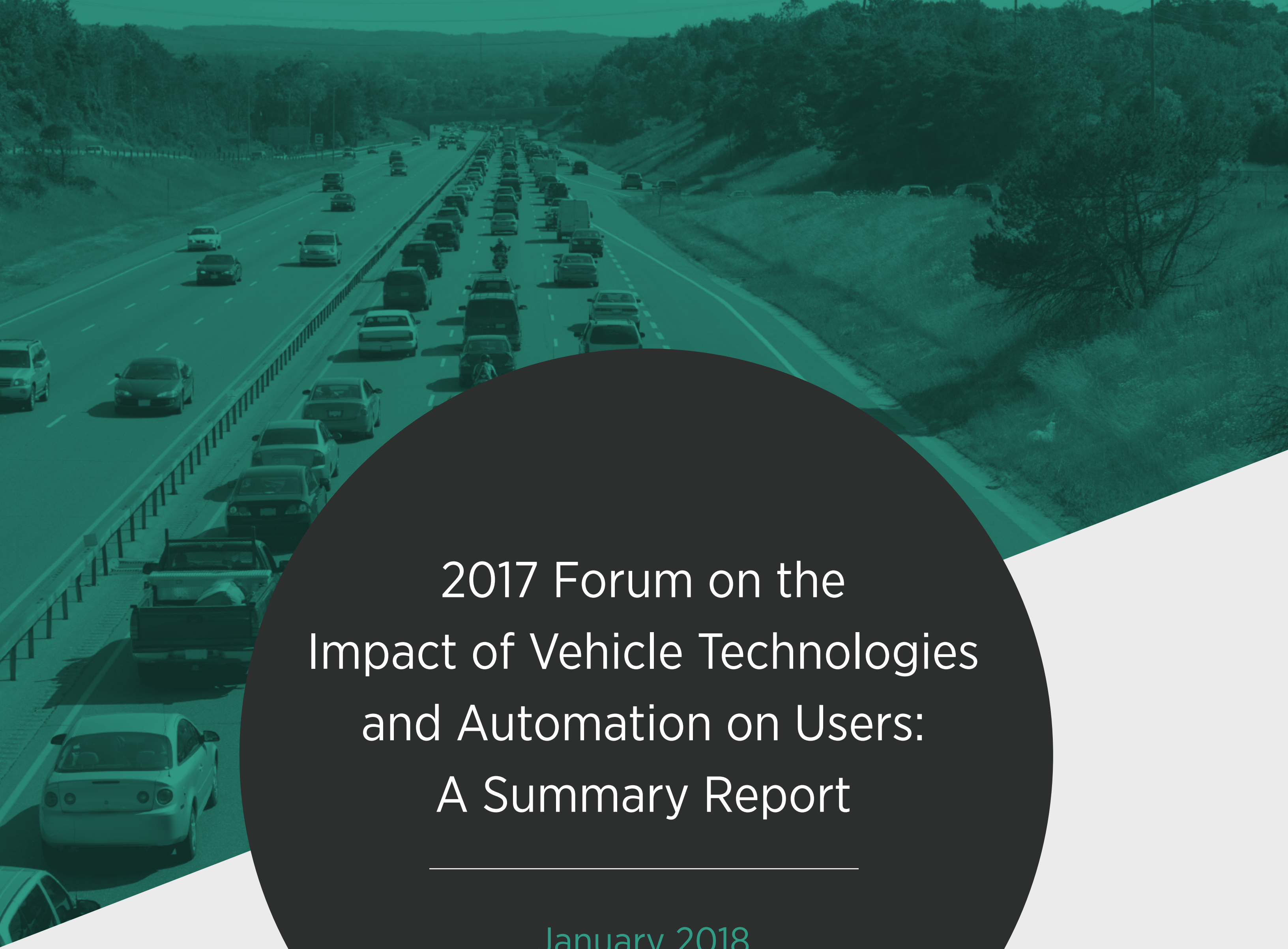

2017 Forum on the Impact of Vehicle Technologies and Automation on Users: A Summary Report

January 2018

607 14th Street, NW, Suite 201 | Washington, DC 20005 | 202-638-5944

AAA Foundation for Traffic Safety

Title

2017 Forum on the Impact of Vehicle Technologies and Automation on Users: A Summary Report

(January 2018)

Foreword

As vehicle technologies evolve and we move closer to the vision that future cars will drive themselves, it is critical that the transportation community takes an active and well-considered approach in developing and implementing new technologies and automation.

This report summarizes presentations and discussion from a forum held in November 2017 at the University of Utah in Salt Lake City. A group of stakeholders from academia, industry and government gathered and exchanged information and ideas about the impact that 21st-century automotive technologies are having on drivers. Contents of this report should be of interest to researchers and practitioners who are involved with vehicle technologies and automation work.

C. Y. David Yang, Ph.D.

Executive Director
AAA Foundation for Traffic Safety

About the Sponsor

AAA Foundation for Traffic Safety
607 14th Street, NW, Suite 201
Washington, DC 20005
202-638-5944
www.aaafoundation.org

Founded in 1947, the AAA Foundation for Traffic Safety is a not-for-profit, publicly supported charitable research and education organization dedicated to saving lives by preventing traffic crashes and reducing injuries when crashes occur. Funding for this report was provided by voluntary contributions from AAA/CAA and their affiliated motor clubs, individual members, AAA-affiliated insurance companies and other organizations or sources.

Table of Contents

Abbreviated Terms

ACC – Adaptive Cruise Control

ADAS – Advanced Driver Assistance System

AAA – American Automobile Association

ABS – Anti-lock Braking System

ADS – Automated Driving System

AV – Automated Vehicle

AEB – Automatic Emergency Braking

FARS – Fatality Analysis Reporting System

FCW – Forward Collision Warning

HMI – Human-Machine Interface

NHTSA – National Highway Traffic Safety Administration

NTSB – National Transportation Safety Board

NDS – Naturalistic Driving Study

NCAP – New Car Assessment Program

NGO – Non-Governmental Organization

ODD – Operational Design Domain

OEM – Original Equipment Manufacturer

SAE – Society for Automotive Engineers

TRB – Transportation Research Board

VIN – Vehicle Identification Number

VR – Virtual Reality

Introduction

On Nov. 7 and 8, 2017, the AAA Foundation for Traffic Safety and the University of Utah hosted a forum to discuss and identify future research needs on the impact of vehicle technologies and automation for drivers and other transportation users. The event was attended by academics, automobile manufacturers and industry representatives, government agencies, advocacy groups and other research organizations. The forum was co-sponsored by AAA Public Affairs, the University of Iowa National Advanced Driving Simulator and the Transportation Research Board.

The main objectives of this forum were to: (a) gather representatives/experts from the research community, government, and industry to discuss and identify research needs/direction on the impact of vehicle technologies and automation for drivers and other transportation users, (b) develop a living document of research needs and share it with other stakeholders to improve coordination and encourage collaboration, (c) identify organizations that are willing to "adopt" and make future resource commitments in one or more research areas, and (d) make connections and work together to help shape the future of vehicle technologies.

On Day 1, two expert panels were convened to discuss a variety of topics related to vehicle technology and automation and users. Each panel was followed by an extended question-and-answer period. On Day 2, all attendees engaged in small breakout group discussions and presentations aimed at identifying the most pressing research needs as well as potential approaches and barriers. The panel presentations and discussions, breakout group exercise, and outcomes are described in the sections below.

Day 1: Panel Presentations & Discussion

Panel 1: Vehicle Technologies and Automation (Facilitated by Dr. Tara Kelley-Baker, AAA Foundation for Traffic Safety)

Dr. Chris Monk, National Highway Traffic Safety Administration

Dr. Monk provided an overview of the newly released guidelines issued by National Highway Traffic Safety Administration (Automated Driving Systems Version 2.0; https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf). He noted that the voluntary guidance was intended to help support industry, states, and legislatures as they work toward automated driving systems. Compared with regulations, voluntary guidance provides flexibility for stakeholders and improves turnaround times. The guidelines are intended to apply to Level 3 automation and higher (http://www.sae.org/misc/pdfs/automated_driving.pdf).

The guidelines describe 12 safety elements, including vehicle and driver fallback, cybersecurity and crashworthiness. They also provide some best practices for state legislatures. A safety assessment letter, which constitutes a voluntary self-assessment, is also outlined. It covers issues concerning engineering and the operation design domain (ODD) of the system, as well as the human-machine interface.

Dr. Johan Engström, Virginia Tech Transportation Institute

Dr. Engström posited that the net safety effects of new technologies are a function of the benefits as well as the disbenefits of the systems—the latter reflecting the potential for systems to contribute to new types of crashes as a result of technical factors (e.g., edge cases related to the ODD) or human factors issues (e.g., failed expectations, situation awareness/driver out-of-the-loop; see Figure 1). Dr. Engström also described the crash trifecta, where crashes are more likely in situations where an unsafe behavior leads to transient inattention and is met with an unexpected event. A consideration of all of these components is fundamental for our understanding of crashes.

Given challenges in establishing the safety benefits of the new technology, Dr. Engström underscored the need to capitalize on different data sources and experimental approaches in order to fully understand and explore the role and importance of edge cases, where the systems are unable to perform as intended or were not intended to perform at all. He provided an example of such an approach, where data is first gleaned from naturalistic driving studies (NDS) in order to identify real-world edge cases. These cases can then be prioritized and modeled in virtual environments in order to promote careful and controlled testing in human-in-the-loop studies. Following this, edge case scenarios can be brought to a test track environment for further study using actual vehicle hardware and technology, again using human-in-the-loop studies and rapid-cycle development. Lastly, this collective information can feed back into on-road NDS as well as inform the design and development process of this technology.

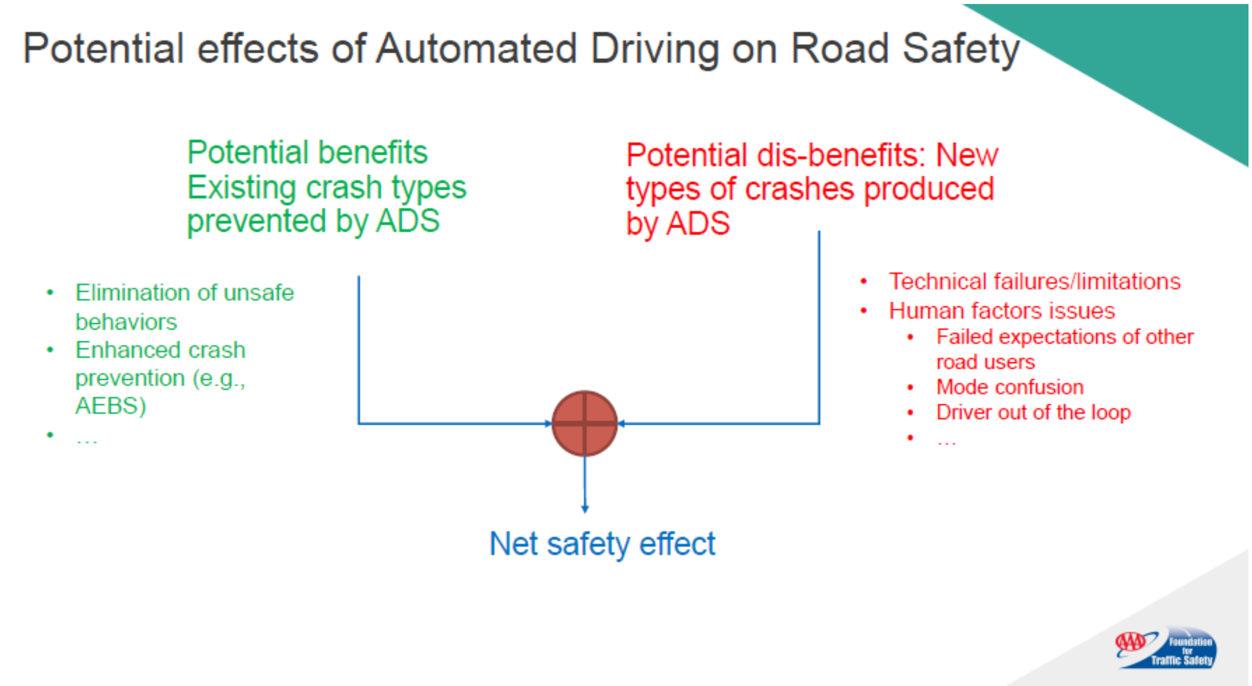

Figure 1. Net safety effects of automated driving systems (from Johan Engström, 2017, used with permission).

Dr. David Strayer, University of Utah

Dr. Strayer discussed several fundamental issues concerning driver attention, distraction, and situation awareness when interacting with (or not interacting with) advanced in-vehicle technology. In models of attention, driver awareness of the roadway decays whenever attention is directed to activities other than driving (e.g., distraction). When attention returns to the roadway, situation awareness is re-established. Importantly, the loss and recovery of situation awareness over time and the engagement in non-driving related activities can be parameterized and modeled. Moreover, the rate of decay and recovery can be impacted by the nature and difficulty of the secondary task being performed.

As shown in Figure 2, Dr. Strayer noted that a similar decay and recovery function might be applied to the use of advanced vehicle automation, where drivers are exposed to periods of system engagement and manual driving. Many fundamental studies in human factors have shown that humans are not very effective as passive monitors of systems.

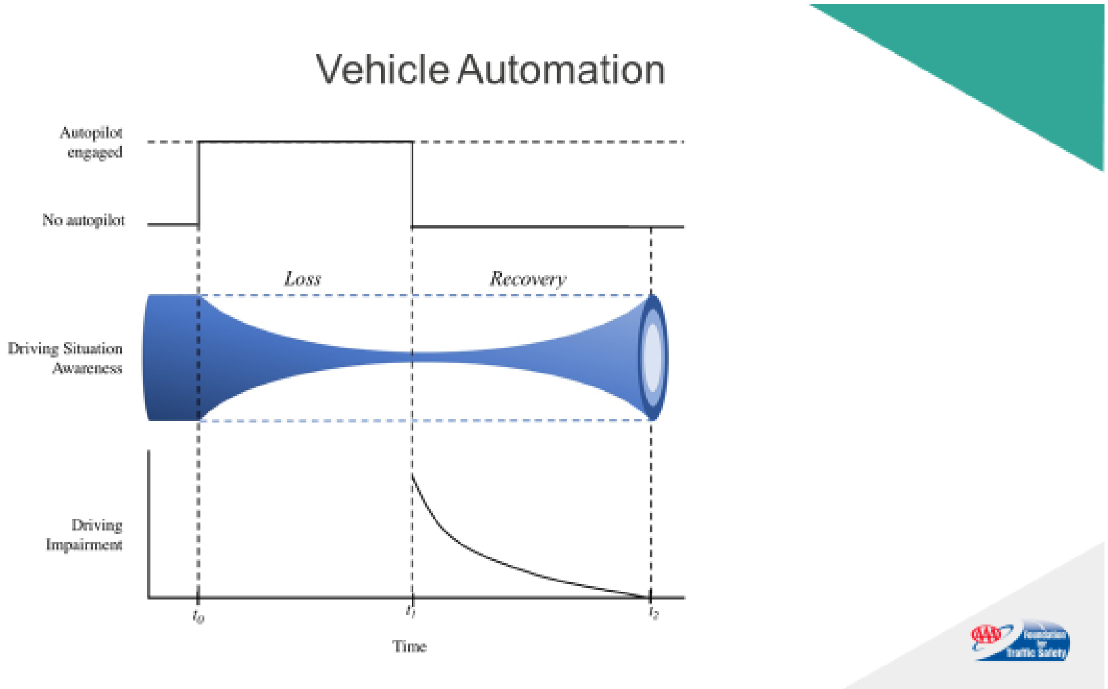

Figure 2. Loss and recovery of situation awareness with the use of automated driving systems (from David Strayer, 2017, used with permission).

Dr. Daniel McGehee, University of Iowa

Dr. McGehee began his presentation with a compelling example of history repeating itself with the branding and marketing of the 1958 Chrysler Imperial's Auto-Pilot system, which essentially was an electronic cruise control system. He also commented on antilock braking systems (ABS), noting that although they were introduced in the mid-1990s and are currently enjoying full market penetration, consumers still do not have a good understanding of their operation. Dr. McGehee dovetailed this discussion into an illustration of the importance of consumer knowledge and education about these new technologies (e.g., www.MyCarDoesWhat.org). These are not only relevant for the safe and appropriate operation of the systems, but also are critical factors in determining user trust and willingness to use the technology (which, in turn, impacts the overall market penetration).

Dr. McGehee gave an overview of a recent consumer survey about driving safety technologies and a technology demonstration study. As shown in Figure 3, these studies revealed that as knowledge increases, so too does trust and willingness to use the technologies, along with a decrease in apprehension toward them. Moreover, knowledge increased when drivers received ride-alongs followed by a review of the owner's manual.

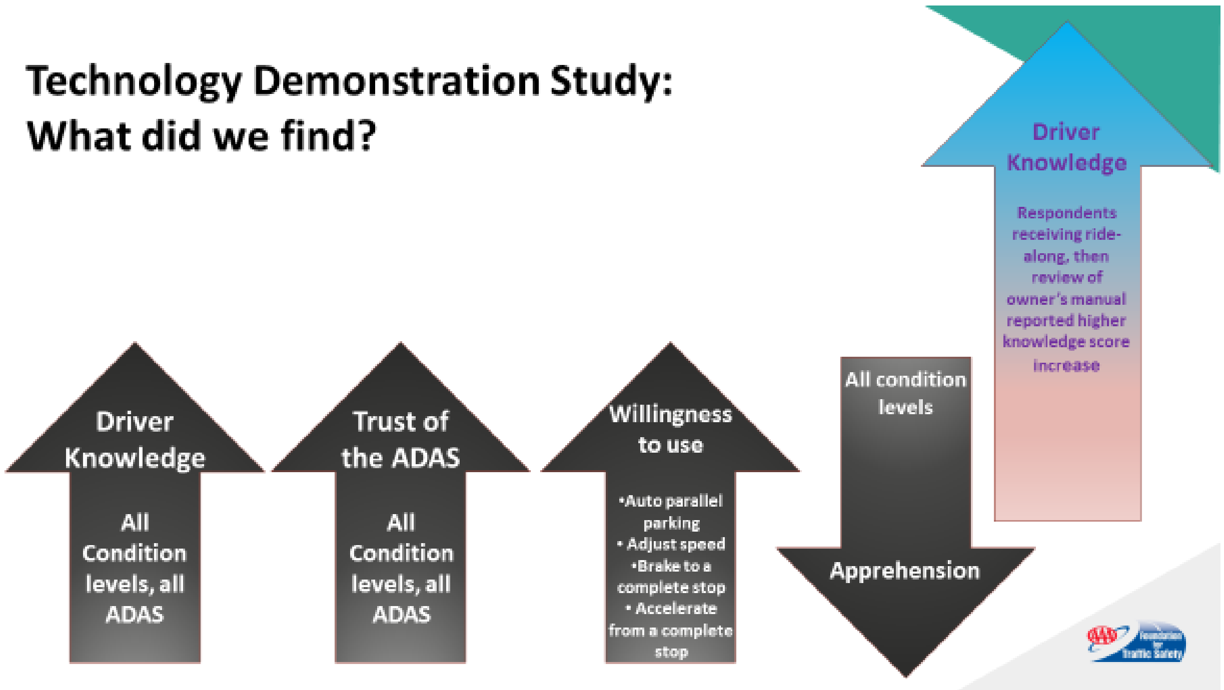

Figure 3. General outcomes from the technology demonstration study (from Daniel McGehee, 2017, used with permission).

Dr. Deborah Bruce, National Transportation Safety Board

Dr. Bruce led with some reflections on the aviation industry and NTSB experiences with automation. She noted that highway automation is a much more challenging environment because of many factors, including the diversity in the operational environment and the drivers themselves. She provided a detailed overview of the 2016 fatal Tesla crash and the subsequent NTSB investigation (https://www.ntsb.gov/investigations/AccidentReports/Reports/HAR1702.pdf). She noted one challenge for NTSB was weighing recommendations with the available case size (i.e., the amount of available data).

She also underscored some recommendations regarding the data requirements in order to fully understand crash circumstances (relating to event data recorders), as well as the importance of establishing and communicating clear guidance regarding operational design domains (ODD), vehicle-to-vehicle communication and other facets of new technology.

Panel 1 Discussion

The panel presentations were followed by an extended question-and-answer period, with lively participation from the forum audience. Many topics were fielded, including (but not limited to):

- The value of pursuing Level 3 automation
- Distinguishing between Levels 2 and 3 and the overall effectiveness of the current definitions and scope of SAE levels
- Training new users of the systems. Can systems be effective without training requirements?
- Ethical considerations
- Barriers to implementation
- How to quantify safety. Can 100% safety be achieved?
- Dealing with ambiguities – how many errors can be linked to design problems?
- Is a massive regulatory shift practicable?
- The role and efficacy of aftermarket devices
- The product testing cycle in light of rapidly changing technology
- Degree of driver engagement while operating automated systems
- How to make roadways compatible with higher levels of automation
- How to message future system errors and failures to maintain public confidence

Panel 2: Users (Facilitated by Dr. William Horrey, AAA Foundation for Traffic Safety)

Dr. John Lee, University of Wisconsin-Madison

Dr. Lee described how trust in automation interacts with the end user's mental model of the system. He also discussed the role of user intuition when dealing with a complex system and the power of feelings over rational thought. These carry implications for an individual's perception of risk, which can lead to under-trust in some situations and inappropriate levels of "dread risk"—which can negatively impact the rate of adoption of new technology. Dread risk tends to manifest itself in situations of fatal consequences, where humans have a lack of control and where outcomes are difficult to fix—all outcomes that can be implicated in people's perceptions of automated technology.

Dr. Lee also described trust as an attitude—a multifaceted one—that can help achieve an individual's goals in a situation characterized by uncertainty and vulnerability. That is, trust can guide one's choices and actions, including the decision to use automation toward an end. Moreover, trust is based on the user's perception of the purpose, process, and performance of the automation. Trust can be miscalibrated; that is, user trust in system might not align with actual system capability. For example, as shown in Figure 4, trust can be appropriately calibrated to system capability (along the diagonal line) or it can fall into the upper left region (i.e., over-trust in system) or lower right region (i.e., under-trust in system). Dr. Lee noted that over-trust in systems is likely to be a common outcome in the implementation of semi-autonomous vehicles.

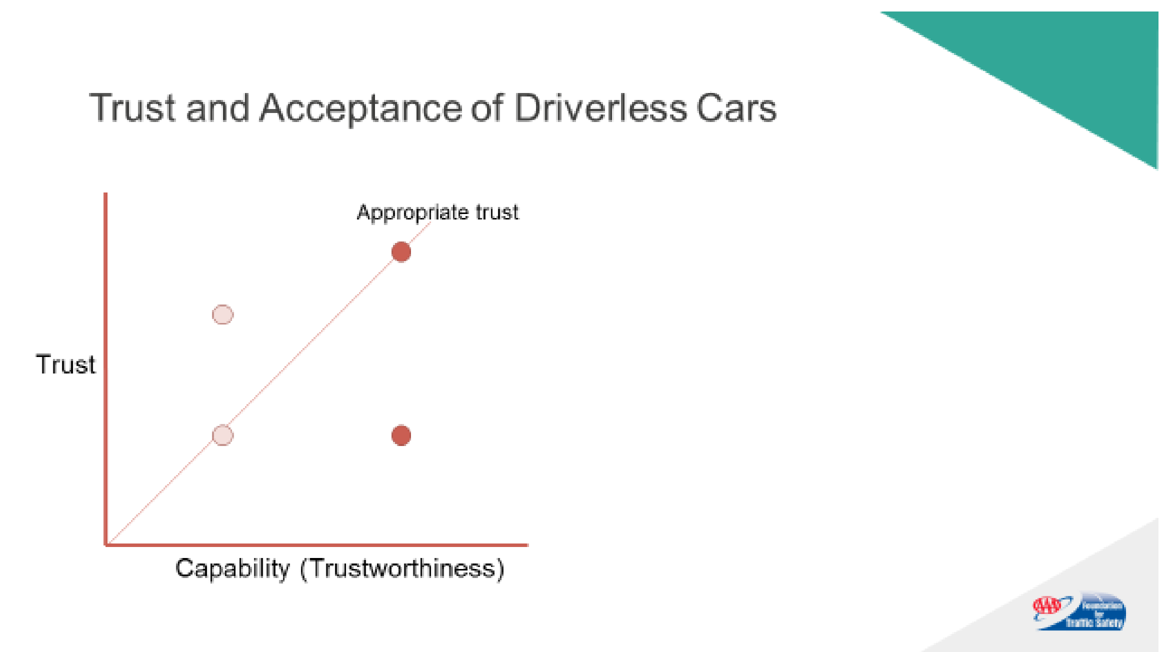

Figure 4. Calibration of trust with system capability (from John Lee, 2017, used with permission).

Dr. Linda Boyle, University of Washington

Continuing some of the themes raised in the first presentation, Dr. Boyle noted that a key element in the human-automation system is the matching of user beliefs with actual system capabilities and, by extension, matching attention to the momentary demands required. Much of this is underscored by users' mode awareness. Confusion arises when a user fails to understand the mode of automation in operation, the context that a system may fail, or the context where a system may initiate a hand-off.

She noted that shared control can create confusion, especially as human function is not always clearly defined in the context of systems. Transfer of control goes both ways—vehicle to human and vice versa—and control is impacted by environmental changes, fluctuations in the system sensing capabilities, and the interpretation of system functions and features. Users need to know when to take control: when their goals have changed, when automation is not responding as expected or in light of environmental changes (Figure 5). Conversely, an automated system needs to know when to take control: if the user is not responding in time or as expected, or in light of environmental changes.

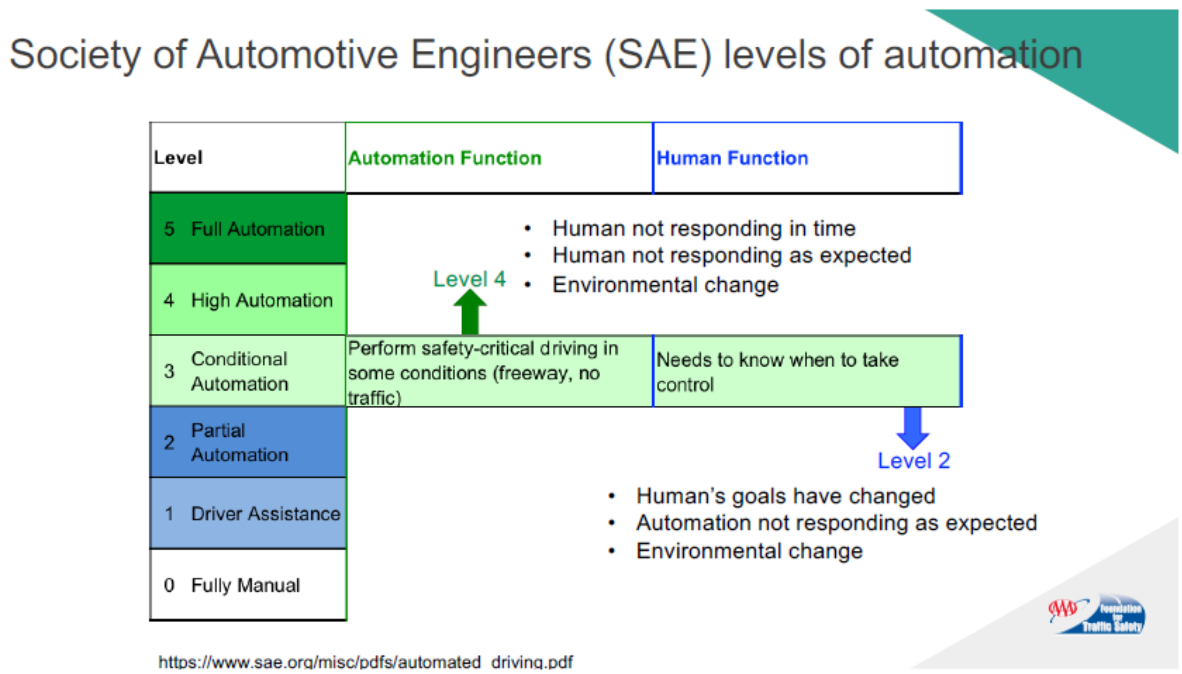

Figure 5. Challenges for transfer of control from Level 3 automation (from Linda Boyle, 2017, used with permission).

Dr. Donald Fisher, Volpe National Transportation Systems Center

Dr. Fisher focused on the role of training in the context of advanced automated systems: whether it is necessary for first-time users, what type of training is needed, and what policies and procedures would be necessary for training and skill maintenance. In the context of automated systems, training may help reduce misuse/disuse, overreliance, workload and stress, and mode confusion.

Dr. Fisher provided an example of overreliance in hazard anticipation, emphasizing that training is not simply about knowledge of the system. Practice is important as well. He noted that retrieving relevant information or knowledge from memory in high stress situations is very difficult, a point that was underscored by a recent study of unintended acceleration. Lastly, referring to Figure 6, Dr. Fisher discussed the importance of skill degradation over time and the need to refresh aspects of training periodically.

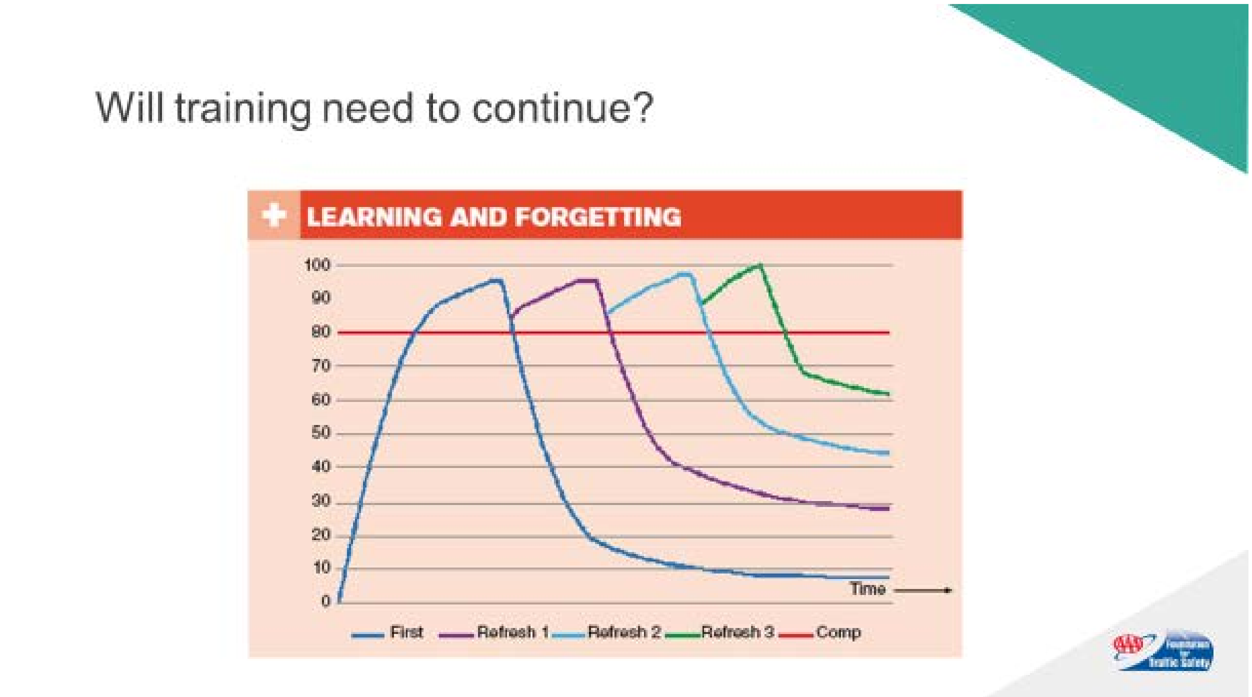

Figure 6. Plot of learning and forgetting curves with training refreshers across time (from Donald Fisher, 2017, used with permission).

Dr. Michael Regan, Australia Road Research Board

Dr. Regan described issues concerning distraction and inattention in face of advanced automation and their impact on performance and takeover. He speculated on whether automation could promote distraction, for example, during prolonged use and with higher levels of automation. Distraction stands to impact drivers' situation awareness of the traffic environment, not to mention their understanding of the state of automation, which can consequently impact the ease and success with which control can be transferred back to the driver. Dr. Regan also noted that inattention can manifest itself in different ways, including driver drowsiness and fatigue.

Dr. Regan also discussed the importance of self-regulation and individual differences in the driving population, as well as, in mixed fleets, the prospects of drivers of non-automated vehicles becoming distracted by the operation and behavior of vehicles with the technology. He also raised the question of whether automated vehicles themselves could be distracted, for example, through their algorithms and relative prioritization of information and tasks.

Ms. Ashley McDonald, University of Iowa

Ms. McDonald revisited and elaborated on the discussion of users' knowledge of advanced technology. She detailed some current work examining the perceptions, experiences, and behaviors of current owners of ADAS-equipped vehicles, as well as the training needs and knowledge of the advanced systems.

In a survey study, researchers looked at a variety of systems, including adaptive cruise control, blind spot monitoring, lane keeping assist, automatic emergency braking, and forward collision warning, among others. The study found that the majority of owners have experienced the activation of their FCW and AEB systems; however, only 55% of people could correctly identify the proper function of ACC and only 67% correctly understood AEB. These data points continue to underscore the point that users have an incomplete or inaccurate understanding of available systems.

Panel 2 Discussion

Following the panel there was another extended question-and-answer period. Panelists fielded many topics from the audience including, but not limited to:

- How to train trust and, by extension, appropriate system calibration (reliance) in drivers
- Parallels with trust in shared economy (e.g., as passengers, trust taxi and Uber drivers)

- How to account for changes in driver/system capabilities over time and in different situations
- How to communicate to drivers the capabilities of the system moment-by-moment
- Effective implementation of training
- Role of virtual reality (VR) and simulation in training
- How to capitalize on human factors fundamentals in order to keep out in front of the pace of technology
- Interactions of automated vehicles and pedestrians and other road users
- How generation cohort effects will impact the degree of trust in systems

Day 2: Breakout Tasks and Outcomes

The main charge on Day 2 was to break into small groups and discuss three main questions, then prioritize and present responses back to the overall group. Nine groups were created, and a diverse set of backgrounds and job roles was included in each (e.g., representatives from research/academia, industry, government, etc.). The specific questions were:

1. Brainstorm your ideas about research needs/gaps related to the impact of vehicle technologies and automation on users. Then, list your group's top three research needs/gaps in terms of priority, timeliness or impact.
2. How should the top three research needs be addressed, considering methodological approach and data types/sources? Who should take on these research needs? Are there any potential consortiums or collaborations that could be established to facilitate these research needs?
3. Are there any roadblocks that could hinder carrying out research to address these needs/gaps? How about barriers to the effective implementation or application of the research? If so, how can they be removed?

Information from the group presentations as well as the notes from group interactions have been distilled and synthesized in the sections below.

Question 1: Research Needs

Many topics were discussed related to research needs knowledge gaps. Efforts were taken to group them into broad categories. That said, the categories are not mutually exclusive. Underlying questions, in many cases, were relevant to multiple categories.

Mental Models

Drivers' mental models were prominently featured in the group discussions, both directly and indirectly. A mental model refers to a given driver's perception and understanding of the automated system they are interacting with. Importantly, mental models can either be accurate or inaccurate (in degrees). Accurate mental models reflect the true capabilities and functionality of the system. To the extent that they are incorrect, drivers might believe that their system can perform actions it cannot or that it performs in environments or conditions it is unequipped to deal with (to name a few).

Mental models are also connected to education and training (i.e., how new users develop their mental model) as well as to unintended consequences and inappropriate use of systems, not to mention system design. Given the integral nature and the complexity of this construct, it is not surprising that there were numerous questions related to mental models; development as well as the implications of erroneous ones. Some of the specific questions and comments raised by groups include:

- How are mental models developed and what factors are most influential?
- What are the safety implications of inaccurate mental models?
- What is the impact of name branding and inaccurate marketing (e.g., overgeneralization) on driver's mental models—both within and across ADAS features?
- Within a particular driving situation, what happens when there is mode confusion (drivers thinking that the system is in one mode when in reality it is in another)? What approaches are ideally suited to ease the potential escalation of mode confusion (e.g., system and human inputs working against one another)?
- How do mental models influence a driver's perception of the overall system (e.g., other automated vehicles, variations in technology and functions across make/model)?
- Can mode confusion be minimized by standardizing levels of automation?
- Can systems be designed in such a way that drivers will not need to know what state their vehicle is in?
- What scenarios lead to "automation surprises"?
- How do software updates impact driver mental models? Are drivers aware of updates, let alone what features have been updated?
- What happens when a driver is exposed to different vehicles (with different underlying technology or with different implementations of similar features)?
- Do drivers know what features their vehicles have?

Automation Misuse and Unintended Consequence

Clearly, the accuracy of one's mental model can have important safety implications, especially in terms of system misuse (e.g., overreliance) and other unintended consequences. These were important themes that the group discussion also raised:

- How does user perception affect misuse by early adopters? Or, to what extent do discrepancies between actual and perceived system limits lead to misuse?
- How can we effectively match users' expectations with vehicle capabilities, especially with the hand-over problem?

- What system functions and what circumstances will lead to negative driving behaviors?
- What is the prevalence and impact of intentional misuse of the systems? For example, drivers might be exploring system limits.

Automation: Trust and Acceptance

Trust is an important factor in the context of human-automation interaction. While it affects how a user interacts with a given system, it also influences user acceptance of technology. Many questions surrounding trust and acceptance emerged:

- What are the barriers to the adoption and use of advanced systems? (i.e., trust barriers)
- What is the relationship between trust, comfort and confidence in automated systems?
- What is the long-term impact of these technologies on behavior and trust?
- How often do we encounter edge cases (i.e., situations that automated systems are not equipped to deal with effectively) in normal driving and how do they affect trust?
- What measures can be taken to calibrate driver comfort and choices with the system's capabilities?
- How does user education and training impact trust in the system?
- Given the nature of trust, how can drivers effectively build up enough exposure to systems in order to accurately calibrate their trust? What techniques can be used in experimental settings to evaluate trust (often in absentia of long-term exposure)?
- With respect to user acceptance, how can we make system warnings and feedback feel less punitive and more positively reinforcing?
- How can consumer trust in automation effectively be built?
- How can public acceptance of storing data for research needs be gained?
- How can the dreadfulness of perceived risk be reduced? (e.g., make mishaps more understandable, driver feel more equitable)

Education and Training

Driver education and training as also inexorably linked to user mental models. These topics also engendered much discussion at the forum. While many questions emerged, there were also different schools of thought regarding the overarching philosophy concerning education and training. Some attendees thought that active training would be a fundamental component of future system use while others felt that intuitive and effective system design should readily counter the need to engage drivers in (prolonged) training exercises. Whichever course is likely to prevail—possibly something in between—the following issues emerged:

- Major questions related to training emerged including broad strokes of how? What? Where? And who?

- How can we use simulation to meet the needs of learning the technology and building trust?
- What training/education do drivers need to operate various autonomous levels?
- How much information is needed? That is, can drivers learn to understand their role-appropriate response to technology without needing a detailed description of what the system does?
- In practice, where will training take place and who will administer it? For example, will there be some training criterion prior to taking a new vehicle from the lot?
- What are training priorities?
- What is the life cycle of skill degradation and what approaches can best mitigate it?
- Should training be tailored to a driver's capabilities?
- What are the licensing requirements and/or implications?
- Is a completely intuitive system possible?
- How much training or knowledge is sufficient?
- What are the safety implications of de-skilling?
- If the vehicle is handing over control at the times when demands are too high, are the de-skilled drivers going to be able to act appropriately?
- Whose responsibility does it become to educate users? Should there be some sort of standardization before these safety features make it into vehicles?
- Can we leverage alternative approaches to education/training? For example, video games have a tutorial level that you cannot skip before moving onto the real game.
- What would be the impact of in-vehicle training that is required before activating a system? That is, a system would become enabled once user has completed the required exercises.
- Are videos effective means of conveying system functionality and limitations?
- How can individuals be incentivized to learn how to use technology?
- How can different learning styles be accommodated in the end user population?
- Where are existing education campaigns succeeding? Where do they need improvement?

Mixed Fleets and Infrastructure

Another theme that emerged in the group discussions related to the implications of a mixed vehicle fleet—that is, a fleet that is a mixture of automated or semi-automated vehicles and vehicles that do not have these advanced features and technology. A mixed fleet is seemingly inevitable given the time required for new features to penetrate the market and other related factors (e.g., costs, regulations). Some of the specific questions that emerged were:

- What are the anticipated safety outcomes that result from a mixed fleet (e.g., increased rear end collisions?)
- How do enhancements from automated technologies affect behaviors of pedestrians and other drivers on the road?
- How do risk factors change over time with increases in market penetration?

- Given that automated vehicles generally drive very defensively, how will they react to bullying by drivers of non-automated vehicles? What are the safety implications of this?
- What is the impact of infrastructure degradation on performance and safety of automated systems?
- How do we design infrastructure to accommodate a mixed fleet?
- How will continuous or intermittent software updates for specific vehicles impact the overall system function and coordination? What are the implications of that when we are expecting these autonomous vehicles to talk to each other?
- What about other road users (motorcyclists, bicyclists, pedestrians)?

Design and HMI

The design of systems, including the system interface, has far-reaching consequences and is highly intertwined with other aspects of automated vehicles. In addition to being a focal point for research needs, the design of systems was often identified as a potential solution to some of the other issues that came up. For example, a well-designed and informative interface could effectively deal with some of the issues surrounding inaccurate driver mental models. Questions that were explored included:

- How can we build intuitive systems that do not require a manual?
- What are the roles and safety implications of customizable/adaptable displays or features? This includes but is not limited to machine learning approaches.
- What is the safety benefit of multiple levels of redundancy? How many of layers are necessary? Can you quantify the differences in levels?
- Can geophysical data be used to enhance data systems?
- How do assumptions made by engineers in the design phase percolate into inappropriate system use?
- What is the most effective means of conveying edge cases to drivers?
- How can systems leverage human capabilities to enhance overall system performance and value?
- How can systems handle infrastructure degradation—graceful or otherwise?
- How will new systems and technology change the overall design of the vehicle cockpit and what are the potential safety implications? (e.g., seats that turn around, fully recline)
- To facilitate interactions with other road users, how can systems model human intent?
- How can systems effectively depict the state of complex decision-making processes without overwhelming drivers?
- Is standardization a solution? Is it possible? By what criteria should system designs be evaluated?
- Can system designs afford drivers the opportunities to encounter and understand their functionality in partial-automation situations or otherwise?
- Can simulation be used to effectively train automated vehicles in edge case scenarios?

- What is the role of HMI in the development of driver mental models?

Measurement

The operationalization of performance and safety metrics is an important aspect for many if not all of the research questions raised during the forum. The group discussions also led to some focused questions concerning the types of measures and how they might impact the design and architecture of automated systems. For example:

- What are the most appropriate metrics for real-life misses (i.e., so-called edge cases)? How do we quantify these occurrences?
- How do we measure impaired driving? Which types of sensor offers the most promise (e.g., pupil/eye/face/head tracking, body posture, heart rate)?
- How generalizable are the results of current studies—especially those derived from simulation settings?
- In what ways can the new technologies be leveraged to learn more about drivers themselves? (i.e., can automated systems advance new sources of data regarding driver behaviors and performance?)
- What data comes back to developers/community to improve the technology and the safety?
- Can a complaint database be established?
- Can naturalistic driving data be used to determine what kinds of misuse is occurring? Is there enough data?
- Can an NCAP system be used to evaluate the safety performance of automated systems?
- How can VIN information be improved to facilitate understanding of technology installed in vehicles?

Driver Situation Awareness and Automation Hand-offs

One of the concerns in the advent of automated driving systems is the impact on driver's situation awareness—particularly at lower levels of automation, where the driver still has some role or function in the system. For example, at Level 3, drivers must remain vigilant and be prepared to resume manual control from the automation. However, drivers are not very good at monitoring system status for prolonged periods and are also prone to fatigue and distraction. With this as a backdrop, many research questions followed:

- What state of mind is driver in when they need to gain control of car and how does that impact cognitive and visual abilities?
- When is the driver sufficiently/adequately prepared to take control? What is the appropriate metric for determining driver readiness?
- How can a system keep the driver engaged in the driving task while automation is operating?
- How can systems leverage the driver's sophisticated visual system?

- Level 2 takeover is not discussed as often as Level 3. How big of a problem is the takeover of a Level 2 system? Is there an acceptable duration of takeover?
- What is the prevalence of inattention and distraction while using automated systems? How long are instances of disengagement from monitoring the system under different task and driving conditions?

Driving Populations and Individual Differences

While the issues noted above impact all road users, certain driving populations and subgroups merited special consideration in the course of the discussion. A number of pertinent research needs were identified; however, it is important to note that the demographic issues noted are also implicated in the other research needs.

- How do you target technologies toward a specific age group?
- Who is eligible to drive with ADAS? Can we improve mobility for everyone? (e.g., blind, deaf, physically disabled, mentally challenged)
- How do special populations (elderly, teens, disabled, risk-takers) interpret and use these systems?
- How can we address socioeconomic concerns in the implementation of the technology?
- How do we help teach older drivers how to use this information?
- How do we motivate different driver groups to want to learn this information?
- What are the information or learning needs of different driver subgroups?
- How can the technology be leveraged to meet the needs of novice drivers?

Question 2: How to Address Research Needs

In most cases, the necessary approaches for addressing research needs as well as the stakeholders' were described from a general standpoint (versus linked to a specific question). Different questions, not to mention the availability of resources, will lend themselves to different experimental approaches. Ideally, fundamental questions regarding safety will be amenable to a variety of data sources, approaches and active participants, such that the collective (and hopefully convergent) evidence can be evaluated in context.

Data Types and Source, Approaches

The forum attendees largely agreed that multiple sources of data and experimental approaches are needed in order to address the research gaps, tailoring the approach to the particular question being asked. The listing covered the whole range of available methods, including:

- Naturalistic driving studies
- Analysis of data from Event Data Recorders
    - Fatal crashes, in particular, and other situations

- Observational studies
- Surveys – National, international
- Simulation/simulator
    - Using a simulator to create a wide variety of possible scenarios
    - "Near misses" programmed into the simulation from real-world occurrences
    - Microsimulation
- Closed tracks/environments
- Expert and discussions/agreements
- Longitudinal data

Who? Consortiums and Partnerships

There was also consensus among the group that efforts to address the research needs should include many stakeholders. The involvement could vary from active participation or collaboration, dialogue and sharing of information and ideas, consensus discussions regarding standards and practices, among others. There was support for open and supportive environments for collaboration, including activities such as the current forum. Some of the specific stakeholders included (with some redundancy/repetition):

- Industry: OEMs and technology manufacturers (developers/engineers)
- Academia, graduate programs
- Government (federal/state/local) and policymakers
- Transportation safety professionals
- Marketing and communications professionals
- Driver trainers
- Medical community
- Human machine interface researchers
- Human factors experts
- NHSTA and other agencies
- NGOs
- SAE, TRB
- Nonprofits and advocacy groups
- Constituents, politicians

Question 3: Roadblocks and Barriers

Given the scope and expansive list of the research needs in this domain, it is not surprising that many important barriers were noted by attendees as well. Attempts were made to organize the information into selected themes below:

Technology and Infrastructure

- Keeping pace with technological advances (research lags)
- Lack of technology readily available today for evaluation

- Critical mass of organizations and “automated vehicle readiness”
- Technology cost and scalability
- Impact of market for and prevalence of used cars
- Design cycle that manufacturers go through
    - Do not always get the opportunity to apply human factors principles
- Infrastructure preparedness

Transparency and Data Sharing

- Proprietary and competitive advantages, branding
- Access to algorithms, research-based on assumptions
- Privacy concerns (access to data from driving public), cybersecurity
- Incentivize sharing from OEMs?
- Sharing information regarding ODD
- Reporting of failures
- Knowing how the automation will behave

Data Limitations

- Penetration/low sample
- Sample bias/inability to generalize the data
- Sensors are not advanced enough yet for some measures that systems could benefit from
- Accuracy, validity, and reliability of monitoring systems
- Self-report is subjective, so we need to use objective measures
- Creating the right scenario in a simulator
- VIN shortcomings
    - Modernizing the VIN may be an important federal mandate; NHTSA has a VIN decoder, but it doesn’t have all data because much of that data is proprietary, private-sector data
- Lack of context around AV data (not enough video, other data)
- FARS is collecting information about fatal accidents; are there other elements we want FARS to start collecting?
- Uptake and belief in data/research

Lack of standardization and guidance

- Terminology
- Differences in guidelines between countries
- Categorization, acronyms, etc.
- How information/data is collected
- Performance thresholds
- Voluntary safety testing guidance
- Who can provide trusted certification or rating criteria
- Interfaces

- VIN and build sheets
- Miles to market readiness
- Populations involved in testing of systems
- Measuring system performance. Protocols, qualifications, and criterion? Guidance on what is a proper “safety assessment”
- Collecting and disseminating big data about automation uses appropriately

Acceptance and User Issues

- One big (and adverse) event can slow advancement
- Ability to examine relevant states in safe, ethical settings
- Changing behavior and public acceptance, safety beliefs
- Education for consumers; e.g., how open are experienced drivers going to be on being trained on new technologies?

Closing Remarks

This forum was convened with the aim of fostering discussion among key stakeholders in the research community, government, and industry regarding critical research needs in the area of vehicle technologies and automation. The compilation of research questions and needs above provides a compelling illustration of the breadth of important topics that merit consideration, not to mention the complexity of these human-automation systems. Hopefully this information can inspire interested parties, whether students and academics, research institutions, OEMs or other stakeholders, to pursue answers to some of the questions. Ideally, this information gleaned for their future efforts will become part of our knowledge base, so the benefits can be widely reaped.

While it is important to capture and document this information, it is equally important that these topics and related discussions are dynamic and ongoing. As technology changes and our own knowledge and understanding of the space progresses through new research, so too will our needs change. As such, it is imperative that this report will become a living document that evolves along with the changing technology and research landscape.

Another aim of the forum was to foster and improve coordination and collaboration among stakeholders with the longer-term goal of identifying groups or organizations willing to make future commitments towards one or more research needs. The forum and the discussions that took place in and around it are only the first step. Ideally, the meeting has already sparked some new connections that would not have otherwise happened. Beyond this report, AAA Foundation for Traffic Safety and AAA are working with our partners to promote and advance further venues for keeping the discussion moving forward and, more importantly, turning these discussions into action.

Appendix A: List of Organizations That Participated in the 2017 Forum

AAA Club Alliance
AAA Foundation for Traffic Safety
AAA National
Aimsun
Alliance of Automobile Manufacturers
American Honda
American Occupational Therapy Association
Apple, Inc.
Australian Road Research Board
Brigham Young University
CarProfConsulting
Children Hospital of Philadelphia
Bureau of Transportation Statistics, U.S. Department of Transportation
Drive Smart Virginia
Dynamic Research, Inc.
East Carolina University
Federal Highway Administration (FHWA)
FocusDriven LLC
Highway Safety Research Center
Insurance Institute for Highway Safety
JITSIK LLC
Johns Hopkins University School of Medicine
Lindsey Research Services LLC
Louisiana State University
Massachusetts Institute of Technology
Mazda North American Operations R&D
National Advanced Driving Simulator, University of Iowa
National Highway Traffic Safety Administration (NHTSA)
National Safety Council
National Transportation Safety Board (NTSB)
Northwestern University
Ohio State University
San Diego Associations of Governments
Schepens Eye Research Institute/Harvard Medical School
Stopdistractions.org
Texas A&M Transportation Institute
The Veridian Group, Inc.
Toyota Motor North America
Transport Canada
Transportation Research Board
University of Alabama at Birmingham
University of Alabama in Huntsville
University of Iowa
University of Michigan
University of New Hampshire
University of Utah
University of Virginia
University of Washington
University of Wisconsin
Utah Department of Transportation
Virginia Tech Transportation Institute
Volpe National Transportation Systems Center
Westat
Wichita State University
WSP

Appendix B: Forum Agenda

AGENDA

Wednesday, November 8, 2017

8:30 AM – 9:00 AM
Continental Breakfast

9:00 AM – 10:30 AM
General Session
Small Group Exercise: Group Assignment Discussion
- Research needs & gaps
- Resources to support the necessary research
- Collaboration opportunities

10:30 AM – 10:45 AM
Refreshment Break

10:45 AM – 12:15 PM
Small Group Reports & Feedback from Expert Panel
- Action items
- Next steps

12:15 PM
Forum Adjourns

12:30 PM – 2:00 PM
Optional Activity:
Vehicle "Show and Tell", Rice-Eccles Stadium Parking Lot
AAA Foundation for Traffic Safety commissioned the University of Utah to assess in-vehicle infotainment systems (IVIS) of 30 model year 2017 vehicles. Research results were released publicly on October 5. This optional activity will offer participants the opportunity to experience some of the vehicles that were evaluated. ***This is an outdoor event; please dress appropriately for the weather.***

THANK YOU TO OUR SPONSORS

AAA Public Affairs | The National Advanced Driving Simulator, The University of Iowa | TRB Transportation Research Board

Wi-Fi Access
To access complimentary Wi-Fi during the forum, please follow the instructions below.
- Select the network "UGuest" on the device
- Via the browser, go to utah.edu
- Check "I agree to the Terms & Conditions" and click the gray "Start" button on the bottom right
- Select "Guest Access" for 24 hour access to the Wi-Fi

Shuttle Service
Complimentary Shuttle Service between Stadium and Marriott Salt Lake University Park.

Operating hours as detailed below:

November 7
8:00 AM – 8:45 AM.............................Marriott to Stadium
4:45 PM – 5:30 PM.............................Stadium to Marriott

November 8
8:00 AM – 8:45 AM.............................Marriott to Stadium
12:15 PM – 3:00 PM.............................Stadium to Marriott

AAA Foundation for Traffic Safety | The University of Utah

Welcome to the inaugural Forum on the Impact of Vehicle Technologies and Automation on Users, hosted by the AAA Foundation for Traffic Safety and the University of Utah.

Thank you for being part of this event! As vehicle technologies evolve and we move closer to the vision that future cars will drive themselves, it is critical that the transportation community takes an active and well-considered approach in developing and implementing new technologies and automation.

This forum is bringing together stakeholders from academia, industry and government to discuss and identify the impact 21st century automotive technologies are having on drivers. Additionally, we hope this forum can serve as an incubator for new partnerships and collaboration among participants from various sectors of the transportation community to find ways we can make these technologies even safer and easier to use.

We look forward to your contribution and working with you.

Sincerely,

C. Y. David Yang, Ph.D.
Executive Director
AAA Foundation for Traffic Safety

AGENDA

All sessions and meals will be held in the Scholarship Room with the exception of Wednesday's Vehicle "Show and Tell" (see location details below).

Tuesday, November 7, 2017

8:30 AM – 9:00 AM
Registration and Continental Breakfast

9:00 AM – 10:30 AM
Opening General Session
Welcome & Forum Objectives
David Yang, Ph.D., AAA Foundation for Traffic Research
Cynthia Berg, Ph.D., University of Utah

Panel 1: Vehicle Technologies & Automation
Deborah Bruce, Ph.D., National Transportation Safety Board
Johan Engström, Ph.D., Virginia Tech Transportation Institute
Daniel McGehee, Ph.D., National Advanced Driving Simulator
Chris Monk, Ph.D., National Highway Traffic Safety Administration
David Strayer, Ph.D., University of Utah

10:30 AM – 11:00 AM
Refreshment Break

11:00 AM – 12:30 PM
Facilitated Panel 1:
Vehicle Technologies & Automation Discussion
Facilitator – Tara Kelley-Baker, Ph.D., AAA Foundation for Traffic Safety

12:30 PM – 1:30 PM
Lunch and Networking

1:30 PM – 2:30 PM
Panel 2: Users
Linda Ng Boyle, Ph.D., University of Washington
Donald Fisher, Ph.D., Volpe National Transportation Systems Center
John Lee, Ph.D., University of Wisconsin
Ashley McDonald, PMP, National Advanced Driving Simulator
Michael Regan, Ph.D., Australia Road Research Board

2:30 PM – 3:00 PM
Refreshment Break

3:00 PM – 4:45 PM
Facilitated Panel 2: Users Discussion
Facilitator – Bill Horrey, Ph.D., AAA Foundation for Traffic Safety

Summary of Day 1 and Assignments for Day 2

7:00 PM – 9:00 PM
Forum Dinner at Squatters Pub*
Hosted by AAAFTS and University of Utah
Squatters Pub is located in downtown Salt Lake City at 147 West Broadway (300 South), Salt Lake City, 84010

* Round-trip transportation is available to Squatter's Pub from Marriott Salt Lake City University Park, departing from the hotel lobby at 6:30 p.m. Paid parking is available in a city lot next to Squatter's.