as the technology improves and business cases evolve
• Managing consumer expectations will be critical in an evolving market
• Well conceived policy and / or industry collaboration is needed to ensure appropriate standardization across levels and platforms
• Human centered engineering throughout the automotive ecosystem will require new HMI and enhanced system integration to build and maintain user trust
• Collaborative driving deployments can become (at least for the foreseeable future) a savior to the automotive industry