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PAVING THE WAY FOR SELF-DRIVING VEHICLES

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BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

JUNE 14, 2017

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

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PAVING THE WAY FOR SELF-DRIVING VEHICLES

WEDNESDAY, JUNE 14, 2017

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10:05 a.m. in room SR–253, Russell Senate Office Building, Hon. John Thune, Chairman of the Committee, presiding.

Present: Senators Thune [presiding], Wicker, Fischer, Moran, Heller, Inhofe, Capito, Gardner, Young, Cantwell, Klobuchar, Blumenthal, Markey, Booker, Udall, Peters, Baldwin, Hassan, and Cortez Masto.

OPENING STATEMENT OF HON. JOHN THUNE, U.S. SENATOR FROM SOUTH DAKOTA

The CHAIRMAN. Before we begin this morning, our thoughts and prayers are with the members, staff, Capitol Police, and others who were at the congressional baseball practice this morning. Capitol Hill is something of a community, and while details are still coming in, we already know that this despicable act has affected people that we know and their families.

I know that many of us in this room have already sent and/or received text messages or e-mails to and from friends and family that are checking in. So we obviously want to know what happened, but the well-being of our friends and colleagues, especially those wounded, are first in our minds. We're also very grateful to the Capitol Police, who work diligently to protect us and, as I understand, saved many lives this morning.

This morning, we're here to talk about self-driving vehicles. Self-driving vehicles have the potential to make transportation smarter, safer, and more accessible. A little over a year ago, we held the first hearing ever in Congress focusing on this technology and had the opportunity to see some of these new vehicles in action.

Today, we'll be discussing the great potential of this technology, but also the numerous policy questions we will need to address in order to facilitate the testing and safe deployment of these vehicles without delay. Self-driving vehicles are poised to bring enormous disruption to our transportation networks that will improve our lives and our society. Indeed, the CEO of General Motors has said that she envisions more change in the auto industry in the next five years than have occurred in the last 50.

For many Americans, that change can't some soon enough. In 2015, over 35,000 people died in motor vehicle crashes in the

United States, or nearly 100 people per day. That includes car and truck drivers, passengers, motorcyclists, and pedestrians. Worldwide, we lose on average 3,500 people per day.

With more than 90 percent of those deaths attributable to human error, self-driving vehicles—which, after all, can't fall asleep, use drugs or alcohol, or get distracted by texting—have the potential to reduce these tragic numbers dramatically. Drunk driving, in particular, has been a significant challenge, and I appreciate Mothers Against Drunk Driving for being here today to discuss this issue.

Self-driving vehicles also have the potential to improve mobility for many Americans and fundamentally change the way many of us get around. Offering a new means of accessible transportation, including for our nation's seniors, and lessening congestion will improve productivity and efficiency in all of our lives. Strategy Analytics and Intel predict self-driving technology will enable a new global passenger economy worth $7 trillion by the year 2050, representing an incredible transformation of the world economy.

Self-driving vehicles are no longer a dream of science fiction. The stepping stones to self-driving vehicles are already in cars on the road today. Technologies like automatic emergency braking and lane keeping are proving their worth.

While technology challenges still exist, manufacturers are becoming increasingly confident that the technology for fully self-driving vehicles will be ready by 2021, just a few short years away. In fact, just last week, I rode in a Level 3 Audi A7 prototype. The company plans to release a Level 3 vehicle to the public next year.

Manufacturers are asking for regulatory certainty now so that when the time comes, they will be able to deploy these vehicles. These great changes are coming fast, and the Federal Government must be ready to keep pace. As other countries devote significant attention and effort to stimulating this technology, strong Federal leadership will be necessary to maintain our position as a global leader of this innovation. There are several hurdles to achieving this goal, and Senator Peters, Ranking Member Nelson, and I are working together on possible legislative solutions. In fact, just yesterday, we released principles for bipartisan legislation to guide this effort.

The transportation laws and regulations currently on the books did not contemplate the concept of self-driving vehicles. Current Federal motor vehicle safety standards do not address automated technologies, and in some cases directly conflict with them. We are looking for ways to address these conflicts in dated rules without weakening the important vehicle safety protections they provide.

We also must be careful to avoid picking winners and losers in this space. Self-driving vehicles may employ different technologies, and their deployment may follow varying business models. So it is important for Congress not to favor one path before the market figures out what really works best.

While we look for ways to help self-driving vehicles get on the road quickly, we need to make sure that safety remains our number one priority. Industry must find ways to show the technology is safe and reliable to address public skepticism.

The Federal Government must also recognize that it does not have all the answers. Instead, it must seek outside technology ex-

pertise to begin the hard work of updating existing standards and setting new rules. As I've said before, government needs to challenge itself to overcome the traditional 20th century conception and regulation of a car and a human driver.

AVs will, over time, bring changes to jobs, insurance, law enforcement, infrastructure, and many other things we cannot yet foresee. Similar to when the car was first invented, these challenges are not insurmountable. I remain committed to a thoughtful discussion with today's panelists, who share my goal to maintain American innovation leadership and make safety paramount.

I look forward to working with my colleagues on this committee as we move forward with potential legislation, and I now turn to our Ranking Member for the hearing today, Senator Peters from Michigan, for his opening statement.

STATEMENT OF HON. GARY PETERS,
U.S. SENATOR FROM MICHIGAN

Senator PETERS. Thank you, Chairman Thune. It's an honor to be here, and I appreciate the opportunity to sit in for Senator Nelson. Unfortunately, Senator Nelson needed to attend to some other matters and could not be here. But I know he is very much committed to this issue, and I appreciate him working with you, Mr. Chairman, to bring this hearing together.

I also appreciate the opportunity to work very closely with you and your staff, who have been intimately involved in these sometimes very complex issues, to bring this technology forward. I'm looking forward to, hopefully, introducing bipartisan legislation very soon to create a space for this incredible innovative technology to move forward while also being very concerned about safety as we move down that path.

As Chairman Thune mentioned, this technology is without question one of the most transformative technologies to come out of the auto industry probably since the first car came off of the assembly line. I believe it is in every way equal to that innovation, we know what happened when that first automobile came off of the assembly line. It literally transformed America. It created the American middle class. It changed the places where we live, how we get from point A to point B. It created new industries, creating jobs all throughout the economy and driving incredible innovation in the process.

That's going to happen again here at the beginning of the 21st century, and as the Senator representing the great state of Michigan, the center of the auto industry, it definitely brings great pride to me and fellow Michiganders. When we think about this history, it's interesting to think that in the beginning of the 20th century, it was the automobile that really propelled incredible innovation in the economy, and, once again, it's going to be the automobile that moves innovation forward in the 21st century.

I say that because the technology necessary to move these vehicles through a very complex environment on the street with all sorts of potential hazards will mean incredible computer power, particularly developments in machine learning and artificial intelligence, and I look forward to hearing from the panel as to where they see this technology moving beyond automobiles. What is hap-

pening in the auto industry today will have transformative effects in nearly every industry. Certainly, safety is paramount. If we can save the lives of the nearly 40,000 people dying on our highways, that's perhaps the most significant factor of this great technology.

I will have further comments entered into the record, if I may, Chairman Thune, because of my unexpected assuming of this position here with an opening statement. We will have additional comments put into the record.

[The information referred to follows:]

PREPARED STATEMENT OF HON. GARY PETERS, U.S. SENATOR FROM MICHIGAN

When Henry Ford first installed a moving assembly line in a Michigan factory in 1913, he couldn't have predicted how this technology would transform American mobility, help to create the American middle class, create new industries and jobs, and drive innovation for the next several decades. Self-driving vehicles have the potential to be the next transformative technological development in the automotive industry, and perhaps the most significant since the assembly line over 100 years ago. As a senator from Michigan, I take great pride in representing a state that was the center of the automotive revolution in the early 1900s and which promises to be the center of innovation in the self-driving vehicle revolution in the early part of the 2000s.

Self-driving vehicles represent the proverbial "moon shot" of the automotive industry. They have the potential to save tens of thousands of the more than 35,000 lives lost each year on the road, the vast majority of which are caused by driver error. They will provide mobility for those who cannot drive themselves to the grocery store or to a doctor's appointment, greatly improving the quality of life of millions of Americans and making them less dependent on assistance for routine travel. The development of self-driving vehicles will require increases in computing power, development of advanced machine learning and artificial intelligence technologies, and increased cybersecurity. These technologies have the potential to impact a broad number of industries beyond just the automotive industry, and could lead to new products and jobs that we haven't even imagined yet.

I believe that it is critical that we ensure American leadership as the center for automotive innovation in the world. We must act now to solidify our Nation's position as the world leader in the future of mobility. Congress can help by making sure that efforts to develop self-driving vehicles aren't unnecessarily delayed or deterred by regulations that were designed for a different generation of automobiles, while remaining primarily focused on the safety of passengers.

I appreciate the opportunity to work with Senator Thune and his staff on this matter. We plan to introduce bipartisan legislation that will allow self-driving technology to continue moving forward while ensuring that it is done in a safe, responsible, and secure way. The current regulatory regime requires that carmakers certify that their vehicles comply with the Federal Motor Vehicle Safety Standards, which assume the presence of a driver and refer to components like steering wheels, brake pedals, and rearview mirrors—all of which may be unnecessary in a self-driving vehicle. Left unchanged, these standards would make it challenging for manufacturers to test and deploy these potentially life-saving vehicles, threatening America's position as the global leader in automotive innovation.

Yesterday, Chairman Thune, Ranking Member Nelson and I released principles for bipartisan legislation that will address these problems. This legislation will create a space for innovators to develop new self-driving vehicle designs while prioritizing innovation and remaining tech-neutral, allowing for a variety of different forms or technologies in the vehicles of the future. It will remove barriers to development that exist today, while working towards a more comprehensive set of standards as the industry develops and matures. I greatly appreciate the constructive efforts of the Chairman and Ranking Member throughout the process of developing this legislation, and I look forward to its introduction.

A key part of the process of developing new safety standards and industry norms will be research, development, and testing of self-driving vehicles in more realistic environments. This will require proving grounds like the American Center for Mobility in Ypsilanti, Michigan that can simulate the variety of conditions that these vehicles will have to deal with, including busy streets, weather conditions, pedestrians, and more. I believe that public-private partnerships between the Department of Transportation, industry, academia, and proving grounds will help ensure contin-

ued American leadership in innovation while speeding the process of developing safety and testing standards.

America's great innovation engine is poised to lead the world into a new age of mobility with the development of self-driving vehicles. Michigan's automotive manufacturers and suppliers, excellent educational institutions, and now the American Center for Mobility will be at the center of this disruptive technological revolution. I look forward to continuing to work with this committee and Chairman Thune to develop legislation that will help transform mobility and create jobs in Michigan and around the country.

Senator PETERS. I want to take this opportunity to introduce one witness, and then Chairman Thune will introduce the other three witnesses.

As I mentioned, my home state of Michigan is definitely leading the way in innovation, and we have an incredible concentration of both automotive industry manufacturers and suppliers. We have engineering talent and research and development facilities, and I think these are really the focal point of this technological development.

That's why I'm honored to welcome to the Committee Mr. John Maddox, who is the President and CEO of the American Center for Mobility in Ypsilanti, Michigan. This facility is a U.S. Department of Transportation designated automated vehicle proving ground and one that will play an essential role in testing and validating the technologies powering connected and self-driving cars.

John brings a suite of unique experiences to his leadership at the American Center for Mobility. John started his career in automotive safety engineering in NHTSA's Office of Defect Investigation and later served as Associate Administrator for Vehicle Safety Research from 2008 to 2012. Originally from Baltimore, John has strong ties to Michigan, living there with his wife, Magda, and son, Ben, and working at several companies, Ford Motor Company, Volkswagen Group, as well as now at the University of Michigan's Mobility Transformation Center.

John, we're lucky to have you testify today. Because of the expertise of the American Center for Mobility, we'll definitely save thousands and thousands of lives every year and fundamentally change the way we get from place to place in the future. Thank you for sharing your expertise, and I know the entire Committee looks forward to your testimony today.

Thank you.

The CHAIRMAN. Thank you, Senator Peters, and I'll mention the other panelists we have before us today: Mitch Bainwol, who is President and CEO of the Alliance of Automobile Manufacturers, Incorporated; Mr. Rob Csongor, who is Vice President and General Manager of automobile business for NVIDIA Corporation; and Ms. Colleen Sheehey-Church, who is the National President of Mothers Against Drunk Driving.

We want to welcome you all here as well and appreciate you taking the time to inform this committee in our deliberations with your thoughts about this important subject. So we'll start on my left and your right with Mr. Bainwol, and if you could confine your oral remarks to five minutes or as close as possible, that will give us time to ask questions.

So, Mr. Bainwol, please proceed. Welcome.

STATEMENT OF MITCH BAINWOL, PRESIDENT AND CHIEF EXECUTIVE OFFICER, ALLIANCE OF AUTOMOBILE MANUFACTURERS

Mr. BAINWOL. Thank you, Chairman Thune, Senator Peters, and members of the Committee. I testify here today on behalf of auto manufacturers who built 80 percent of the cars on the road today and who are investing billions of dollars in automation.

I've got to confess I'm a bit distracted by the events that occurred earlier. Our thoughts and prayers are with the members and the staff and the security. It puts everything into perspective.

Let me start by commenting on the bipartisan principles. I just want to say thank you. It is a wonderful first start. It frames the debate and the discussion perfectly. So it's a great start and we're heartened by your leadership.

I'd like to make five broad points as this Committee continues its work to craft legislation. Point one: four independent trends are emerging to dramatically reshape mobility as we know it—increase in automation, connectivity, ride sharing, and electrification. The move toward autonomy during this past decade has accelerated, with Driver Assist that offers important automated functionality, like adaptive cruise control and active lane keeping. The more consumers experience Driver Assist, the more they are favorable toward full automation.

Trend two is connectivity, characterized both by growing built-in Internet access, as well as communication between cars and between cars and infrastructure. Trend three is the various forms of ride sharing. While we think of Uber and Lyft, Car2Go, Maven, Chariot, and ReachNow, there are many new entrants in this space, all predicated on the notion that car sharing can be more efficient use of a high-cost asset than personal ownership.

And, finally, the fourth trend is electrification. Electrification has been adopted more slowly than we had expected and environmentalists hoped, but as range increases and battery prices fall, the electric power train will become more competitive. We'll see a tipping point, particularly as business-owned, self-driving ride sharing fleets emerge.

Point two: the future is here but will take time to fully kick in. Few debate where we're headed, but there's significant debate about the length and nature of the journey. The first automated driving system, so-called SAE Levels 1 and 2, are on sale today. Level 3 will be for sale, as Senator Thune indicated, in about a year or so. Introduction of Level 4 probably will begin before 2021, but retail sales to consumers of Levels 4 and 5 is unlikely to occur before 2025.

Given vehicle cost and how long cars last today, about 20 percent of the cars on the road now were built before 2000. AVs are not anticipated to be the majority of the fleet for about three decades, and ubiquity won't come for another 10 years, so 2055, ubiquity. It's equally tricky to predict the percentage of VMT that will be by personally owned vehicles versus ride hailing services, but we know this. Change is coming rapidly.

Point three: AVs will usher in a mobility era of profound social good. Thousands of lives every year can be saved because technology, while never perfect, can correct for human errors respon-

sible for so much loss on our roadways. AVs also offer huge quality of life advantages, access for the disabled and elderly and time saved for everyone. And, crucially, AVs offer massive net economic benefits, lower insurance premiums, lower fuel cost, increased personal productivity, faster commerce, and better land use.

Yes, AVs will generate disruptions and challenges. No transition is ever easy, but accelerating this transition should be our goal.

Point four: the rate of technology innovation is faster than the rate of regulation and also confuses traditional regulatory responsibilities. The last NHTSA administrator, Mark Rosekind, often said government had to be nimble and flexible—he always said nimble and flexible—because the regulatory process could not keep up with technological change, and he was right. The foundation of the Federal AV policy issued last September was fundamentally sound, relying on guidance rather than strict rules and seeking to clarify the division of responsibilities between the Federal Government and the states.

With conventional vehicles, the states regulated the driver and the feds regulated the vehicle. When the car becomes the driver, regulatory chaos ensues. A patchwork of different requirements across states is a recipe for delayed deployment and delayed realization of the enormity of the benefits that autonomy offers. There are now 70 bills in 30 states addressing AVs. So Federal leadership and clear rules are vital.

Fifth and final point: given the enormity of benefit to the social good, the key question for this Committee is how to forge public policy that optimizes the safe deployment of these vehicles. So we have three suggestions toward that end.

First, pass legislation significantly expanding the number of FMVSS exemptions NHTSA can grant to facilitate more robust real-world testing, generating the data necessary to refine the technology before wide scale deployment. Second, pass legislation clarifying Federal versus State responsibilities to foster innovation by creating uniformity through a single Federal framework. And, third, work with DOT to refresh and modernize existing safety standards to remove obstacles to the safe deployment of automated vehicles.

The fact that we're here today having this conversation is tremendously encouraging. Auto makers are eager to work with you to achieve the remarkable public good within our grasp when we combine the brilliance of innovation with responsible and forward-leaning public policy.

I look forward to answering your questions.

[The prepared statement of Mr. Bainwol follows:]

PREPARED STATEMENT OF MITCH BAINWOL, PRESIDENT AND CHIEF EXECUTIVE OFFICER, ALLIANCE OF AUTOMOBILE MANUFACTURERS

Chairman Thune, Ranking Member Nelson, and Members of the Commerce Committee. Thank you for inviting me to testify today on pathways to deployment of self-driving vehicles and related technologies. I am here on behalf of twelve iconic manufacturers who produced 80 percent of the cars now on American roads and are investing billions of dollars annually on R&D to improve fuel efficiency and enhance safety. Self-driving technologies have the potential to do both. I would like to say from the outset that the Alliance and its members are deeply appreciative that this Committee, and its House counterpart, have invested so much time and focus on

the various issues implicated by self-driving cars. We are grateful for your interest in our views and want to continue being collaborative partners in the process.

Although the automotive sector is highly competitive, we are unified in recognizing the transformative impact that self-driving technologies will have on society and the importance of Federal leadership in removing barriers to their safe development and deployment.

Unfortunately, we are all familiar with government statistics regarding highway fatalities: 35,092 people died in traffic crashes in 2015 [1] an increase over 2014. Preliminary results for 2016 show another increase. This is a disturbing trend.

The 2015 increase in fatalities is a 7 percent increase from the prior year. The National Highway Traffic Safety Administration's (NHTSA) early estimates for calendar year 2016 suggest a possible 10 percent increase. These numbers are concerning and warrant attention, especially since 94 percent of car crashes are attributable to human behavior or error (see attached charts). These figures are particularly relevant to today's hearing and the role that self-driving technologies can play in possibly reducing overall crashes and fatalities.

I would like to make five broad points to frame the issue and then close with three recommendations for the Committee to consider as it works to craft bipartisan legislation to help spur additional technological and safety advances.

Point 1—Four trends are merging to dramatically reshape mobility as we know it: increasing automation, connectivity, ride sharing and electrification. These trends are mutually reinforcing but not mutually dependent. The move toward *autonomy* during this past decade has accelerated significantly—with advanced driver assist systems that offer important features—like adaptive cruise control and active lane keeping. Effectively, these technologies have a multiplier impact: the more consumers experience driver assist systems, the more excited they become about the prospect of self-driving technologies.

The Alliance has conducted several public opinion surveys that show the generational shift that is emerging with acceptance of these technologies. A sample is provided below:

What best describes your view about so-called autonomous vehicles that drive for you?

											Assists:		
	All	M	W	GOP	Dem	18-29	30-39	40-49	50-64	65+	0	1	2
Can't wait for this awesome technology	13	16	11	12	15	23	23	9	7	5	10	14	31
Not sure, but keeping an open mind	33	34	31	30	36	39	34	29	30	30	33	32	32
Not sure, but wary of the technology	27	24	31	29	25	19	21	30	35	32	28	29	22
It's a terrible idea	24	24	24	27	21	14	18	30	27	31	26	24	13
Not sure	3												
	-11	-8	-13	-15	-6	+9				-26	-16	-10	+18

Almost two-thirds (62 percent) of those under 29 years of age are open to self-driving technology, including 23 percent who view the technology as "awesome." Only 5 percent of people over 65 years of age think the technology is "awesome," and almost a third believe self-driving technologies are a "terrible idea"—three times higher than the views of those under 29 years of age. But, importantly, experience with driver assists has a profound impact on attitudes. Drivers who have cars with at least two driver assists are dramatically more favorable (63–35) about autonomy than those who have none (43–54). Thus, as these technologies make their way into the national fleet, consumer acceptance will grow materially.

Trend two is *connectivity*—characterized by growing technological capabilities that improve the driving experience, vehicle performance and safety. Trend three is *ride sharing*—and while we think of companies like Uber, Lyft, Car2Go, Chariot, Maven and ReachNow to name a few, there are a huge number of new entrants in this space, all predicated on the idea that in certain instances car sharing and ride hailing is a more efficient use of a high cost asset versus personal ownership. Finally, trend four is *electrification.* Adoption of electrification has been slower than some predicted and other experts hoped—including in California. However, we expect that as range increases and battery costs fall, EV powertrains will become more competi-

[1] NHTSA 2015 Quick Facts

tive with internal combustion engines. Other coming market forces, like self-driving ride share fleets, may further spur electric vehicle deployment. We will see a tipping point—we just do not know when this will occur.

Point 2—For self-driving technologies, *the future is here but will take a while to be fully realized.* Few debate where we are headed. However, there is significant debate about the length and even nature of this journey. Keep in mind, even small introductions of self-driving technologies can reduce fatalities and traffic congestion. The first driving automation systems—so called SAE Levels 1 and 2—are on sale today. Introduction of Levels 3, 4, and 5 self-driving technologies, or Highly Automated Vehicles (HAVs), has yet to begin. Level 3 features, such as automated driving in freeway traffic jams, are expected to be introduced soon, perhaps within a year. Level 4 geo-fenced self-driving vehicles that can only be operated by an Automated Driving System will probably begin around 2021. But, retail sales to consumers of so-called Level 5 vehicles that can operate anywhere a person can drive a conventional vehicle today is unlikely to happen until around 2025 or after. Given how much vehicles cost and how long they last—more than 20 percent of cars on the road today were produced before 2000 [2]—vehicles equipped with Level 5 systems will likely not be a majority of the fleet for three more decades. Ubiquity is not projected to occur for at least four decades largely due to the fact that over 260 million light duty vehicles are registered in the U.S. It is also difficult to predict the percentage of vehicle miles traveled in personally owned cars versus ride hailing services. But we do know this: change is coming—and it is coming rapidly.

Point 3—Self-driving vehicles will usher in a mobility era that offers profound social benefits. Self-driving technologies will potentially save thousands of American lives annually, addressing a large portion of roadway fatalities and crashes associated with human error. Cars with self-driving features also offer huge quality of life benefits—access for the disabled and elderly; time saved by being driven rather than driving so the commuting time can be spent on more productive activities; and the increased freedom that comes from quicker trips due to less congestion. Moreover, these technologies offer massive economic benefits—less congestion, fewer injuries and medical claims, lower fuel costs, increased personal productivity, and better land use. The impact on cities may well be enormous. New communities and municipalities are eager to modernize their mobility patterns and hunger to learn where new mobility options are headed so they can begin the infrastructure build-out that could take a decade to complete. They want to prepare for tomorrow, today. The Commerce, Science and Transportation Committee has a long history of understanding the need for and benefits related to uniformity as a building block for innovation—just look at the railroad, aviation, telecommunication sectors and the Internet—all of which have spurred tremendous innovation, social benefits and U.S. leadership.

Point 4—The rate of technology is faster than the rate of regulation and also confuses traditional regulatory responsibilities. Self-driving vehicle technologies will generate disruptions and challenges; no transition is ever easy. However, this is a transition government and this Committee in particular should seek to accelerate, because the greater societal good is clear.

The last NHTSA Administrator, Mark Rosekind, was fond of saying that government must be nimble and flexible because it is difficult for the regulatory process to keep up with the rapid pace of innovation. Furthermore, not enough data is in hand to initiate the rulemaking process to create new standards for self-driving vehicles. If NHTSA were to prematurely set rules today, it would stifle innovation. The foundation of the Federal Automated Vehicle Policy (FAVP) that the Department of Transportation released last September is sound—relying on overarching guidance rather than rigid rules and seeking to clarify the division of responsibilities between states and the Federal Government. Nevertheless, additional Federal leadership is required here.

With conventional vehicles, the states regulate the driver and the Federal Government regulates the vehicle. This division of responsibility still generally makes sense today for self-driving vehicle technologies, especially since a patchwork of differing safety and performance standards or other impediments from state to state, and even city to city, is a recipe for delayed deployment and realization of the safety and mobility benefits these technologies offer. Take for instance the fact that so far this year, there have been 70 different legislative proposals in 30 states that address self-driving vehicles. As we meet today, the U.S. lacks a critical uniform national framework to advance these technologies as was established before in the development of other key innovations.

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[2] IHS data compiled by the Auto Alliance

Federal leadership and clear rules of the road are essential, especially to underscore NHTSA's authority to issue nationwide safety and performance regulations for motor vehicles. America is the true innovation leader in this field. It is in the national interest to protect that advantage. More importantly, members of the Auto Alliance share the belief that lives could be lost and that safety improvements will be delayed without your help.

Point 5—The key question this Committee must ask—is how to use public policy to optimize the safe deployment of these vehicles and their promise of social good, while continuing to let innovation spur economic growth?

Here are three recommendations:

Recommendation 1: Pass legislation significantly expanding the number and duration of the Federal Motor Vehicle Safety Standard (FMVSS) exemptions NHTSA can grant under the Safety Act. There are existing safety standards that serve as direct barriers to the deployment of self-driving vehicles. Without providing NHTSA expanded authority to grant exemptions from these standards, developers will not be able to deploy the technology at a scale necessary to collect more robust real-world data to inform future regulatory action.

Recommendation 2: Direct NHTSA to collect the data and information needed to promptly refresh and modernize the FMVSS to facilitate the safe deployment of self-driving vehicles. The Agency should commence such rulemaking without delay after the necessary data is collected. The existing FMVSS for conventional vehicles have served the public well. Because they were intended for vehicles with human drivers, however, they are ill-suited for vehicles with self-driving technologies. Alliance members appreciate the need for safety standards and also believe the process to modernize them for self-driving vehicles needs to be informed by data generated from increased exemptions.

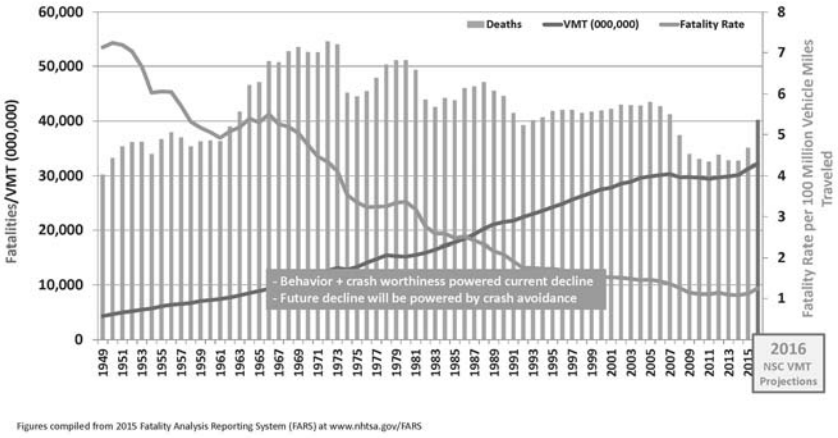
Recommendation 3: Pass legislation clarifying Federal versus state regulatory roles to facilitate innovation and the expeditious deployment of life-saving self-driving technologies. This will provide certainty for all stakeholders in this area and ensure that the United States remains the leader in self-driving innovation.

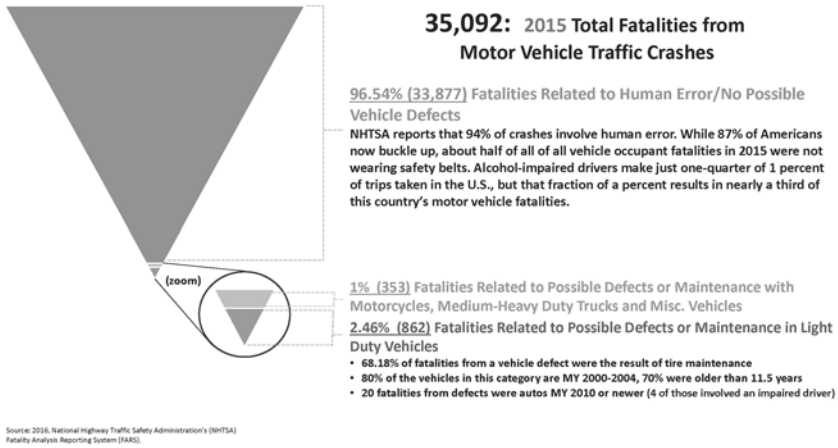
We support Federal clarity that will remove or eliminate impediments to the testing, development, and deployment of self-driving vehicles—particularly any state laws or regulations related to the design or performance of these vehicles. We recognize and continue to support the important role states play in insurance, licensure, and traffic laws and enforcement. However, Congress and this Committee should be aware that state and local laws could still unduly burden or restrict the use of self-driving vehicles in the future.

Providing Federal clarity on rules governing automated motor vehicle design, performance and safety does not mean there will be a vacuum in oversight of the development and deployment of the technology for both automakers and new entrants. NHTSA has broad enforcement authority under existing statutes and regulations to address current and emerging automated safety technologies. As evidence, look no further than the Enforcement Bulletin for Emerging Technologies that NHTSA published in concert with the FAVP last September. That document, which is still operative, outlines NHTSA's authorities and how they apply to self-driving technology including software, hardware, sensors, GPS and vehicle electronics. For example, NHTSA recently used its extensive investigatory authorities with an aftermarket self-driving technology company named—Comma.ai—to ensure it was compliant with regulations before product could be offered for sale.

The fact that we are all here today having this conversation is tremendously encouraging. I would like to reiterate the Alliance's and its members' appreciation of the Committee's work and leadership to date and indicate our eagerness to continue being a collaborative, thoughtful partner. The Alliance and its members look forward to providing constructive feedback on your ideas with a view towards passing bipartisan legislation. We can achieve remarkable public good when we marry the brilliance of innovation with responsible and forward leaning public policy.

Thank you and I look forward to answering your questions.





The CHAIRMAN. Thank you, Mr. Bainwol.

Mr. Csongor?

STATEMENT OF ROB CSONGOR, VICE PRESIDENT AND GENERAL MANAGER OF AUTOMOTIVE BUSINESS, NVIDIA CORPORATION

Mr. CSONGOR. Thank you, Chairman Thune, Senator Nelson, distinguished of the Committee—I'm sorry, Senator Peters. My name is Rob Csongor. I'm Vice President and General Manager of NVIDIA's automotive business.

NVIDIA is one of the world's leading computer technology companies. We're headquartered in Silicon Valley with more than 10,000 employees across the country and worldwide. I appreciate your invitation to give testimony today on the important subject of

self-driving. In particular, I'm grateful for the opportunity to introduce you to the breakthrough work NVIDIA is doing in artificial intelligence.

Along with hundreds of our partners, we believe AI is the new computing model, the game changer that makes autonomous vehicles possible. By understanding how AI works, we can achieve better regulatory decisions and accelerate our progress to what we all want, deployment of safe, self-driving vehicles that will save lives.

NVIDIA's computer innovation is focused at the intersection of visual processing, high-performance computing, and artificial intelligence. It's a unique combination that's at the heart of the world's next-generation computer systems. This new form of computing is based on our invention of the GPU, or graphics processing unit, nearly two decades ago. The GPU was originally designed to power computer graphics, but it has evolved into a powerful computer brain that processes massive amounts of data at extraordinary speed.

Ten years ago, researchers began to use GPUs to accelerate mathematically intense applications, such as mapping the human genome and predicting weather. More recently, scientists working in a new field of AI called "deep learning" discovered that GPUs are critical to creating algorithms that enable computers to learn from experience and data, similar to how the human brain works. In a short period of time, AI algorithms rapidly outperformed code written manually by programmers.

As a result, deep learning has become a strategic imperative across many industries. Consumer services from companies like Google, Amazon, Microsoft, and Facebook powered by our technology are now available to millions. In the healthcare industry, AI is accelerating the search for cancer cures. For scientists and researchers, NVIDIA delivers supercomputing solutions used at the Department of Energy, the Department of Defense, the National Institutes of Health, among other organizations.

The automotive world is next. A self-driving car is an immense computational challenge. The car must be able to detect and perceive objects everywhere around it in motion and in diverse weather and lighting conditions. The car must determine its precise position, plan safe paths from one point to another, and then drive while navigating complex situations such as construction zones. We simply cannot get there with conventional programming science. AI technology can solve these problems.

To this end, NVIDIA has created an open computing platform comprised of powerful processors which are optimized for AI in both the car and the data center. In addition, NVIDIA is developing a full open software stack that the automotive ecosystem can build around.

Today, we are working with virtually every automaker on research and development of advanced self-driving vehicles using AI. Our technology is being used by more than 225 automotive companies worldwide, including Audi, Tesla, Toyota, Volvo, Mercedes, and others. The Audi A7 that you took a ride in, Senator Thune, is based on our technology.

We're now at the point where we can create AI systems that have levels of perception and performance far beyond humans and,

importantly, do not get distracted, fatigued, or impaired. Much like humans gain knowledge through a lifetime of experience, AI systems improve over time with additional training data and testing.

An AI system works by training a deep neural network with large amounts of data in a data center, monitoring and testing accuracy. Once validated, the car is updated with new algorithms over the air, like any modern computer or mobile device. The car runs the algorithms on real road conditions. The results are then sent back to the data center, where the new data can be used to retrain and improve the algorithms. And then the cycle continues, making the entire fleet better with each iteration.

Our methodology along with our partners will combine multiple layers of testing in a data center, on proving grounds, and on public roads. In addition, leveraging NVIDIA's experience in visual computing, we can use computer simulation to accelerate the training and testing process.

So, in conclusion, we believe new regulations are necessary, but, clearly, there are opportunities to streamline development and testing. Ideally, we would be able to test cars and collect diverse data from any state. The patchwork of different regulations across regions hampers that. It would be enormously beneficial to have a unified set of regulations across all states.

It would also be constructive to ensure the standards for compliance are set correctly. The bar we are comparing against is a human driver. A system that is significantly safer than a human driver can save lives once deployed. Conversely, unrealistic compliance targets runs the risk of costing lives. And, finally, the deployment of a fleet on real roads collecting lots of data is the path to achieving safety for the entire fleet.

Self-driving holds the promise to change our lives. Through our inventions, our research, and the incredible work of development partners innovating on our technology, NVIDIA believes this promise is achievable. We look forward to working with this committee, the Department of Transportation, NHTSA, and other groups to ensure the safe deployment of autonomous vehicles through game-changing technology paired with effective policy and regulation.

Thank you for the opportunity to tell you of our work.

[The prepared statement of Mr. Csongor follows:]

PREPARED STATEMENT OF RON CSONGOR, VICE PRESIDENT AND GENERAL MANAGER OF AUTOMOTIVE BUSINESS, NVIDIA CORPORATION

Thank you, Chairman Thune, Senator Nelson and distinguished members of the Committee.

I appreciate your invitation to give testimony today on the important subject of self-driving vehicle technology.

My name is Rob Csongor. I am vice president and general manager of NVIDIA's Automotive business. NVIDIA is one of the world's leading computer technology companies, headquartered in Silicon Valley, with more than 10,000 employees around the country and the world.

NVIDIA is focused on computer innovation at the intersection of visual processing, high performance computing, and artificial intelligence or AI—a unique combination at the heart of the world's next-generation computer systems. Our work has pioneered a supercharged form of computing relied on by the world's most demanding computer users including scientists, engineers, designers, and artists.

This form of computing is based on our invention nearly two decades ago of the GPU or graphics processing unit. The GPU was originally designed to power com-

puter graphics, the pixels on our computer screens, but it has evolved into a powerful computer brain that processes massive amounts of data at extraordinary speed.

Ten years ago, researchers began to use GPUs to accelerate mathematically intense applications, such as mapping the human genome and predicting weather. More recently, scientists working in a new field of AI called deep learning, discovered that GPUs are critical to creating algorithms that enable computers to learn from experience and data, similar to how the human brain works. In a short period of time, AI algorithms rapidly outperformed code written manually by programmers. As a result, deep learning has become a strategic imperative for companies across many industries.

Google, Amazon, Microsoft, and Facebook use our AI technology in thousands of consumer applications. In the healthcare industry AI is accelerating the search for cancer cures. For scientists and researchers, NVIDIA delivers supercomputing solutions used at the Department of Energy, the Department of Defense, and the National Institutes of Health among other organizations. Our nation's fastest supercomputer, at Oak Ridge National Lab, is powered by over 18,000 NVIDIA GPUs. And we are working with them to upgrade the system later this year to our newest processors, which should help the United States recapture the title of the world's fastest supercomputer.

Self-driving is an immense computational challenge. The car must be able to detect and perceive many objects, determine its precise position, plan safe paths from one point to another, and then drive while navigating complex situations. AI is the new breakthrough in computing that can solve these problems, and NVIDIA is focused on delivering this technology.

To this end, NVIDIA has created an open computing platform comprised of powerful processors in both the car and the data center, as well as a full, open software stack that carmakers and the ecosystem are building on.

Today, we are working with virtually every automaker on research and development of advanced self-driving vehicles using AI. Our technology is being used by more than 225 automotive companies worldwide. Audi, Tesla, Toyota, Volvo, and Mercedes have announced they will deploy vehicles using our technology.

We are now at the point where we can create AI systems that have levels of perception and performance far beyond humans, and importantly, do not get distracted, fatigued or impaired.

Much like humans gain knowledge through experience, AI systems improve over time with additional training data and testing.

The ability to create and test new features and functions, then securely update the car over the air like a smartphone or personal computer, enables us to quickly provide cars with safer algorithms and add more autonomous capabilities once they are proven.

Borrowing from our expertise in visual computing, we can use computer simulation to test challenging conditions like snow or blinding sun, as well as potentially hazardous situations without putting anyone in harms way. Our methodology, along with our partners, will combine multiple types of testing—in a data center, on proving grounds, on the road, and in computer simulations.

While we are working with our partners in industry to develop these technologies, NVIDIA looks forward to working with this Committee, the Department of Transportation, and NHTSA to ensure the safe deployment of autonomous vehicles.

With safety as the top priority, we believe new regulations are necessary. But we also believe there are opportunities to facilitate development and testing for companies developing these solutions. Safe, robust AI algorithms are improved through the collection of large amounts of data. Ideally, we would be able to test fleets across all states with their diverse driving conditions. A patchwork of different regulations in different regions hampers development and progress. It would be enormously beneficial to have a unified set of regulations across all states.

Together, as industry and government, we will work to safely and expeditiously bring autonomous vehicles to market and realize their enormous benefits: saving lives, improving traffic flow, increasing productivity, and providing mobility to the elderly, the blind and others who do not have it today. We are committed to this important mission and to driving the safe development and deployment of autonomous vehicles in the United States and the world.

Thank you for your time and consideration. I look forward to answering any questions.

The CHAIRMAN. Thank you, Mr. Csongor.

Next up is Ms. Sheehey-Church.

STATEMENT OF COLLEEN SHEEHEY-CHURCH, NATIONAL PRESIDENT, MOTHERS AGAINST DRUNK DRIVING

Ms. SHEEHEY-CHURCH. Thank you. Good morning, Chairman Thune, Senator Peters, and members of the Committee. On behalf of millions of drunk driving victims across the country, thank you for the opportunity to testify today and really be a witness on the critical issue of self-driving cars. You and the Committee are to be commended for your leadership on highway safety.

Like so many others before me, I came to Mothers Against Drunk Driving after my 18-year-old son, Dustin, was killed by a drunk and drugged driver. Dustin was sober. Dustin was wearing a seatbelt while riding in the back seat of a car. That vehicle crashed, went airborne, flew in the air and landed in the Connecticut River. Dustin could not escape and drowned on July 10, 2004. It was a senseless death and a 100 percent preventable crime.

Dustin's story is my story. But it does represent thousands and thousands of stories of victims and survivors in every state in the country. MADD has changed the culture. In 1980, over 51,000 people were killed on America's roadways, and over 20,000 people were killed each year due to drunk driving.

Since then, MADD has worked to pass tough drunk driving laws in all 50 states and at the Federal level. The 21 drinking age, a national .08 standard, zero tolerance laws for underage drivers, and ignition interlock laws are just a few of the things that we have achieved together since 1980.

Total traffic deaths in 2015 were over 35,000. This was an increase of 7.2 percent over 2014 and represented the largest increase in 50 years. Unfortunately, preliminary numbers for 2016 show another substantial increase in traffic deaths. That alone must serve as a wake-up call to the Nation.

According to the National Highway Safety Administration, 94 percent of traffic deaths occur because of human behavior. That means that 33,000 deaths occurred in 2015 due to the driver. Many, if not all, of these were preventable. It breaks my heart to deliver messages like that.

In 2006, MADD launched a new initiative called the Campaign to Eliminate Drunk Driving, and I know that our goal is ambitious, but to literally eliminate drunk driving in America. Our campaign is based on four prongs: number one, to support our law enforcement; number two, to have ignition interlocks for all convicted drivers; number three, the development of advanced vehicle technologies; and, four, grass root support for all these efforts. That third initiative, that third prong, is why I'm here today to witness.

We have been pleased to work with this Committee in support of the Driver Alcohol Detection System for Safety, also known as DADSS, and progress has been steady, and I would ask this Committee to help expedite DADSS by encouraging program partners to have the technology ready for vehicle integration as soon as possible. But today, I'm here to be a witness on AVs.

Autonomous vehicles represent the other technology that actually presents an enormous potential to eliminate drunk driving and other behavioral traffic deaths. MADD strongly supports this technology and hopes it will begin as soon and as safely as possible.

But I need to be clear. MADD is not an expert on the intricacies of the technology. My panelists are. But we are absolutely a huge stakeholder. Technology will ultimately be the way we eliminate drunk driving. Autonomous vehicles are vital in helping us achieve our goal.

There are some principles that MADD recommends as Congress and the administration address this issue. Number one, support Federal regulatory framework. It doesn't make sense for states to pass laws or to regulate the safety of autonomous vehicles. It is critical that the Congress and the administration provide the necessary guidance and regulations to the autonomous vehicle community in order to allow a very safe national roll-out.

Number two, support existing state regulatory systems. The state role in autonomous vehicles is to continue what they do for conventional vehicles today—titling, registration, insurance requirements. The states should not regulate AV safety because they lack the technical expertise to do so.

Number three, we support Level 4 and 5 autonomous technologies. For MADD's purposes, it is important that these vehicles achieve the Level 4 and 5 automation to ensure drunk drivers are separated from driving the vehicle.

Number four, supporting and evaluating the technology as it evolves over time. NHTSA's Autonomous Vehicle Policy—this data can be used to enhance the safety benefits of the technology.

In closing, I thank you for the opportunity to testify before this Committee. The promise of safe self-driving cars is very exciting, particularly for those of us who have seen the devastation that human error in driving can bring. I urge the Committee to hold a hearing on the need to address the increase in traffic fatalities and work with the Safety Committee and NHTSA to put these words into actions, and I look forward to working with this Committee on the issue and answer any questions later.

[The prepared statement of Ms. Sheehey-Church follows:]

PREPARED STATEMENT OF COLLEEN SHEEHEY-CHURCH, NATIONAL PRESIDENT, MOTHERS AGAINST DRUNK DRIVING

Chairman Thune, Ranking Member Nelson, and Members of the Committee,

On behalf of millions of drunk driving victims across the country, thank you for the opportunity to testify before the Senate Commerce Committee on the critical issue of self-driving cars. We were pleased to work with you and the Committee on the FAST Act. You and the Committee are to be commended for your leadership on highway safety.

Like so many others before me, I came to Mothers Against Drunk Driving after my 18-year-old son Dustin was killed by a drunk and drugged driver. Dustin was sober and wearing a seatbelt while riding in the back seat of a car. The vehicle crashed and flipped into the Connecticut River. Dustin couldn't escape and drowned. It was a senseless death and a 100 percent preventable crime.

Dustin's story is my story. But it represents thousands and thousands of stories of victims and survivors in every state in the country. I travel to those states and talk to those who suffer. . . and there is one thing that each of them wants . . . NO MORE VICTIMS.

In 1980, a bereaved mother who had lost a child to the needless crime of drunk driving decided enough was enough. Together with a group of other moms, she formed Mothers Against Drunk Driving to tell the country that drunk driving is not a joke, it is a crime. Together with thousands of other victims, the public and law makers heard our plea and as a result, laws and attitudes were changed.

Changing the Culture

We changed the culture. In 1980, 51,091 people were killed on America's roadways and over 20,000 people were killed each year due to drunk driving. Since then, MADD has worked to pass tough drunk driving laws in all 50 states and at the Federal level. The 21 minimum drinking age, a national .08 BAC standard, zero tolerance laws for underage drivers, and ignition interlock laws are just a few of the things we have achieved together since 1980.

As a result, drunk driving deaths have been cut in half since our founding. That's what culture change and tough laws have achieved, but it's not nearly enough. Thirty-seven years after MADD taught the Nation it is not acceptable to drink and drive, one third of all traffic deaths, over 10,000 people, are caused because of drunk drivers.

Total traffic deaths in 2015 were 35,092. This was an increase of 7.2 percent over 2014 and represented the largest increase in 50 years. Preliminary numbers for 2016 show another substantial increase in traffic deaths.

This must serve as a wakeup call to the Nation.

According to the National Highway Traffic Safety Administration, 94 percent of all traffic deaths occur because of human error. That means about 33,000 deaths occurred in 2015 due to the driver. Many if not all of these were preventable.

Campaign to Eliminate Drunk Driving

In 2006, MADD launched a new initiative called the Campaign to Eliminate Drunk Driving. Our goal is ambitious, to literally eliminate drunk driving in America so there are no more victims.

Our Campaign is based on four prongs: support for law enforcement, ignition interlocks for all convicted drunk drivers, development of advanced vehicle technologies, and grassroots support for these efforts.

The third initiative, advanced technology, is why I'm here today.

In 2008, NHTSA and the Automotive Coalition for Traffic Safety (ACTS) formed an ambitious program called the Driver Alcohol Detection System for Safety, or DADSS. DADSS seeks to create a passive in-vehicle alcohol detection system which would prevent an impaired driver at .08 or higher from starting his or her vehicle. The Insurance Institute for Highway Safety has estimated that the DADSS technology could save 7,000 lives per year. We were pleased to work with you and the Committee through MAP–21 and the FAST Act to authorize this technology. Progress has been steady and I would ask this committee to help expedite DADSS by encouraging program partners to have the technology ready for vehicle integration by the end of the FAST Act authorization in Fiscal Year 2020.

Autonomous Vehicles

Autonomous Vehicles represent the other technology that presents an enormous potential to eliminate drunk driving and other behavioral-related traffic deaths. MADD strongly supports this technology and hopes it will begin as soon and as safely as possible.

Let me be clear, MADD is not an expert on the intricacies of this technology, but we are absolutely a stakeholder. Technology will ultimately be the way we eliminate drunk driving autonomous vehicles are vital in helping us achieve our goal.

There are some key principles that MADD recommends as Congress and the administration address this issue:

Support Federal regulatory framework. It doesn't make sense for states to pass laws or regulate the safety of autonomous vehicles. It is important that the playing field be level and states should leave the self-driving car safety issues to the automotive safety experts at the federal level. To that end, it is critical that the Congress and/or the administration provide the necessary guidance and regulations to the autonomous vehicle community in order to allow a national roll-out of this technology. Emphasis must be placed on ensuring that the technology is safe, and that processes are followed to ensure that rigorous safety standards are followed, and that effective methods for educating the public on technologies are developed. We believe the DOT/NHTSA Autonomous Vehicle Policy issued last year is a good beginning for providing safety guidance to those companies developing Highly Automated Vehicles. MADD and others in the traffic safety community look forward to working with the Committee to help ensure that public safety is of the highest priority, that the development of the technology continues at a rapid pace, and that future public acceptance comes to fruition.

Support existing state regulatory system. The state role in autonomous vehicles is to continue doing what they do for conventional vehicles today. This includes titling, registration, insurance requirements, etc. States should not regulate the safety of autonomous vehicles because they do not have the technical expertise to do so and

their involvement could hinder the technological progress in the deployment of this life-saving technology.

Support for level four and five autonomous technologies. For MADD's purposes, it is important that vehicles achieve level four and level five automation (*i.e.,* vehicles that do not require a human driver in at least certain environments or under certain conditions). Drunk driving is arguably the biggest killer on our roadways. Alcohol and drug impairment have lasting effects, so it is imperative for maximum safety that the car be able to completely take control and remove the driver from driving.

Support for evaluating the technology as it evolves. The Autonomous Vehicle Policy includes provisions for recording and sharing information on system capabilities and data on events, incidents, and crashes. These data can be used to enhance the safety benefits of the technology and should be standardized, anonymous, absent of propriety information, and made available not only to the Federal Government but also to states, researchers, and the public.

Closing

In closing, thank you for the opportunity to testify before this committee. In the last two years, traffic deaths have seen the largest increases in 50 years. This should alarm us all. While great progress has been made in reducing traffic deaths, over 35,000 people died in 2015. This is unacceptable. The promise of safe, self-driving cars is very exciting, particularly for those of us who have seen the devastation that human error and driving can bring. I want to add, however, that we must not sit back and wait for technology to solve the public health epidemic on our roads. There are actions we can take today, this month, this year that will make an enormous impact and save lives. I urge the Committee to hold a hearing on the need to more aggressively address the increase in traffic fatalities, and work with the safety community and NHTSA to put words into action.

Longer-term, Autonomous Vehicle technology provides the opportunity to eliminate traffic deaths, including drunk driving fatalities. There is a major role for the Federal Government to play in ensuring that these vehicles are safe. It is also important to create a national regulatory framework to ensure that the technology can move forward and build public support.

MADD will continue to strongly support the safe development of this technology and work to build public acceptance for the adoption of autonomous vehicles so that people understand the safety benefit of these cars with regard to behavioral safety.

Thank you again for including MADD in this panel. I look forward to working with this committee on this issue and am happy to answer any questions you might have.

The CHAIRMAN. Thank you, Ms. Sheehey-Church, for sharing a deeply personal and painful experience and your effective advocacy.

Ms. SHEEHEY-CHURCH. You're welcome.

The CHAIRMAN. Mr. Maddox?

STATEMENT OF JOHN M. MADDOX, PRESIDENT AND CHIEF EXECUTIVE OFFICER, AMERICAN CENTER FOR MOBILITY

Mr. MADDOX. Good morning. Thank you, Chairman Thune, Ranking Member Peters, for your interest in automated vehicles and your leadership on this issue, and I certainly thank you for the opportunity to speak in front of you today about key steps for creating a much safer and more efficient transportation system for the United States of America.

The American Center for Mobility is a nonprofit public-private partnership. That's a mouthful. We are building a world-leading facility for innovation, testing and product development, and to act as a national proving ground for automated vehicles in Ypsilanti, Michigan.

First and foremost, we are focused on safety, on public safety, including testing and validation of these technologies, including vehicles and infrastructure. In addition to testing, our mission is to accelerate the development of standards, voluntary and Federal regu-

lation, that is, and to provide educational opportunities for the workforce of the future, for STEM K–12 programs, and the public, in general.

Our past transportation system has served us well over the last 100 years but is showing signs of strain. Every year, we endure a national tragedy of tens of thousands of Americans, individuals, losing their lives on our roads in the United States. That's the numerical equivalent of 10 September 11 attacks or seven Iraq wars every year on our soil. In many cities, we see ever-increasing congestion with accompanying loss of productive time, loss of time, wasted energy, and unnecessary greenhouse gas emissions. Largely, we have come to accept these as the status quo.

It is clear we need a significant change in our transportation system going forward, and safety must be everyone's first focus. My colleagues and the Chairman have cited the statistics. I won't do that again. But it is clear that this technology can help by reducing human error. In addition, transportation really is the lifeblood of our economy and our society. The ability to move people efficiently and goods is critical to the social and economic well-being of the U.S. and will help us remain competitive with other international economies.

Because of this promising safety potential and economic benefit, the U.S. should focus clearly and specifically on developing and deploying connected automated vehicle technology in a responsibly expedient manner. AV technology is being developed very rapidly by industry, as we know, but also aided by key frameworks and research from government and academia. Other countries, including China and the EU, are currently working on HAV programs, very significant programs.

Our voluntary standards have proven to be a key early step in the development of almost every safety technology. These voluntary standards often form the basis for Federal FMVSS; therefore, it is critical to accelerate voluntary standards in order to ensure safe deployment of HAVs. SAE International—the Society of Automotive Engineers International—has begun to promulgate basic standards, but many additional voluntary standards are needed immediately, including scenario catalogs, test procedures, mapping, labeling, cybersecurity, to name a few. The complexity of AV technology will require innovative thinking for testing simulation, validation, and certification tools to support these vehicles and infrastructure.

Voluntary standards must also be accelerated for purposes of avoiding a patchwork, as even a small number of differing or conflicting regulations would significantly inhibit the development of AV technology. Consumers' interests would not be served if they could not operate their vehicle or share a vehicle across state lines. Certainly, differing standards would put the U.S. in a compromised position compared to other countries and regions around the world.

It may be prudent to consider the adoption of a Federal FMVSS framework standard that establishes key foundational requirements, such as definitions, manufacturer identification, reporting processes, et cetera; however, it is too early to promulgate detailed vehicle performance or equipment standards as the needed technical requirements to do so are not sufficiently developed, and, cur-

rently, there is no agreement within the technical and stakeholder community on the nature or specifics of such requirements.

U.S. DOT's Automated Vehicle Proving Ground Program, AVPG for short, is important to the safe development of HAVs. The AVPG program with 10 designated sites across the United States provides key infrastructure and framework for the development of AV tools, products, standards, data sharing in a rapid and collaborative fashion. These proving grounds can form the backbone of the Federal Government's framework for supporting HAVs. This program will be a critical asset to ensure the focus on safety in HAVs while ensuring the U.S. remains competitive.

The need for HAV data collection will continue after initial deployment, and exemptions are important to allow that data generation. According to U.S. DOT, a number of existing FMVSS contain requirements that conflict with or do not allow basic HAV design. In order to enable early product development and regulatory data gathering and to enable HAVs, in general, it's important that Congress and the U.S. DOT review that authority and implement a solution for exempting compliance of a sufficiently substantial number of vehicles. It does remain imperative for HAVs that the petitioner demonstrate that the exempted vehicle provides an equivalent level or better of safety through sufficient data and analysis.

In closing, I'd like to offer three recommendations. One, that U.S. DOT be authorized and funded to create collaborative voluntary industry standards to support safe deployment. Two, the AVPG program should be funded as important infrastructure for HAVs. And, lastly, Congress should consider revising NHTSA's exemption authority and ensuring appropriate FTE head count to implement these key programs.

I appreciate this opportunity and look forward to your questions. Thank you.

[The prepared statement of Mr. Maddox follows:]

PREPARED STATEMENT OF JOHN M. MADDOX, PRESIDENT AND CHIEF EXECUTIVE OFFICER, AMERICAN CENTER FOR MOBILITY

On behalf of the American Center for Mobility, it is an honor to provide testimony about the future of automated vehicle (AV) and transportation technology, and key steps for creating a much safer and more efficient transportation system.

This testimony will focus on the need to maximize the benefits of new transportation technologies for the United States, while ensuring safe deployment on public roads. It will explain how voluntary standards inform Federal regulation, and how these can be accelerated through coordinated industry and government collaboration, including the USDOT Automated Vehicle Proving Ground (AVPG) Program. It will also describe the need for new tools and data, including practical flexibility in the NHTSA Part 555 exemption program to enable the near-term development and long-term deployment of these safety-beneficial highly automated vehicle (HAV) technologies.

The American Center for Mobility is a non-profit public/private partnership. We are building a world-leading facility for innovation, testing and product development, to act as a national proving ground for future mobility. First and foremost, we are focused on public safety, including the safe testing, validation, and self-certification of connected and automated vehicle and infrastructure mobility technology. In addition to testing, our mission is to accelerate the development of standards, and to provide educational opportunities. ACM incorporates a purpose-built test track environment directly integrated with active on-road highway corridors, simulation laboratories, and a combined corporate/academic technology park campus to facilitate effective industry, government and academic collaboration and information sharing, as well as a focus on educating the mobility workforce for the future, STEM K–12 programs, and educating the public in general.

It is clear we need a significant change in our transportation system.

Our past transportation system has served us well over the last 100 years, but is showing signs of strain. Every year we endure a national tragedy of tens of thousands of Americans losing their lives on our roads, in urban, suburban, and rural areas. That is the numerical equivalent of over ten *September 11 Attacks,* or seven *Iraq Wars,* every year. In many cities, we see ever-increasing congestion, with accompanying loss of productive time, wasted energy, and unnecessary greenhouse gas emissions. Largely we have accepted these undesirable outcomes as the status quo. It is clear we need a significant change, and we are now on the cusp of introducing connected automated vehicle (CAV) technology that can begin that change.

Safety must be everyone's first focus. NHTSA's census of fatal car crashes[1] shows that 35,092 people lost their lives in 2015. Historically, human error or actions account for, or contributed to, 94 percent of these fatal crashes.[2] By reducing the effects of human error, connected and automated vehicles have the promising potential to reduce or even eliminate these fatal outcomes by avoiding the crash scenario altogether.

Because of promising safety potential, the United States should focus on developing and deploying CAV technology in the most responsibly expedient manner possible.

Transportation is the lifeblood of our economy and society. The ability to efficiently and effectively move people and goods is critical to the social and economic well-being of the United States, and will help us remain competitive with other international economies. The United States covers a very large geographic area, and part of our industrial and economic strength is that we can transport people and goods across that large area in a safe, efficient, and economical manner. In addition to safety benefits, CAV technology provides the opportunity for a "systems approach" to transportation, with substantial potential improvements in mobility, energy use, equity in transportation, and positive impact on the Nation's economy.

AV technology is being developed very rapidly, largely led by industry, but aided by key frameworks, research, and support from Government and Academia. While we have one hundred years of experience with human-driven vehicles, we need to gather experience and data with automated vehicles in a much shorter timeframe. Inherently, automated vehicles will be data-rich due to the basic operational need to sense, analyze, and act on data that is generated continuously through operation. We need the initial experience of operating these vehicles in sufficiently substantial numbers to generate the broad data across a multitude of scenarios and environmental operating conditions necessary to ensure safety, and to scale the technology to full deployment.

Over the last decades, automotive safety technology has progressed significantly, and that progression has resulted in the savings of hundreds of thousands of American lives.[3] The development and introduction of each technology has required a very thorough engineering process, including research, testing, product development, verification, validation, standardization, certification, education, and in-use monitoring. Even the simplest of technologies, the seat belt, was conceived, designed, and introduced through this phased process. Many safety technologies developed by industry and government through this process have become mandated through regulation by Federal Motor Vehicle Safety Standard (FMVSS).

Modern safety technologies have become more and more complex. Airbags and Supplemental Restraint Systems (SRS), Automatic Braking Systems (ABS), Electronic Stability Control (ESC), Forward Crash Warning (FCW), Lane Departure Warning (LDW), Crash Imminent Braking (CIB), and Vehicle-to-Vehicle Communication (V2V) have required ever-greater developmental efforts, and are subject to factors outside the control of the vehicle alone. However the basic engineering processes listed above have proven capable of developing these systems to an extremely robust level that is befitting of a life-saving technology. AV technology will likely be the most complex automotive safety innovation yet deployed, however the basic process honed over the last decades will serve as a capable and required starting point.

Voluntary standards have proven to be a key step in the development of all of these safety technologies. Industry and Government research and testing generate the basic scientific and technical knowledge for a new technology. This leads to standardization of key definitions, designs, test procedures, validation models and methods, and certification protocols that enable a new technology to be commercialized. Often, these become codified in voluntary industry standards, such as by SAE International and other Standards Development Organizations (SDOs). Occasionally, but often for safety technologies, these voluntary standards form the basis for Federal regulations as codified by FMVSS, as shown in Figure 1.

Figure 1. safety technology standards development process

It is critical to accelerate voluntary standards in order to ensure safe deployment of AVs.

AV technology is being developed and is advancing at a faster rate than the traditional standards process can fully accommodate. SAE international has begun to promulgate basic standards, such as taxonomy and definitions, which have already served as the basis for the Federal AV Guidance. Additional voluntary standards are needed immediately to ensure that these new approaches in testing, validation, data collection, data-sharing, privacy, cybersecurity, and others areas are developed to ensure safety, while not inhibiting or stalling the technology development. These standards will also likely form the technical basis for future FMVSS requirements for vehicle performance or equipment.

It is critical to accelerate these voluntary standards in order to ensure safe deployment of AVs. From now through 2025, AV development will continue to move very rapidly, and initial voluntary standards must be in place by that time-frame to support the first significant vehicle deployments. Other countries and regions, including China and the European Union, are funding and working diligently on standards efforts to support their deployments and industry partners. The complexity of AV technology will require innovative thinking for testing, simulation, validation, standardization, and certification tools and methodologies to support these standards.

Voluntary standards must also be accelerated for purposes of creating a collaborative, unified common approach, and avoiding a patchwork of standards or regulations that could inhibit or stall the technology development. Even a small number of differing or conflicting standards or regulations would significantly inhibit the development of AV technology. Consumers' interests would not be served if they could not operate their vehicle, or a shared vehicle, across state lines. Differing standards could certainly limit the safety, equity, and economic benefit of automated vehicles, and would put the U.S. in a compromised position compared to other countries and regions around the world.

It is also important to consider that the pursuit of voluntary standards does not preclude the promulgation of State or Federal standards. Indeed it may be prudent to consider the adoption of a Federal FMVSS *framework* standard that establishes key foundational requirements, such as definitions, manufacturer identification and reporting processes, data reporting requirements, exemption processes, consumer notification and privacy, enforcement requirements, etc. However it is too early to promulgate significantly detailed vehicle performance or equipment standards, as the needed technical requirements are not sufficiently developed, and currently there is no agreement within the technical and stakeholder community on the nature or specifics of such requirements. Additionally, the premature promulgation of not-fully-developed safety standards could result in a "false sense of safety," whereby manufacturers or consumers may believe that the technology is more ready or capable than it actually is, simply because it is advertised as meeting safety standards.

State regulations are also ultimately necessary for full scale AV deployment. The traditional State roles dictating operational requirements, such as insurance, registration, training and licensing, driving enforcement, etc., are still required, and ap-

propriate, for AVs. States may also want to proscribe new regulations that require HAV owners or fleet operators to make sure safety-critical vehicle control recalls are completed in a timely manner. However, creating state-by-state standards for vehicle performance or equipment could result in this undesirable patchwork, and should be avoided for reasons described above. Additionally, the creation of state-by-state vehicle performance or equipment requirements may also contribute to the "false sense of safety" discussed above.

USDOT's Automated Vehicle Proving Ground (AVPG) program provides key infrastructure and framework for safe deployment of CAVs.

USDOT's Automated Vehicle Proving Ground (AVPG) program provides key infrastructure and framework for the development of CAV products, tools, and standards in a rapid and collaborative fashion. This will be a critical asset to ensure safe deployment, as well as ensuring that the U.S. remains competitive in AV industry and deployment. This AVPG Program was established very recently, and has the mission to serve as a Community of Practice (CoP) to enable USDOT, industry, and other stakeholders to develop, test, and validate AV products, standards, and supporting tools.

This CoP will convene and enable stakeholders from companies, government agencies, academia, facilities, consumer groups, and other organization, to share best practices and innovations for testing operator safety, facility design concepts and details, facility operational best practices and lessons learned, data acquisition and analysis system concepts, and testing and analysis equipment best practices and standards. This intellectual capital will form the basis for voluntary standards and mandatory regulation.

AV testing and validation must occur through three coordinated approaches: Closed-Track testing, On-Road testing, and Simulation, as shown in Figure 2 below.

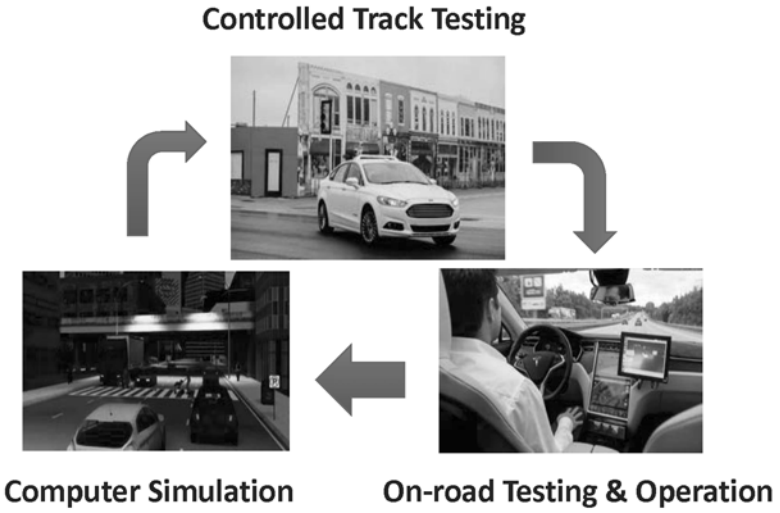


Figure 2. AV development process – 3 coordinated approaches

It is crucial that AV testing and development programs include three key complementary and fully integrated tools: (1) *Test-track and laboratory* tests that validate full vehicles, systems, and components, under realistic, variable, repeatable, and controlled conditions; (2) *on-road* tests that verify the systems' robustness in real life situations, including some that can't be implemented, or even imagined, in the above tools; and (3) *detailed simulations,* including roadway, traffic, vehicle, sensors, drivers, infrastructure, etc. that mathematically model the millions of technology and environmental variations.

These testing tools and methodologies must be used in combination in an iterative fashion. Simulation results help prioritize and define the initial round of test-track tests. The test-track allows a safe, controllable, and repeatable environment for development of functionality in numerous scenarios, and provides sufficient confidence

to begin on-road testing, but can never accommodate all scenarios. On-road testing provides identification and validation to real-world behavior, including unanticipated, key scenarios, but often does not allow repeatability, so key critical scenarios must be reproduced in simulation and track testing. This process must be rigorously planned and executed to validate artificial intelligence as a substitute for decades of experience of a human driver. These new methodologies are not yet fully defined, and are the subject of intense research and rapid development.

USDOT's AVPG program contains a combination and range of track, on-road, and simulation facilities and capabilities across wide geographic areas and environmental conditions. This range of capabilities is important for the development of these products and tools in a rapid and collaborative fashion, and will be a critical asset to generate experience and data to ensure the safety of AV products and that the U.S. remains competitive in AV industry and deployment.

AVs present both challenges and opportunities regarding data and data sharing, requiring that a large amount of data and information be sensed, acquired, amalgamated, analyzed for rapid decision-making in a wide variety of travel scenarios and environmental conditions, while protecting consumer privacy and ensuring cybersecurity. This data must then be acted upon through control decisions and operational monitoring. This same data can enable understanding of what is going right, or wrong, with an AV, and if shared, provides an opportunity for many vehicles to learn from the experience of one. While data best practices for AVs are still under significant development by vehicle manufacturers, testers, suppliers, government agencies, and service operators, generally, these data practices will likely include established processes and tools for the collection of in-use event, incident, and vehicle information data for crashes, malfunctions, degradations, failures, and unintended operation outside established operational domains, while maintaining and protecting consumer privacy and manufacturer/tester confidentiality and security. It is expected that this information will become extremely useful for vehicle development and operations activities, especially in early years of deployment, as well as accident/event reconstruction purposes.

The AVPG Program will be critical infrastructure for developing concepts, structures, processes, tools, and programs to enable and implement these data sharing activities that are required for safe deployment, while maintaining consumer privacy and system cybersecurity.

For these reasons, the AVPG Program overall will provide the foundation and program for the development of safe testing, operation, and deployment, including the necessary voluntary standards and mandatory regulations. As described above, significant work will need to be undertaken by expert technical and policy communities to theorize, prioritize, draft, and codify these standards in a coordinated yet accelerated manner. U.S. investment in AVPG infrastructure, facilities, equipment, and programs is a vital necessity to ensure safe deployment of AVs, and to keep the U.S. competitive with other major auto-manufacturing countries who are investing in similar facilities and infrastructure at a much more rapid pace.

HAV Data collection will continue after initial deployment, and Exemptions are important to allow that data generation.

HAV data collection and analysis must also extend through the initial years or even decade(s) of deployment. In addition to data gathered and analyzed throughout the product development and validation process, it will be critical to gather data in the initial years of product deployment, and perhaps even continuing ad infinitum. HAVs, like human drivers, must be capable of operating in a wide variety of travel scenarios and environmental conditions. No amount of testing and simulation can guarantee that every possible scenario has been encountered before initial deployment, just as human driver education cannot accomplish that before a driver is licensed. Secondly, setting of standards, especially government regulation is always aided by the collection and analysis of real-world safety experience and data. Because of this it is imperative to create, collect and analyze in-use data for initial deployments of these HAV vehicles.

According to a 2016 NHTSA/Volpe study,[4] a number of existing FMVSS contain requirements that either conflict with, or do not allow, basic HAV design tenets, especially related to human operated controls. In order to enable that early product deployment and regulatory data gathering, and to enable HAVs in general for their significant safety and mobility potential, it is important that Congress and USDOT review the current authority, and identify and implement a solution for exempting compliance of a sufficiently substantial number of vehicles to FMVSS requirements that do not pertain to HAV design or operation.

CFR 49 Part 555 currently allows NHTSA to temporarily exempt petitioning manufacturers' vehicles from certain FMVSS requirements, based on one or more of four situations:

(1) Substantial economic hardship
(2) Facilitation of development of new safety features
(3) Facilitation of development of new "low-emission" features or vehicles
(4) Inability to sell a vehicle with an overall equivalent or greater level of safety

It could be argued that initial deployment of HAVs would already be covered by situations 2, 3, and 4. However the number of vehicles (up to 2,500) and the time duration (up to 2 years) for the exemption is somewhat limited, and may not serve the need of collecting a sufficient body of data to ensure safe operation, and ultimately create appropriate FMVSS requirements.

Notably, and importantly, situations 2, 3, and 4 include the requirement that the petitioner demonstrate an equivalent or better level of safety, as compared to a non-exempted fully conforming vehicle, as part of the information for NHTSA's consideration.

As part of this recommended Congressional and USDOT review, it should be debated whether situation 1 is applicable or advisable as an exemption rationale for HAVs, especially since this basis does not require the demonstration of an equivalent level of safety.

Regardless of the rationale for exemption, it remains imperative for HAVs that the petitioner demonstrate, ideally through test-track, on-road, and simulation data, that the exempted vehicle clearly provides an equivalent or better level of safety, and that NHTSA have the final judgment that that requirement is met. Lastly, NHTSA must be authorized and adequately funded, including appropriate FTE levels, to ensure that this exemption program can be enacted fully and expeditiously so that it meets its full intent.

Closing

In closing, I wish to reiterate that we are entering a new era for a greatly improved transportation system built on key technologies. The United States must embrace and invest in these technologies to provide increased safety, mobility, and equity for the travelling public, as well as support the economic competitiveness of our automotive industry and our country.

I urge Congress to consider the following:

- Authorize and fund USDOT to direct, fund, and collaborate on voluntary industry standards, including testing, validation, cybersecurity, privacy, and self-certification tools and methodologies, including appropriate FTE to implement this program.
- Authorize and fund the USDOT AVPG program to provide facilities and opportunities for product development, standardization, education, and public-private partnerships.
- Consider revising NHTSA's exemption authority to enable HAV deployment and early data collection, and authorize and fund appropriate FTE to implement this program.

I appreciate this opportunity very much. Thank you for your attention.

About The American Center for Mobility

The American Center for Mobility's proving ground is designated by USDOT as part their AVPG Program. ACM's core mission is to enable the safe development of automated vehicles as part of a future transportation system. To perform that mission, ACM is committed to develop and share safety-related approaches, information, and data in both test facility design and test operations, as well as explore and create data sharing opportunities for non-confidential, non-PI, testing and operation data, as part of a similarly-committed Community of Practice, while maintaining and protecting consumer privacy and manufacturer/tester confidentiality and security.

With $110M in direct or incorporated investment, and leveraging an additional $115M of regional assets, ACM is designed to be the premiere national proving ground for shared-use mobility and advanced automotive testing. Founded in early 2016, ACM is a joint initiative among the State of Michigan, including the Michigan Department of Transportation (MDOT) and Michigan Economic Development Corporation (MEDC), the University of Michigan (U–M), Business Leaders for Michigan (BLM), and Ann Arbor SPARK. ACM incorporates private funding in partnership with public funding from the State of Michigan. ACM is strategically located in

southeast Michigan and is recognized as a centerpiece of the state's "Planet M" initiative representing the collective mobility efforts across the state defining Michigan as the global center of mobility.

ACM's testing and validation capability is based on real-world representative testing environments designed to address a wide range of variations of pre-crash scenarios, including variable but controllable critical near miss scenarios. This testing is critical to the proper development and validation of CAV products and will serve AV developers' needs for both hardware and software. ACM's testing assets will also be critical to the work of government agencies and academic researchers collaborating on safety, mobility, and energy aspects of a CAV-based transportation system.

The American Center for Mobility program will focus on three activity pillars that are critical to CAV safety: testing/validating, standard setting, and education. CAV technology, including communication, infrastructure, and cyber security, is developing very rapidly. All three of these key "pillar" activities should be advanced simultaneously to ensure that the technology is developed to maximize safety, mobility, energy, transportation equity, and other benefits.

ACM is working with other facilities, government agencies, academia, industry, and like-minded experts, to share best practices and innovations for testing operator safety, facility design concepts and details, facility operational best practices and lessons learned, data acquisition and analysis system concepts, and testing and analysis equipment best practices and standards. ACM is convening operators and designers of other test facilities to lead the effort in the formation of this Community of Practice. ACM is partnering with standards organizations, such as SAE International, IEEE, ISO, NIST, ASTM, and others in these sharing discussions at the appropriate time, and will work with those bodies to enable voluntary standards as appropriate.

ACM's mission includes the acceleration of these voluntary standards through convening and the creation of laboratories designed specifically for AV testing and standardization. ACM has partnerships in place with SDOs which will enable an accelerated process that will allow the standard setting experts to convene at ACM and participate in testing and demonstrations that inform the strategy, details, and ultimately decisions on the standards that are created. ACM provides a unique venue to contemporaneously develop and validate standards in rapid cycles and serve as a convening center where industry, government, SDOs, and other interested stakeholders can collaborate and accelerate the development of critical standards.

Through its ability and focus to convene technical experts, numerous automotive development users, and standards bodies, ACM will establish a user group to develop a uniform approach or voluntary standard to data sharing. While it is unlikely that any manufacturer or tester will share all of its vehicle and incident data, this user group will act to establish a process to share noteworthy scenarios, and to define a subset of data and data retrieval/access methods, that they can agree to share. ACM will fully protect consumer and public privacy and security, and will take steps to ensure that any data or information sharing activities do not violate, hinder, or compromise integrity of any consumer privacy/security agreements or arrangements put in place by manufacturers, testers, agencies, public entities, or by ACM itself. Similarly, ACM commits to maintaining the confidentiality and security of proprietary confidential business information and data on behalf of its users, testers, and private partners.

ACM will lead the formation of a specific Community of Practice focused on safe CAV testing, as a proposed subgroup of the International Committee for Proving Ground Safety (ICPGS) established to enable the rapid sharing of information, best practices, and data including the following aspects: Best safety practices specific to CAV testing, including vehicles, infrastructure and communication; driver training (remote and in vehicle); safe conduct of testing and operations; safety management plans and protocols; common safety incident reporting protocol; and common data format and agreement to share non-proprietary/non-confidential data.

ACM fully supports the establishment of a network of experts and commits to providing engaged expertise through comments, meetings, workshops, and more formal activities including volunteered participation in an expert committee. In addition, the ACM facility will serve a very important purpose to educate the current and next generation of engineers, policy-makers, lawyers, and strategists and, in league with a consortium of universities and community colleges, will develop a curriculum to ensure that expertise is generated and available for hiring or appointment throughout industry, government, and academia.

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(3) National Highway Traffic Safety Administration (2015, January). DOT HS 812 069 Lives Saved by Vehicle Technologies and Associated Federal Motor Vehicle Safety Standards 1960–2012

(4) USDOT John A. Volpe National Transportation Systems Center (2016, March) DOT–VNTSC–OSTR–16–03 Review of Federal Motor Vehicle Safety Standards for Automated Vehicles; Identifying potential barriers and challenges for the certification of automated vehicles using existing FMVSS—Preliminary Report

The CHAIRMAN. Thank you, Mr. Maddox.

Let me direct this question to the entire panel. In order to realize the safety benefits of self-driving vehicles, manufacturers and new market entrants must be able to test and deploy on public roads and across multiple states. Traditionally, as Mr. Bainwol pointed out, the Federal Government has regulated the vehicle while states have regulated the driver. While I believe that states have a role to play in the deployment of these vehicles, we must be careful to avoid a patchwork of regulations, as a number of you have pointed out.

So the question is: Would you support a Federal framework governing the safety of these vehicles? We'll start with Mr. Bainwol and move across the panel.

Mr. BAINWOL. Short answer, sure, absolutely.

Mr. CSONGOR. The answer would be yes, especially if it simplifies our ability to deploy and test across the different states. So, of course, the devil would be in the details, but we test today in California, New Jersey, and we're able to deploy and test vehicles, and there are certain standards that are completely fine and very logical. I think the devil is in the details, but I would agree with a framework of that nature.

Ms. SHEEHEY-CHURCH. An even shorter answer would be, obviously, yes, we do, but I'll broaden it just a little bit. To avoid that patchwork, you know, of state requirements, it's important to make sure that we balance the technology and the regulation. So in saying that, it's important that NHTSA, the auto industry, and safety advocates really get together and make sure that the collaboration is key and ongoing, along with the data that we will be taking and looking and watching. But the short answer is absolutely.

Mr. MADDOX. And, last, I would add a fourth yes to that question, for sure. I think it's a necessary step, as I talked about, to be able to create the data that we need to validate these vehicles and, importantly, to educate the public about what they can and can't do. I think a framework would be a very good first step.

The CHAIRMAN. Many of the regulatory challenges for the testing and deployment of self-driving vehicles stem from the fact that current Federal motor vehicle safety standards, as written, don't take into account self-driving vehicles. With an increasing number of auto manufacturers and new market entrants looking to test and deploy this technology in the next few years, many have expressed the need for exemptions from certain Federal standards to deploy vehicles on public roads.

I guess this would be perhaps more specifically for Mr. Bainwol, Mr. Csongor, and Mr. Maddox. But why is the expansion of current exemptions important, and how will that inform future standards?

Mr. BAINWOL. It's vitally important. We look at this as a multipronged approach to maximize this transition. On the one hand, you have to have Federal uniformity, but you also need exemptions in a substantial number to generate—really, for two reasons. One is to generate the test data so that we can get to the point where we can deploy with confidence that's data driven.

Second, there's a massive economic commitment here. This is billions of dollars of R and D. In order to make it economically attractive, to make the math work, you've got to be able to deploy—not just test, but deploy, and it's going to take time for the final rules to be written, and in this interim period, you need a mechanism to deploy. So you need it for two reasons, testing to prove a concept and, second, to make sure that the math works on the capital investment.

The CHAIRMAN. Mr. Csongor?

Mr. CSONGOR. I think the expansion of the Federal exemptions, particular to NVIDIA and to someone who is developing the underlying computer technology that would make a self-driving car possible—in my remarks, I commented on the connection between getting to that level of safety and the amount of data that's generated, and that we can ensure that the data that's generated is as diverse as possible and that we can get it as quickly as possible in order to deploy it.

I know that other issues will come up with regard to the data, including cybersecurity and privacy. All of these are important issues. But in terms of the Federal guidelines, from a development point of view, access and development of that data is critical to the safety of the car fleet.

The CHAIRMAN. Mr. Maddox?

Mr. MADDOX. I would echo that, perhaps with a bit more specific thought. Certainly, we need a significant amount of in-use data to validate the technology and to give the vehicles a chance to experience a given scenario and learn from it, and then maybe even educate other vehicles or other manufacturers how to handle that scenario. That's the way we learn as humans to drive. We're taught the basics. We can't experience every scenario before we're let loose, if you will.

But with automated vehicles, we need a significant amount of data, and the number of vehicles to gather that data will need to be substantial. So for that reason, I think raising the numbers of vehicles that could be exempted would be a very positive step.

The CHAIRMAN. Final question, Ms. Sheehey-Church. And, again, I want to express my sympathy to you for your family's loss and just appreciate you being here today to testify.

In your testimony, you highlighted the fact that, tragically, the highest percentage of deaths that occur on U.S. highways are due to drunk driving and are, therefore, preventable. Can you elaborate on how you see self-driving cars being part of the solution to drunk driving?

Ms. SHEEHEY-CHURCH. Absolutely, Chairman. When we look at the numbers, the 35,000, and you break it down, very simply,

10,000, as you said, for drunk driving. But the opportunity for autonomous vehicles will allow for all those other human behavioral errors and including drunk driving—again, MADD is there—our mission is to eliminate drunk driving, and we'll look and support any advanced technology.

So when we look at AV, it was something that we said—it's an emerging technology that just has to be done, because it will not only take care of the other behavioral errors that are happening, you know, the drowsy or sleepy or seatbelts or speeding, but it will allow also drunk driving. What we want to do at MADD, we want to stop—we separate the drinking from the driving. With AV, we're going to separate the driver from the vehicle itself. And, again, we're looking at Level 4 and 5 when I answer that question.

The CHAIRMAN. Thank you.

Senator Peters?

Senator PETERS. Thank you, Mr. Chairman, and thank you to all of our witnesses for excellent testimony and we appreciate all four of you being here today.

This first question is for Mr. Maddox. Prior to becoming the CEO of the American Center for Mobility, you developed and implemented a connected and automated vehicle public-private research and development partnership with the University of Michigan. You and I are very familiar with the auto industry, and we know that it is very competitive. Competition is healthy as it leads to better products.

But we also know that in this new era of transportation innovation, we're going to have to see an awful lot of collaboration between the industry. We know part of these technologies are connected vehicles that are going to be talking to each other, and a General Motors vehicle needs to talk to a Toyota on the road and to a Ford and a Nissan, et cetera, et cetera. That's a whole new business model in terms of some of the ways in which we use proving grounds and test vehicles, and we need to have that collaboration to eventually inform safety standards for development.

So my question to you is: How will the American Center for Mobility facilitate this work? What are some of the partners? How are you bringing industry together? How is it also necessary for us to use facilities like the American Center for Mobility to go much broader than the auto industry?

Mr. MADDOX. I'll start with that last one first. Certainly, the American Center for Mobility and the other nine designated proving grounds around the United States—we are key infrastructure. To prove these vehicles out, we need to do both on-road driving, simulation, and certainly track testing, and the proving grounds are the facilities to do that testing.

More importantly, as you point out, it's the facility—it's a convening location for these companies and different industries to come together and develop the technology consistently and collaboratively. At the American Center for Mobility, we certainly are working with auto makers and Tier 1 suppliers, but, in addition, communications companies, technology companies, insurance companies. They all have a stake in understanding how the products work, how they don't work, and to develop them so that they actually work together for the public.

Importantly, we believe, all of those industries as well as government has a stake in educating the public about what the technology does or does not do, how it functions, what its implications are. So these proving grounds also will serve as a locale for educating the future workforce, the public, in general, as well as each other.

Senator PETERS. It's obviously very important to be doing all of that, and it's important for us to move the development forward, but also to understand that we're in a global economy. We're going to have significant global competitors. A number of other countries are also racing to get to this technology, and whoever gets there first or is very early to get there will have a significant competitive advantage.

Tell us a little bit about these centers, like the American Center for Mobility. Where are other countries, who are our competitors, and do we have to really get moving even quicker?

Mr. MADDOX. That is absolutely right. Other countries are moving very quickly. This technology was largely invented in the United States, and I think we're still in the lead on a technical level. However, when you look at the funding and the activities and the programs that other countries—China, Korea, Japan, the European Union—China alone has built two facilities already and has plans for five more for a total of seven.

They are, like us, focusing on technology development and standardization, because they know that the countries and the regions that set those standards will certainly create an opportunity for their industries that other countries don't necessarily have. So we see that activity. We see them coming to Ypsilanti, coming to Michigan, coming to other facilities around the United States on a regular basis. We know it's going on.

Senator PETERS. Thank you.

Mr. Csongor, I'd like to have you elaborate a little bit on some of the comments you made in your testimony related to artificial intelligence, deep learning, machine learning, and why really moving this technology forward in the auto industry is critical, not just for autos, not just for the incredible advances in safety, which we've already articulated, but for the entire economy and for every industry. It has been described to me that this auto technology is the moon shot for artificial intelligence, and when that happens, we'll be able to have incredible advances in every industry imaginable.

Is that accurate? Where do you see this going? Why is it important to get it right with autos?

Mr. CSONGOR. I think that's very accurate, Senator Peters. I don't think it's an over-exaggeration or hyperbole to say that AI is the fourth industrial revolution, and what that means is that everything will change, and it's specifically targeted, as any industrial revolution, against problems that exist within society. Many of the problems that we have can be broken down to computational problems. The pursuit of a cure for cancer is a computational problem.

We have enormous amounts of data being generated in every field across so many industries. We just can't make sense of the data. What's really required and the real—I think the really crit-

ical role of AI is to get insight from large amounts of data. So if you gather large amounts of data on speech, you can understand idioms of human speech. You can create automatic translation literally out of a Star Trek episode, where you're able to speak one language and you hear another language out the other side.

You can collect information on the oceans and have an AI agent that sifts through the data to look for important trends. And, of course, you can break down the world—highways, roads—and then sift through that data, and then be able to identify all the important things that matter to driving a self-driving car.

Just imagine trying to break down the world into objects, all the objects that we see when we drive a car. Imagine that you had to have a person write manually software code to describe what that object is. This is a stop sign. This is a stop sign at an angle. This is a stop sign at night. This is a stop sign that's covered with snow. We're able as humans to recognize objects even though they're hidden or what we call occluded, and deep neural networks are very good at that kind of thing.

So I think that as we as a society evolve into a world where we have lots of data, I think the ability of AI to provide insight in that data is going to provide breakthroughs everywhere across every industry.

Senator PETERS. Thank you.

The CHAIRMAN. Thank you, Senator Peters.

Senator Moran?

STATEMENT OF HON. JERRY MORAN, U.S. SENATOR FROM KANSAS

Senator MORAN. Chairman, thank you and Senator Peters not only for the hearing but for your efforts to determine guidance.

The panel gets your blood flowing, excited about the potential of what this means, not just for driverless vehicles, but as you're describing what it means for us as a society, a country, and a world. I'm having trouble putting my hands around what it means in rural America. Incidentally, I come from a place in which driving is still enjoyable. We look for it. There's still occasionally Sunday drives, and then you add to that farm equipment, and it is a different environment.

So, first, I would start by asking do we see this as something that is, at least for the foreseeable future, limited to cities and interstate travel?

Mr. CSONGOR. Maybe I can take a quick shot. There are two comments I'd like to make. First of all, the use of AI in a car, in our vision at NVIDIA, can really accomplish two things. The first thing is the AI can drive the car for you if you want. We all refer to a self-driving car as one thing, but in actuality, this technology will likely be deployed in small steps toward a big vision.

The big vision is a self-driving car that can drive very largely autonomously, but I think the idea of a self-driving car that can drive anywhere, absolutely anywhere, is not true. If you drop a self-driving car in the middle of Greenland, it will not drive on its own, just like a human would not be able to drive on their own.

So one part, I think, is you already have solutions on the road today, and then you're going to see every year products come out

that are better and better and better, and they'll have more and more features and more and more capability. However, in addition to self-driving, we actually believe that the AI can be a co-pilot, or think of it as a guardian angel. So with a camera inside the car that's connected to the cameras outside the car, for example, we can track the position of the driver's head, their gaze, if they happen to be looking to the side and a pedestrian steps off on the right, but you're driving, the AI can say, "Attention, there's a pedestrian on the right."

So the use of this technology, I think, is not just limited to self-driving but also to assisting the driver and being there in case you'd like to drive because you enjoy driving.

The second comment is regarding your question on rural areas. The system that I described to you on the self-driving does not require that the car be continuously in connection with a central computer. So in the system that I described, the algorithms are tested with massive amounts of data, and then they're over-the-aired to your PC.

So imagine your computer that you can get an update on, and once you have the update, you can go anywhere with the computer, and then at some point, you get back to an area where you have a connection, and then as soon as you have a connection, if there's an update, then you can do it. So I think the architecture of the self-driving car that we're all working toward does not require you to be in continual connection.

Senator MORAN. Thank you.

Mr. Bainwol?

Mr. BAINWOL. If I can add perhaps a less sophisticated answer, if you're in Russell, Kansas, you may not have the same level of ride sharing ultimately. But you certainly will benefit from the access questions. You know, if you're blind or disabled in Russell, Kansas, it's the same benefit to be able to get a self-driving vehicle to take you to your destination. So that's part one.

Part two is, ultimately, this is all about crash avoidance, and it doesn't matter where you are, crash avoidance inures to the benefit of everybody. So you're avoiding accidents, you've got the property damage issues, you've got the time issues, you have the fuel savings questions, but, most of all, you have the saving of life.

So I would argue that there are certain applications that may be more prevalent in urban centers. But as a bottom line, this is good for rural America just as much as it is for urban America.

Senator MORAN. Thank you very much. Let me see if I can one more question. The question is related to insurance. I chair the Subcommittee that has jurisdiction over insurance in this Committee.

Let me ask you, Mr. Bainwol. The question really is: what's the private sector role in insurance? Volvo stands out to me. In 2015, they announced that the company would accept full liability whenever one of its cars is in autonomous mode. What's the industry's expectations? And then, second, what's the request of Congress? What's required here in regard to insurance?

Mr. BAINWOL. Well, the insurance piece has a couple of different dimensions. There's the question of liability, and certainly on the question of aftermarket, the OEMs would like to be protected from

aftermarket adjustments to the vehicle. I think there is a range of perspectives on liability on the system itself from the OEMs, and that's something that we're just going to have to work through. There obviously is a tort system in place as well as broad enforcement authority, and that does govern behavior in terms of the introduction of technologies and the risk taking.

The other point on insurance that we often hear about is that premiums will go down, and, ultimately, that may, some say, damage the insurance industry, but at the end of the day, if you have fewer accidents, that's a good thing, and claims will go down.

When Volvo introduced the XC60 originally in the U.S. five or six years ago, it was the only vehicle that had automatic braking on the sport utility. No others did, and all of the sport utilities that Volvo introduced did. So you had a nice control group, and it was found that the incidence of claims for the first six months was 27 percent down. So automation has really a fantastic opportunity to change the very essence of the relationship, and the need for insurance will go down. But, ultimately, the payout on insurance will also go down.

Senator MORAN. Thank you all very much. It's nice to get excited about something as compared to worrying about something. This gets me excited. Thank you.

The CHAIRMAN. I think this probably gets your staff and your family more excited than you, Senator Moran.

[Laughter.]

The CHAIRMAN. He may not be out there driving on his own.

Senator Cortez Masto is up next.

STATEMENT OF HON. CATHERINE CORTEZ MASTO, U.S. SENATOR FROM NEVADA

Senator CORTEZ MASTO. Thank you, and thank you for this incredible panel and discussion.

Two weeks ago, I was back in Nevada, and I had the opportunity to walk through the Tesla site and plant that we have there and drive in one of their autonomous vehicles. The technology was absolutely incredible. I am very, very excited about this phase.

One of the interesting aspects that I've seen in transportation, particularly in Nevada, is the concept of smart communities. I want to follow up on what you're saying, because what we were talking about and what I heard was that these autonomous vehicles are just one part of a larger community—of smart communities, the Internet of Things and the connection of things. I'm actually working on legislation to try and continue that momentum for our communities to invest in smart communities.

I wonder if anyone could elaborate on how you see this fitting into that larger goal of smart communities that I know so many communities are looking at right now.

Mr. MADDOX. I'll start, if that's okay. Yes, we believe that smart vehicles, automated vehicles, connected vehicles are an important piece of a smart community, and really, a smart community is all about data, how you collect data, and, importantly, how you use data, and that is a very difficult challenge. Certainly, automated vehicles and the way that we'll move people, the way that we'll move goods will be a huge contribution of that data source to that

overview of how a smart city is operating. So we know that these automated vehicles will be that important piece.

The question is: how do you integrate all this data together? And, frankly, we don't know that anyone has got that real answer yet. That's one of the key reasons that we need to do these early deployments so that we can actually get experience with the vehicles in that smart city setting and figure out how to use that data.

Mr. CSONGOR. First, I just want to comment on your ride in the Tesla. I actually own one myself, and I share your enthusiasm. It is not a new feature like a seat warmer or a premium sound system. Traffic has just such a terrible effect on your life that the absence of having to drive in it just improves the quality of your life. So I do believe that beyond safety, it's just delightful to have.

With regard to smart cities, NVIDIA has actually invested very heavily in extending our technology into smart cities. In many of the applications that you look at, whether it's consumer applications from Facebook or Google or whether it's self-driving cars or smart cities, there are common elements of technology. For example, all of these feature and require the ability to do image recognition, intelligent analysis of video.

So, for example, there's a concept called IVA, intelligent video analysis. So being able to sift through lots of data to be able to understand, either for security purposes or for crowd management or, you know, things like this, a lot of these same algorithms can be applied into smart city types of things.

Beyond that, there are other communication methods, vehicle to vehicle, vehicle to infrastructure, where you can have cars communicating with traffic lights, and, in theory, in theory, the logical extension of all of these would be a society where you don't have traffic lights or stop signs, that you're able to have traffic flow completely naturally, intersecting with each other. So there's quite an enormous amount of potential in combining AI elements in the vehicle as well as the city, because the infrastructure would have to expand to support a world where you had autonomous vehicles and you can realize a lot more benefits.

Senator CORTEZ MASTO. Thank you. I know my time is running out here.

Very quickly, first of all, Ms. Church, thank you for what you do. I had the opportunity to work very closely with not only MADD but Stop DUI in Nevada, and thank you for that collaboration, because it wasn't just drunk driving. It was distracted driving, it was driving under the influence that we worked very hard to eradicate, and I think this technology will help us address this issue, working closely with law enforcement.

I think the data, besides insurance, will also help law enforcement on so many levels that we can't even contemplate right now. But one of them I do have a concern about is cybersecurity space, this space of how we address hacking into this technology. Do you think that, right now, we are adequately staffing, and are we already preparing to address cybersecurity needs as we build this infrastructure out? I'll open it up for anyone.

Mr. BAINWOL. So cyber is a real concern. It's one that everyone shares. The fundamental proposition here is big data provides an opportunity for great benefit, but we've got to find a way to maxi-

mize the benefit and minimize the challenges, and cyber falls into that category.

Several years ago, the OEMs came together and formed an ISAC as other sectors have. What was unique was that we did it in advance of an event, and to date, there has still not been a market event. There has been wide hacking, but not a malevolent attack. We've been fortunate—knock on wood. But as we formed the ISAC, we promulgated best practices. The product cycle of vehicles starts with security by design.

So we can always do more. It's not a static moment. This is a journey, and the challenge will grow over time. But there's a commitment to meet that challenge.

Senator CORTEZ MASTO. Thank you.

Mr. CSONGOR. Of course, the subject of cybersecurity is extremely important, and I know that there has been publicized instances of vehicles that were hacked; however, I do think it's important to note that the automobile is in the middle of transformation. It was not very long ago when the most sophisticated computer in that car was the radio. The automotive is now becoming a computer, and in that recognition, that's a challenge, and it's something that we have to do.

But the good news is this is not the world's first computer. The computer industry has been building computers for 50 or 60 years, and they're used largely in autonomous vehicles today. The aircraft that we fly today are powered by computers. They're secure. There's computers powering every facet of our society and our lives.

So I believe that there is a lot of knowledge on cybersecurity. It just needs to be applied to automotive. NVIDIA has been developing solutions for 20 years. If we did not provide secure functionality in our computers, we would not be in business. So I think this is a matter of application.

Mr. BAINWOL. And we have about 18 suppliers in our ISAC, and we welcome you joining the party.

Senator CORTEZ MASTO. Fantastic.

Mr. MADDOX. One last comment, if I could, on cybersecurity. If we think about cybersecurity, we should consider security of the entire transportation system. Certainly, the vehicle is part of that, but so is the infrastructure, the traffic controls, signs, and growing increasingly, even our personal mobile devices will be part of that mobility infrastructure. So when we think about cyber, we should consider cyber for all of that.

Senator CORTEZ MASTO. Great. Thank you so much. Oh, please.

Ms. SHEEHEY-CHURCH. I'm obviously not the engineer on this panel, but I know that MADD is looking at this issue and knows that the auto industry itself is taking it very seriously. We look at maximizing societal benefits while minimizing the disbeliefs about it or minimizing the benefits about it, but the fact is that the Auto ISAC is tracking and sharing and is accountable of all the intelligence that we started in January 2016.

So the possibility is obviously always there, but they are really overcoming the threats with the help of our automakers and their suppliers. So I think they will have a good track record going forward.

Senator CORTEZ MASTO. Thank you. Thank you all.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Cortez Masto.

Senator Gardner?

STATEMENT OF HON. CORY GARDNER, U.S. SENATOR FROM COLORADO

Senator GARDNER. Thank you, Mr. Chairman, and thanks to all of you for being here today.

I was going to share my Sunday drive routine with Senator Moran in the 1971 International Harvester Travelall that I finally got running. So the only autonomous thing about that is its consistent breakdowns.

Mr. Bainwol, I'll direct this question to you. Colorado has been one of the states at the forefront of autonomous vehicle technology. The Colorado Department of Transportation has been pursuing rolling out their new RoadX program. It uses innovative transportation systems to improve traffic flow and modernizes the infrastructure itself to allow autonomous vehicles to move safely and effectively.

It's incredibly important as you drive up to the mountains from the airport when you fly in to ski. There's really only one way that you can get there quickly, and it's a little bit of a chokepoint at times. In October of last year, a fully autonomous truck made a commercial shipment from Fort Collins, Colorado, to Colorado Springs, and because it was Colorado, of course, it was a shipment of—no, not that. It was beer.

[Laughter.]

Senator GARDNER. With Colorado as one of the fastest-growing states in the nation, I'm excited about the opportunities created by autonomous vehicles to reduce congestion and prevent accidents. In your testimony, you talked about timelines for Tiers 3, 4, and 5 highly autonomous vehicles. You talked about Tier 5 and that it can operate seamlessly anywhere, and a person can drive—you know, anywhere a person can drive a conventional vehicle, and that you think it would hit the roads around 2025. But going on with your testimony, you talk about how you don't think these vehicles will make up a majority of the cars on the road for three decades or so.

So what are the first sort of changes that we will see in things like urban planning as autonomous vehicles hit the market?

Mr. BAINWOL. You're asking the tricky but correct question, because we're going to have a situation of fleet mix for decades. The estimates and timing were actually Moody's, not ours, but it's all predicated on the reality that the average age of a car is 11 years old. So if you go down to the 20th percentile, they're really old cars, and so once you introduce the technology, it takes a long time to wind its way through the fleet.

So planners have to deal with a transition that's going to occur for 20 or 30 years, and there's no magic answer. Part of it depends on how aggressive a city or a state approaches it. Part of it is not knowing exactly what the adoption is going to be. There are fundamental questions. We don't know whether VMT is going to go up or go down. We don't know whether car ownership is going to decline and by how much versus ride sharing.

So there are lots of open issues here, and you almost have to place a bet and then try to mobilize and accelerate the future. There are lots of crazy things. I met with a very provocative nuclear physicist who talks about the future all the time, and his comment, unrelated to his profession, was that at some point in the future, metros will become basically parking stations, because the last mile value of autonomy will be so cheap that metro systems will end up collapsing, so they'll become storage for something else. What do you do about parking, and how long will that transition take?

So I don't really have a great answer. But the question is profoundly on target, and planners are going to have to wrestle with this question in a really profound way.

Senator GARDNER. I'm happy if anybody else wants to take a shot at that. Now, the technology you were talking about—is it Csongor? Is that how you say it?

Mr. CSONGOR. It's pronounced Csongor.

Senator GARDNER. Will AI be able to pronounce that?

[Laughter.]

Mr. CSONGOR. Probably not.

Senator GARDNER. All right. Please go ahead if you have anything else.

Mr. CSONGOR. I think one of the interesting next ripple effects as a result of AV, autonomous vehicles, will be a big problem in our cities and our infrastructure, which is parking lots. Today, a lot of urban sprawl is caused by the fact that every building has to have a parking lot right beside it, because the people driving don't want to walk for a long period of time.

NVIDIA is actually—we're building a new corporate building in Santa Clara, and if you look at it, there's no parking lot on the outside. Now, the parking lot will be underground, but the AV capability introduces the possibility of being able to free up a lot of land, to eliminate a lot of this sprawl, and then to simply have an autonomous vehicle go park and it doesn't matter to you how far away it is, as long as it's somewhere close by. So I think that's an exciting——

Senator GARDNER. Well, I look forward to carrying on the conversation about the rollout of Tier 5 and other technologies and the integration of Federal, state, and local regulations and policies as we move forward.

Really, Mr. Bainwol, to your point of whether a metro or something like that is necessary as we're pursuing appropriations to put billions of dollars into certain public infrastructure projects, at what point does the intersection of cost to benefit, because of AV technology, start impacting those decisions? So that's a question we're going to have to answer.

So thanks very much for your time.

The CHAIRMAN. Thank you, Senator Gardner.

Senator Young.

STATEMENT OF HON. TODD YOUNG,
U.S. SENATOR FROM INDIANA

Senator YOUNG. Well, thank you, Chairman, for holding this hearing, and I want to thank our panelists for their testimony here today. I really appreciate it.

Today, private industry is taking the lead in developing many of the standards that are driving how we talk about automated vehicles. For example, the Society of Automotive Engineers has issued standards defining six levels of automation. Many governmental bodies, including our Department of Transportation in the Federal automated vehicles policy, have adopted or referenced those standards.

That strikes me, generally speaking, as a good model to continue as technology is still developing. That said, if we're to preclude states from enacting safety standards for fear of a patchwork of regulations, something that's been invoked here today, we may need to have some minimum level of reporting to NHTSA.

Are you concerned—anyone can speak to this—that new entrants and startups in the industry might have difficulty working with NHTSA?

Mr. BAINWOL. Concern may not be the right word. But I think everybody who wants to enter the space ought to. The rule set should be technology neutral, and at the end of the day, for common opportunity, there should be a common obligation to meet the safety standards. The entire enterprise is predicated on the notion that we're going to improve safety, NHTSA's reality is a positive reality. We've had 50 years of safety standards, and the CDC describes the outcome as one of the great public health achievements of the century. So we want to recognize the value that that system provides and make sure that everybody complies.

Senator YOUNG. So we see this across industry sectors, right, where the incumbents oftentimes play an important and constructive role in developing new standards, but sometimes those standards are also tailored to advantage their business models, right? They have to answer to shareholders. They're publicly traded companies.

So to ensure as much dynamism, as much innovation, so we can best serve the consumer markets, which all of us want, are there specific steps that anyone has in mind that can be taken to ensure that we're responsive to these new startups?

Mr. MADDOX. I'll add to that, if I could. Certainly, voluntary standards are a critical step. I discussed that a little bit earlier. The key thing we need to ensure is that those voluntary standards efforts are really directed and focused on an outcome that can result in a FMVSS and result in the ability of manufacturers, be they new or existing, to deploy their vehicles so that we can learn from them.

So I think the critical piece is that U.S. DOT, NHTSA, perhaps directly, should work together with SAE and ITE for traffic engineering and IEEE for communications to make sure that those voluntary standards efforts are directed to be something that could be useful for a future FMVSS standard.

Senator YOUNG. Mr. Csongor? If I said that correctly?

Mr. CSONGOR. It's OK. The Cs are like Ch.

Senator YOUNG. All right. Csongor. All right, sir.

Mr. CSONGOR. It's OK. Startups are an important part of any technological disruption. They're a hotbed of innovation, a hotbed of ideas. When I joined NVIDIA in 1995, we were one of them, and because of the climate that was made possible by our government and by Silicon Valley, we were able to grow and make a difference in the world. So our DNA is wired to not just permit, but encourage the development of breakthrough technology on top of our platform.

When we work with startups, they are all aware of standards from committees or industries, ASIL ratings, and they are able to work with them. I think as long as regulation creates reasonable compliance rules for reporting information and things like this, I think that we're going to have no problem and we're going to enjoy a lot of benefits from the startups.

Senator YOUNG. Thank you.

Mr. Maddox, as I conclude here, you know, you might imply or infer from my previous line of questioning that I'm concerned about Congress or Federal agencies or, frankly, some incumbents putting their thumb on the scale to the disadvantage of others. SAE is obviously at the forefront of developing many of the voluntary standards you've discussed. Are there other standards development organizations that should be part of the conversation as we move forward, domestically or internationally?

Mr. MADDOX. Certainly, if you think of a future transportation system as a system, which includes vehicles, roads, communication systems, then there are other standards organizations like Institute for Transportation Engineers, ITE, based here in the U.S.; IEEE for communications. Those will be critical to bring together, and now we're talking about a very difficult lift, but an important one, which is getting standards bodies to talk to one another, just like the vehicle manufacturers and the other technologies have to. So those are critical stakeholders in the standards game.

Certainly, there is an international standards effort, and we always have a goal to try to harmonize vehicle standards and other standards internationally. It's very difficult to do that, but the best time, the best opportunity to do that is when the technology is nascent. So we should involve those other international bodies also.

Senator YOUNG. Well, thank you. It sounds like we need some standards for the various standards organizations discussing these topics together.

Thank you.

The CHAIRMAN. Thank you, Senator Young.

Senator Inhofe is up next.

STATEMENT OF HON. JIM INHOFE,
U.S. SENATOR FROM OKLAHOMA

Senator INHOFE. Thank you, Mr. Chairman.

So that a lot of the people here and at the table be aware of it, one of the problems we have is we have lots of meetings happening at the same time, and it happens that half the members of this committee are also on Environment and Public Works, and we're meeting at the same time. So if I ask something that has already been asked, you can just be offended.

[Laughter.]

Senator INHOFE. Mr. Csongor, to facilitate the deployment of autonomous vehicles, there's a lot of conversation about the types of Federal regulations that should be in place. One thing I'm concerned about that DOT is guilty of is setting up a kind of system where new technology cannot be quickly adopted because of an onerous approval system. This is exactly what happened with FAA. When we get some things as innocuous as applying GPS into an iPad system that you can use, it actually took years to get that done. So I am concerned about this, because, you know, that's government.

Does that concern you, too? And tell me why if it does not. What can we do now to put something in place to keep up with this?

Mr. CSONGOR. I think that the path that we're going down, which is—and the spirit of this Committee, I think, is not just to ensure the safety, but you can feel that the spirit of this committee is to make sure that development work goes on, whether it's from infrastructure or startups or all the people here on this panel, and that we can streamline the effort to do it.

So I feel that we all understand the goal. We understand the benefits of what's being—what's at stake, and there might be just a few small steps, you know, to focus on first, and I had mentioned it earlier in my comments, but I'll cover it again. The nature of the technology of an autonomous vehicle through AI is one where access to large amounts of data that's very diverse is very important. So it has been mentioned a number of times, but, certainly, unified regulations and then enforcement through NHTSA to provide that single unified compliance would dramatically help us in developing cars.

Senator INHOFE. I'm glad to hear you say that your observation is that this Committee has a reputation of getting things done and avoiding some of the unnecessary steps that other bureaucracies do. So I think this committee should be complimented, and I think you are accurate when you say that.

Now, when you talk about all the data that's going to be necessary, Oklahoma is proud to be a data center state, and Google has a massive facility that we're very proud of. It's in Pryor, Oklahoma. It's supplied with power from the GRDA, Grand River Dam Authority, in Oklahoma, the entity that generates power off of a large lake.

Autonomous vehicles will be collecting all kinds of data, pictures, and video every second that they're in operation, and this is going to require vast amounts of data stored at facilities like Google's. But what we don't want is the wrong people to get ahold of that.

Have you discussed in some detail safeguards that can be made? Because that threat is out there. There will be a lot of the wrong people wanting access to stuff that we don't want them to have access to. What are your thoughts about that?

Mr. CSONGOR. I agree with you very much. I can speak on behalf of NVIDIA, and I can talk to some of the steps that we take or the protocols that we put in place. First of all, the data that we collect, we use for one purpose and one purpose only, and that's to improve AI algorithms so that you can have a safer car. We regard any of the information that is collected as a part of that data as private

information. We don't share it with anybody unless we have a very secure way of sharing that data.

The data collected in our vehicles, if it's updated in a system where you have an over-the-air update, the transmission of the data, the upload and the download, is encrypted. And then within the building, there's a multilayer security protocol, ranging from the building security and the server infrastructure, and then within the server, there are various layers of firewall. So I won't get into all the details. I think that, again, the data that we collect, we treat as if it's the data that is our secrets, the secrets of our use and everything, and then we protect it as such.

Senator INHOFE. Sure. Well, you don't need to detail any more of it, but it sounds like you're on to this and you recognize that the problem exists, and you're in a position to take care of it.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Inhofe.

Senator Hassan?

STATEMENT OF HON. MAGGIE HASSAN, U.S. SENATOR FROM NEW HAMPSHIRE

Senator HASSAN. Thank you, Mr. Chair and Ranking Member.

To the panel, thank you all for being here this morning.

When many individuals discuss the development and scaling of automatic vehicles, it's often in the context of breaking down barriers for individuals who are not currently able to drive a vehicle. In 2015, the National Council on Disabilities released a report titled "Self-driving Cars: Mapping Access to a Technology Revolution." This report recognized the promise that this technology holds for individuals with disabilities while at the same time highlighted some challenges of independent use of these vehicles, such as the integration of accessibility and assistive technology, mapping system accuracy, and equipment failure.

Keeping these challenges in mind, I'd ask anybody on the panel who would like to address it: What role do you see in automated vehicles providing greater access for individuals who experience disabilities? And then the add-on to that is that we've seen time and again that advanced technology best serves individuals who need it most when those individuals are part of the development process to ensure accessibility. So what can the industry and local, state, and Federal Government do to ensure that people with disabilities are included in the development and rollout of this technology, from licensing issues, insurance, design, usability?

Mr. MADDOX. I'll start.

Senator HASSAN. Sure.

Mr. MADDOX. I wholeheartedly agree that automated vehicle technology could be extremely beneficial for those who don't have access to transportation for many different reasons. Equity in transportation is something that I think, over the next 20 years, we will build a greater and greater, more thorough understanding of and a more comprehensive solution set than we have today. There's no question about it. Automated vehicles will play a strong role in that.

I think it's critical if we think about how to accelerate automated vehicles—and this is really Level 4, Level 5, the highly automated

vehicles. Demonstration programs really are key. We need to actually put them on our streets, first in small numbers, but in ever-increasing numbers. That will provide the opportunity for this group of folks who don't have equitable access now to really experience the technology, and it does come back to consumer education. It is critical to educate every transportation user, and that's probably everybody in this room, for sure, if we walk or drive to work or to the office.

So I think that really involving that community—the best way to do it is through demonstration programs where they can learn firsthand and provide input to the designer of the vehicle or the system.

Senator HASSAN. Thank you.

Mr. Csongor?

Mr. CSONGOR. This is a subject particularly dear to my heart. My mother lives in a retirement community, and I've had a chance to talk to them, and they're very excited about this potential. I think that one of the interesting applications of AV vehicle technology is actually even beyond the self-driving cars that he mentioned, but also in the introduction of autonomous scooters or shuttles.

We're working with startup companies in shuttles and scooters that actually have the potential to be deployed much sooner to these people, and the reason being that, for example, if you had shuttles within a community, a retirement community, it's what we call a geo-fenced area. You don't have to have it operate all over the world. So the potential for rapid deployment to help these types of communities is actually very exciting.

Senator HASSAN. Anybody else want to comment? Mr. Bainwol?

Mr. BAINWOL. I'd just add that's precisely the right point. In a geo-fence context, it's going to happen sooner rather than later. To realize the full potential of what you're asking really is Level 5, though, and as we've talked about, the transition is a long one. So from a congressional perspective, if that's the focus, then the mission is to accelerate that day that we get to Level 5, and that means public policy that is geared toward accelerating the future.

Senator HASSAN. I would just ask you all—as we think about piloting, getting upfront input from people who experience disabilities before the product is finalized is really, really critical. We see this right now. We're having to upgrade and change a lot of existing technology for accessibility purposes, and if you can include the community sooner rather than later, I think it streamlines the whole process, and you learn that when you address issues with people with disabilities, you often address convenience and other issues for the general public as well.

Because I am running out of time, I will make sure we submit this question to you all in writing. But, you know, the other thing that strikes me is as we discuss infrastructure, generally, for transportation in this country, it would be very useful to get your input about what a new generation of infrastructure should include, whether it has particular kinds of street lights, cameras, clear roadway lines, adequate signage, et cetera, to accommodate these vehicles. And I'll look forward to your written answers to that. Thank you very much.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Hassan.

Senator Blumenthal.

STATEMENT OF HON. RICHARD BLUMENTHAL, U.S. SENATOR FROM CONNECTICUT

Senator BLUMENTHAL. Thanks, Mr. Chairman. Thank you for having this hearing.

Ms. Sheehey-Church, I want to thank you for coming from Connecticut, from Madison, where I believe you live, and for sharing your really tragic story about your son. As a father of four, I can't imagine your loss. It's every parent's worst nightmare. So I'm particularly grateful that you've come to Washington, but also for your tremendous work and that of Mothers Against Drunk Driving throughout Connecticut and our Nation.

I've been very, very privileged and proud to work with MADD over many years as Attorney General and now as a U.S. Senator and know full well that too many families have been devastated by this continuing scourge. We tend to focus on the issue of the moment while young people, really people of all ages, continue to perish as a result of this fully preventable condition.

I would like to ask you perhaps if you could reflect why we should be especially careful about semi-autonomous vehicles and the possibility that it may create a false sense of security?

Ms. SHEEHEY-CHURCH. Thank you, Senator Blumenthal. I think in the beginning when I talked about MADD's concerns and MADD's four principles, we were really looking at 4 and 5. That's the level that we have to look at, because zero through 3 does have the capability of human interaction. So I'll borrow a phrase from my colleague here that when we talk about artificial intelligence in that 4 and 5, it really does go far beyond what humans can do.

So when I look at AVs myself, and I take out my role as National President, and I look at my role as a parent or as a mom, and I look at AVs—and, again, just relating myself to the 4s and 5s—there needs to be a cure to stop 35,000 deaths that—not only drunk driving deaths, but there are also behavioral traffic-related deaths—that we have the opportunity to have a cure here, and the AVs themselves, the 4s and 5s, could actually be that vaccine that we could utilize across the country to save more lives. So I'd have to answer it, in terms of self-driving, I'm really looking at 4 and 5 as being that vaccine over time.

Senator BLUMENTHAL. And do you think it's important that NHTSA make sure that certain safety features are mandatory in all vehicles so that drivers and individuals know what to expect, not only for their sake, but for the sake of people who are driving on the road unaware about the lack of those safety features?

Ms. SHEEHEY-CHURCH. Oh, absolutely. I mean, just like with seatbelts, when we needed to educate, it's like we're educating on ignition interlocks right now. So now the consumer acceptance will only come with pure education on what AVs can do. So it's really—I beg that NHTSA and the auto industry and safety advocates really sit at the table and all have a collaborated effort in bringing the AVs—we all want the same thing. We want safety. Safety comes first. So when I say that, you know, before anything is rolled out in masses, that safety is our number one concern, and every one

of these individuals in the auto industry, safety advocates, have to be at that table to be able to collaborate together.

Senator BLUMENTHAL. Mr. Maddox, how do we make sure that voluntary standards regarding safety are adopted?

Mr. MADDOX. I think the key there is that we enter into the activity to create those voluntary standards with a number of outcomes in mind, certainly one of them being the creation—the support for the creation of FMVSS. So if you look at the history of safety technology over the decades, every major safety technology on our vehicle today started with that voluntary standard approach.

So if we use that, there's no reason we can't continue that process that works for automated vehicles. It is much more complex. As Mr. Csongor has pointed out, the data involved here is far, far higher—in order of magnitude, higher than prior safety technologies. So the key is for NHTSA, U.S. DOT, the auto industry, and other stakeholders to really get together and decide what's the end game, what voluntary standards would be needed to enable the technology to be deployed at scale, and, very specifically, which pieces of those voluntary standards would inform future Federal regulations.

Senator BLUMENTHAL. Thank you. Thank you all for being here. I appreciate your excellent testimony today.

The CHAIRMAN. Thank you, Senator Blumenthal.

Senator Klobuchar?

STATEMENT OF HON. AMY KLOBUCHAR, U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Thank you very much. Thank you for being here.

I wanted to thank you, specifically, for your work, Ms. Sheehey-Church. As you know, as a former prosecutor, I did a lot of work with MADD, and we passed finally in Minnesota the felony DWI law, which was helpful, and I am supportive of your words about how technology can help as well.

Mr. Bainwol, I think I would start with you. As you know, fully autonomous vehicles are still a few years out. What technology is on the road now to intervene if a driver is distracted behind the wheel?

Mr. BAINWOL. Good question. There are——

Senator KLOBUCHAR. It's hard to find questions to ask after everyone has asked them. So I really appreciate that. Thank you.

Mr. BAINWOL. Yes. So you did a good job. So, generally, crash avoidance technologies are the answer to your question. Automatic braking is probably the best example, where the car will brake for the driver if the driver is not engaged soon enough. Drivers should not drive in a distracted situation. We shouldn't rely entirely on the car to make up for human error.

There's a human responsibility here, and there's no question that, as a society, we can do the same kinds of things we did with MADD, the success of MADD, that kind of changed the culture. We need to do the same with distraction. But there are technologies that will help, and emergency braking is probably the best example.

Senator KLOBUCHAR. I think so.

Mr. Maddox, as we see these changes coming upon us, what are some of the steps that can be taken to ensure consumers understand this with some of the current changes that are there? I just picture people running cars and not used to it or people getting a new car. I know I had the same car for—now my car confessions occur—for 12 years, a Saturn. It was great, and then it got a hole where I put the brake down in the actual——

[Laughter.]

Senator KLOBUCHAR. So I got a new car, which I truly enjoy, a Malibu, and it has some of the brakes—if you go over the lane a little bit, it sort of jerks you back, and at first, even though they told me about it, it was a surprise. So I'm just picturing some of this. How do you educate consumers?

Mr. MADDOX. I think that is another great question. Certainly, I would commend—NHTSA has undertaken a program. I think it's called My Car Does What?, and it's actually being implemented——

Senator KLOBUCHAR. That seems like a perfect thing for me.

Mr. MADDOX. Exactly, I think, for a lot of us, as a matter of fact, even us experts. We don't get to drive every car with every little nuance of technology. So I think that educating the consumers on what their vehicle does and what it doesn't do——

Senator KLOBUCHAR. And the limits as well. Senator Hoeven and I have led a lot of efforts on distracted driving and got a bill passed just recently with Senator Thune's help. Thank you. It was part of the FAST Act, which allowed some of the grants to go out for education efforts to the states on distracted driving. For a while, only one state was getting the money: Connecticut.

[Laughter.]

Senator KLOBUCHAR. So I think this will have to be a major part of the effort.

Mr. MADDOX. Yes. In fact, I would add that with the automated vehicle proving ground program, we are looking at how to utilize those 10 sites to do that consumer education. Imagine—what we're considering in Michigan is that on the second Sunday or the fourth Sunday in every month, we would invite the public in and let them actually experience this technology in a vehicle—maybe they don't own it yet—because, really, driving it and experiencing it is worth a thousand words and pictures.

Senator KLOBUCHAR. Let me just go to a few quick questions for you, Mr. Maddox.

Mr. MADDOX. Sure.

Senator KLOBUCHAR. Ensuring that highway construction workers are safe in a work zone is critical to the testing and deployment of connected automated vehicles. Since work zones often temporarily block off lanes and redirect traffic flow, they can be difficult to navigate, even for experienced drivers. Do you believe it would improve safety if temporary traffic control devices could send safety related information to the sensors on the vehicles?

Mr. MADDOX. Absolutely. In fact, it's a great V to I application. The V to I and V to V really are critical for automated vehicles, also.

Senator KLOBUCHAR. OK. Thank you. Last question. Senator Hoeven and I also worked on a bill to make it clear that the owner

of a vehicle also owns any information collected by an onboard event data recorder. It was signed into law also as part of the FAST Act.

Mr. Maddox, connected vehicles will collect and share large amounts of data. What protections should be in place to keep consumers' personal information secure?

Mr. MADDOX. I can't say that I've got a comprehensive answer to that question at this point. I do believe that we do need to establish rules on that data ownership, and it does seem that the owner or the operator of the vehicle should be the owner of the data.

Senator KLOBUCHAR. And, obviously, for emergencies and for crash sites and things like that, you would want more information to go to the authorities.

Thank you very much, and I appreciate all of you.

Senator PETERS [presiding]. Senator Cantwell?

STATEMENT OF HON. MARIA CANTWELL, U.S. SENATOR FROM WASHINGTON

Senator CANTWELL. Thank you, Mr. Chairman, and thanks to the witnesses.

This industry, I think, is estimated to generate something like $7 trillion by 2050, so we certainly want to continue to see the innovation and are proud that Washington and Kirkland, Washington, specifically, have also been some of the early adopters to enabling this kind of testing.

I wanted to ask you, Mr. Csongor, about working with the trucking industry, particularly PACCAR. You know, from the aviation side, these efficiencies have got pilots doing very little manual operation of our airplanes, and these kinds of innovations can also reduce the demand on drivers. But the obvious efficiencies that we need to get out of freight is very important for my state, very important for the movement of freight.

What do you think that this will do to help us on efficiencies?

Mr. CSONGOR. That's a great question. We actually, I think, as you may know, are working with PACCAR, and we had actually shown a video and demonstrated a PACCAR truck running on basically a computer very similar to this one. So the truck is able to drive and maintain in the lanes, and the deployment of this product is up to PACCAR and to decide how they want to do it and what the policy is. But the capability, certainly, to reduce driver fatigue and to assist the trucker is certainly there and could be deployed fairly soon.

Now, it's very hard to predict the evolution of jobs with the introduction of this technology. The role of a pilot has changed, but the job remains. So with regard to the trucking industry, I think the most immediate benefit would be trucker fatigue. But then the actual implementation of it and how it affects it I would have to defer to someone from that industry.

Senator CANTWELL. What about fuel efficiency? That's not in the target?

Mr. CSONGOR. Oh, it is. As you can imagine, having a computer driving, it would obviously be able to drive more efficiently than a human would and do it with very little effort. So I think that there is also financial benefits to the truckers beyond safety.

Senator CANTWELL. Fuel efficiency for us in the Northwest is a very big issue because we have some of the highest gas prices in the Nation as our supply comes from Alaska and is a somewhat limited market. Anything that helps us drive efficiencies on fuel is very, very important for us in maintaining what is one in three jobs related to trade.

Being a big importer of a lot of products, moving them through the country cost effectively or moving agricultural products out of the Midwest through our ports—all of this is about reducing fuel costs and efficiencies to make operations more successful. If we don't, it goes to Canada or somewhere else. I don't know if anybody else, perhaps Mr. Maddox, wanted to comment on that.

Mr. MADDOX. I would like to comment on that, actually. I totally agree with you. You know, the cost of moving goods, especially in a large geographic area of the United States, really is critical. It's a critical economic issue, competitiveness issue for us. Automated and connected technology can enable truck platooning, which brings significant fuel economy and potential savings, and up even in the 10 percent range. That's a number unheard of with most other vehicle efficiency technologies that are on the near horizon.

Senator CANTWELL. You want to elaborate on platooning a little bit?

Mr. MADDOX. I'm sorry. My apologies. Platooning is where one vehicle follows another very closely. In the case of a truck, it could be anywhere as short as 15 feet but probably more like 25 to 40 feet behind the leading truck. Automation with connection can enable that technology with or without a driver in the lead—certainly in the lead vehicle or the following vehicles.

The key point, though, is the efficiency benefit, if it's the following trucks, as well as the leading truck. So any technology that could deliver a 10 percent fuel savings has to be examined in great detail, especially for a country the size of the United States.

Senator CANTWELL. Well, thank you for bringing that up. I really do think it is about competitiveness, and I know we have many challenges. I know here, we're always saying, "This is Washington and we want to regulate," and I keep saying, "I'm from Washington and we want to innovate." And the innovation aspect of this is critically important, so I hope our state continues to innovate in this area.

Thank you.

Senator PETERS. Thank you, Senator Cantwell.

Senator Udall?

STATEMENT OF HON. TOM UDALL,
U.S. SENATOR FROM NEW MEXICO

Senator UDALL. Thank you, Senator Peters, very much, and I thank the panelists today. I think this has been a very productive discussion we've had here.

I'm particularly interested in autonomous and semi-autonomous vehicles because Rio Rancho, New Mexico, is home to a major Intel semiconductor fabrication plant, and Intel's facility is an economic anchor for that city and central New Mexico as a whole, providing high-paying jobs to New Mexico STEM graduates. This facility in Rio Rancho, this Intel facility, makes some of the semiconductors

used in modern high-tech vehicle technology. So I'm going to be following this very closely and look forward to, if there are additional questions, submitting some to the record.

But my first question is to Ms. Sheehey-Church and has to do with the safety aspects of autonomous vehicles. This technology has the promise to reduce crashes and fatalities, as you've talked about a little bit here, including those from drunk driving. As you know, I've worked with MADD for many years, going back to my service as Attorney General in New Mexico. We had a comprehensive package that we put in, working with MADD, that really reduced drunk driving and drunk driving deaths in New Mexico.

I'm sure that MADD is looking past the industry hype and enthusiasm and is focused on safety and saving lives. So while the benefits of self-driving technology for drunk driving are obvious at first blush, we must remember that the intoxicated person could be sitting at the wheel of an autonomous vehicle and could take over at any time, especially if there's an issue that requires human intervention. Some states have proposed laws on this topic.

Should an autonomous vehicle be required to have technology to prevent an intoxicated person from taking control of the wheel?

Ms. SHEEHEY-CHURCH. Senator, that's a great question, and I don't know if I have the full answer to it, whether they will or will not have that. I know that DADSS in itself in AV vehicles, the 4 and 5 levels, are great complements to each other, but in terms of digging deeper into the AV technicalities, I'm not a technical expert. I only play one on TV. So I can't tell you what exactly is going to be in that. I'd have to probably defer to one of my colleagues to see if that was going to be. But I'm in full agreement that if that individual can take over at any time, that is a concern, obviously, for MADD.

Senator UDALL. Yes. And you mentioned DADSS, and that's a very important part of this as developing technology——

Ms. SHEEHEY-CHURCH. Absolutely.

Senator UDALL.—so that vehicles won't be turned over to an intoxicated person. Now, what are your key recommendations for Congress and Federal agencies to ensure that this technology develops so we can realize the safety potential of autonomous vehicles to eliminate drunk driving deaths?

Ms. SHEEHEY-CHURCH. I go back, Senator, to the four principles that I said in my written testimony. It is really looking at and supporting the Federal regulatory framework. There's the need for that, and also supporting the existing state systems that we have. See, you're not listening and that's why you're tapping him on the shoulder, because I would do that if I was up there.

[Laughter.]

Senator UDALL. No——

Senator MARKEY. We're both listening.

Senator UDALL. Yes. We're both listening.

Ms. SHEEHEY-CHURCH. Just kidding. Just kidding. And, really, the support on MADD's side for Levels 4 and 5 is really looking at that in terms of the technologies, but also really supporting and evaluating the technology and the data that we need to get, evaluating the data as this whole thing evolves. I know we've got skeptics on the fence. We are not going to dismiss that. But I think the

more that NHTSA, the governing bodies, the auto industry, and the safety advocates can sit at the same table, we can start to overcome those, and, obviously, from MADD's point of view, we'd like to overcome them sooner rather than later.

Senator UDALL. Do any of the other panelists have comments on the safety issue?

Mr. CSONGOR. The safety issue, I think, is very important, as we've talked about, and I very much agree with what she said. The safety issue on both protection of the data as well as protection of the system is something that I think will be solved, like we've solved other computer problems—a combination of industry standards and the right regulations that help support them, and I think working together, and I think the devil is in the details.

Senator UDALL. Thank you very much.

Senator PETERS. Thank you, Senator Udall.

Senator Markey?

STATEMENT OF HON. EDWARD MARKEY, U.S. SENATOR FROM MASSACHUSETTS

Senator MARKEY. Thank you, Mr. Chairman, very much.

Ms. Sheehey-Church, we were—believe me, I was listening very intently.

Ms. SHEEHEY-CHURCH. I'm only kidding. It's that kind of—like a squirrel, I'm looking at anybody.

Senator MARKEY. No, no, I know it. I was run over by a car when I was five years old, and nothing will focus you so much on an issue like vehicle safety as event like that. So I thank you for all your great work, historic work, on these issues over the years.

Autonomous vehicles are just computers without drivers. That's all they are. And as we move to the future, we then have to ensure that we are going to build in all of the human values that we want to see built into these new computers that will be riding around on the streets of America.

Senator Blumenthal and I, in 2013 and again last year, asked 20 automakers what they're doing to protect these computers on wheels. Here's what we learned. We learned that thieves no longer need a crowbar to break into your car. They just need an iPhone. A few years ago, we witnessed firsthand how easily cars can be hacked. We watched as hackers remotely took control of the brakes, the steering, and the acceleration of a Jeep Cherokee. Chrysler had to recall 1.4 million vehicles to fix this cybersecurity problem.

Rather than addressing the cybersecurity problems after a hack has occurred, we must ensure that robust cybersecurity protections are built into the design, the construction, and operation of these transportation technologies, particularly as we move into this new era very quickly. That's why Senator Blumenthal and I have introduced legislation once again, the Spy Car Act, that directs NHTSA and the Federal Trade Commission to establish Federal standards to secure our cars and to protect our privacy.

We should not have to choose, as Americans, between being connected and being protected. This should not be a tension. These issues should all be solved before the new era unfolds. So, if you could, each panelist, just give me your answer as to whether or not you believe cars should have mandatory cybersecurity standards,

including hacking protections that protect all access points in a car; data security measures that prevent unwanted access to all collected information; and hacking mitigation technologies that can detect, report, and stop hacking attempts in real time. Should that be a requirement so that these hackers can't get into the system?

Mr. Bainwol, yes or no? Should we have those standards?

Mr. BAINWOL. The short answer is no. The longer answer is we share your concern and we share your objective, but we think that the best way to realize your objective is to have a dynamic approach, and our fear is that standards would become obsolete very quickly.

Senator MARKEY. I appreciate that, but I don't agree with you.

Mr. Csongor—you need dynamic mandatory standards. You're right. The standard could keep getting raised, but to have no standard would be extremely dangerous. That's the world I grew up in, with no seatbelts, no airbags, the steering wheel made out of metal, and so that just can't be the standard as we move into this computer world, from my perspective.

Mr. Csongor?

Mr. CSONGOR. Senator Markey, I'd certainly agree with the goal that you're describing. I'm not sure about the implementation of it, particularly when you talk about the ability of the car to be able to heal itself or to be able to solve the problem. We don't know what we don't know, and cybersecurity is not something that we fix once and then it's done.

Senator MARKEY. Exactly.

Mr. CSONGOR. It's something that you're battling continuously.

Senator MARKEY. Exactly. And should the industry be mandated to be fighting it continuously? Should that be part of the NHTSA rules?

Mr. CSONGOR. Right. I think the only question is just what's the right balance and——

Senator MARKEY. Right. But the balance should be that it can't be hacked and that the constant high standard that the industry has to meet is one that protects against that. Do you think that's a reasonable goal to set?

Mr. CSONGOR. I think that's a reasonable goal.

Senator MARKEY. Thank you.

Let me ask you, Ms. Sheehey-Church. Do you agree with that?

Ms. SHEEHEY-CHURCH. Senator, I think it's a reasonable expectation, but in the position that I am and with the staff that we work with as we work with the panelists, I'm not at this time able to answer the question on what could be put on to the NHTSA for regulations on hacking. I appreciate the question.

Senator MARKEY. I got you.

Ms. SHEEHEY-CHURCH. I think it's a serious concern, but I can't answer it at this time.

Senator MARKEY. Mr. Maddox?

Mr. MADDOX. I think the nature of the risk for cybersecurity is changing so quickly, voluntary standards, frankly, have a better opportunity to keep up with that changing risk than any regulation could. Second, I do believe that we need to think about transportation cybersecurity as a system—security in our vehicles, security in our traffic control, security in our signs, security even in the

communication systems that we rely on increasingly for transportation. So I think voluntary standards would likely have a more effective result.

Senator MARKEY. I think the history, though, shows that with airbags and with seatbelts, et cetera, unless there's a mandate, it's just not accomplished unless you actually pass laws out of this committee nationally. The industry moves slowly, and so the best players move voluntarily. The worst players don't, and the worst players are the ones that cause all the damage out on the highways. So you need to have, you know, those protections so that there is that minimum standard.

And I think that, you know, just as part of this conversation, it's good as we start in this era that we begin to have this discussion, because to a certain extent, there's a repetition syndrome, where the industry is going to be promoting all the wonderful aspects of it, but there's a Dickensian aspect to the Internet, which is what we're talking about here, just to talk about computers. It's the best of technologies and it's the worst of technologies. It's a technology that can enable and ennoble and it's a technology that can degrade and debase and harm families. So it's both at the same time.

Talking about all the great things has to be accompanied by what we're going to do to minimize the bad things that can happen. By ignoring that discussion, we ignore the central concerns that families will have about safety and there will be a lot of concerns families are going to have about autonomous vehicles and the safety of their children in those vehicles.

From my perspective, what I want to hear in the weeks, months, and years to come is that any standards would require computers on wheels to constantly update and patch themselves for any vulnerabilities. I believe that has to be mandatory. You can't just leave it up to any one auto manufacturer to do it. You have to have every one of the players accepting that as a responsibility. Otherwise, the streets won't be safer. These vehicles will be very dangerous. These vehicles will be hacked. These vehicles will subject families to the kind of tragedies that we're trying to protect against.

So you have to build in both simultaneously. I mean, it's the best and the worst, you know, in any technology, and each technology is only as good as the values which we, as a people, animate those technologies with. How high of a standard do we want to make sure that we protect families against the downside of that technology. And, by the way, that's every technology. None of them are exempt from that kind of a situation.

That will be my concern going forward, because I obviously want to see a revolution occur, but not with kind of panglossian glasses that ignore the fact that there are vulnerabilities. I know what happens when those safeguards are not in place.

Thank you, Mr. Chairman.

Senator PETERS. Thank you, Senator Markey.

Before we close out the hearing, I need to take care of a little housekeeping, if you could bear with me. I would ask unanimous consent to include in the record letters from stakeholders providing additional perspective on today's hearing, including a statement from the Advocates on Highway and Auto Safety, the American

Car Rental Association, Continental, the Property Casualty Insurers Association of America, and Uber Technologies, Incorporated. Hearing no objection.

[The information referred to can be found in the Appendix.]

Senator PETERS. One final note. The hearing record will remain open for 2 weeks. During this time, Senators are asked to submit any questions for the record. Upon receipt, the witnesses are requested to submit their written answers to the Committee as soon as possible.

So in closing, I just want to thank our four witnesses for what I think was incredible testimony dealing with incredible technology that will surely be transformative. Thank you for your time today. We look forward to working with you in the years ahead.

With that, this hearing is now adjourned.

[Whereupon, at 12 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF JACQUELINE S. GILLAN, PRESIDENT, ADVOCATES FOR HIGHWAY AND AUTO SAFETY

Introduction

Advocates for Highway and Auto Safety (Advocates) is a coalition of public health, safety, and consumer organizations, insurers and insurance agents that promotes highway and auto safety through the adoption of Federal and state laws, policies and regulations. Advocates is unique both in its board composition and its mission of advancing safer vehicles, safer drivers and safer roads. We respectfully request that this statement and the comments Advocates submitted to the public docket in response to the National Highway Traffic Safety Administration (NHTSA) "Federal Automated Vehicles Policy" (AV Guidelines) Notice and Request for Comments,[i] which are attached, be included in the hearing record.

Motor Vehicle Deaths are Climbing

According to the Federal Government, each year motor vehicle crashes kill tens of thousands and injure millions more at a cost to society of over $800 billion.[ii] Unfortunately, deaths resulting from motor vehicle crashes are on the rise. According to NHTSA, in 2015 our Nation experienced the largest percentage increase of motor vehicle deaths in nearly fifty years.[iii] More than 35,000 people were killed on our Nation's roads, representing a 7.2 percent upturn.[iv] Preliminary information for the first nine months of 2016 appears to be even worse, indicating an 8 percent rise in fatalities compared to the same time period in 2015.[v] Advocates firmly believes that automated vehicle (AV) technology has the potential to make significant and lasting reductions in this mortality and morbidity toll.

Advocates Has Consistently Promoted Advanced Technologies in Vehicles to Save Lives and Prevent Injuries

Advocates has always enthusiastically championed vehicle safety technology and for good reason. It is one of the most effective strategies for preventing deaths and injuries. NHTSA has estimated that since 1960, over 600,000 lives have been saved by motor vehicle safety technologies.[vi] In 1991, Advocates led the coalition that supported bipartisan legislation sponsored by former Senators John Danforth (R–MO) and Richard Bryan (D–NV) that included the airbag mandate in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.[vii] As a result, by 1997, every new car sold in the United States was equipped with a front seat airbag and the lives saved have been significant. In fact, airbags save over 2,000 lives annually.[viii]

Advocates continued to build on this success by supporting additional lifesaving technologies as standard equipment in all vehicles in other legislation and regu-

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[i] 281 F.R. 65703 (Sept. 23, 2016); DOT Docket No. NHTSA–2016–0090.

[ii] The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (Revised), HS 812 013, U.S. DOT, NHTSA (May 2015 (Revised)), available at *http://www-nrd.nhtsa.dot.gov/Pubs/812013.pdf.* (NHTSA Cost of Motor Vehicle Crashes Report).

[iii] National Center for Statistics and Analysis, *2015 motor vehicle crashes: Overview,* Report No. DOT HS 812 318, National Highway Traffic Safety Administration (Aug. 2016).

[iv] *Id.*

[v] National Center for Statistics and Analysis, *Early Estimate of Motor Vehicle Traffic Fatalities for the First 9 Months of 2016,* Report No. DOT HS 812 358, National Highway Traffic Safety Administration (Jan. 2017).

[vi] Lives Saved by Vehicle Safety Technologies and Associated Federal Motor Vehicle Safety Standards, 1960 to 2012, DOT HS 812 069 (NHTSA, 2015); See also, NHTSA AV Policy, Executive Summary, p. 5 endnote 1.

[vii] Pub. L. 102–240 (Dec. 18, 1991).

[viii] National Center for Statistics and Analysis, Lives Saved in 2015 by Restraint Use and Minimum-Drinking-Age Laws, National Highway Traffic Safety Administration, Report No. DOT HS 812 319 (Aug. 2016).

latory proposals. These efforts included: tire pressure monitoring systems;[ix] rear outboard 3-point seat belts;[x] electronic stability control;[xi] rear seat belt reminder systems;[xii] rear view cameras;[xiii] brake transmission interlocks;[xiv] seat belts on motorcoaches;[xv] electronic logging devices;[xvi] and, crash avoidance systems such as automatic emergency braking. These safety advances have saved hundreds of thousands of lives and have been accomplished because of the bipartisan leadership of the Members of the Senate Commerce, Science and Transportation Committee.

NHTSA Has a Statutory Duty to the Public to Ensure the Safety of Autonomous Vehicles

Fifty years ago, Congress passed the National Traffic and Motor Vehicle Safety Act of 1966 because of concerns about the death and injury toll on our highways.[xvii] The law required the Federal Government to establish Federal motor vehicle safety standards (FMVSS) to protect the public against "unreasonable risk of accidents occurring as a result of the design, construction or performance of motor vehicles."[xviii] While motor vehicles have changed dramatically since that time and will continue to do so in the future, the underlying premise of this prescient law and NHTSA's safety mission have not.

Unfortunately, NHTSA has chosen to issue only "voluntary guidelines" for the development of AVs. Voluntary guidelines are not legally binding, are unenforceable and, therefore, are inadequate to ensure safety and protect the public. Manufacturers may choose to deviate from the guidelines or ignore them entirely at any time and for any reason including internal corporate priorities such as cost or marketing considerations. In addition, some entities may choose to follow the guidelines while others may not, creating a dangerous patchwork of noncompliance. Consumers and NHTSA also have no legal recourse against a manufacturer's failure to follow the guidelines. NHTSA cannot bring an enforcement action, force a statutory recall, or even influence a voluntary recall for failure to abide by the guidelines.

A Functional Safety Approach is Essential to Provide the Framework for the Design, Development and Deployment of Autonomous Vehicle Technology

Before the widespread introduction of AV technology to the commercial marketplace and deployment on public roads, NHTSA must establish basic safeguards to protect the public. Advocates strongly recommends that AV manufacturers be required to meet a "functional safety standard" to guarantee safety to the maximum extent feasible of the overall system performance. While manufacturers will still have to certify vehicles meet all applicable FMVSS that address the mechanical operation of vehicle safety systems, a functional safety standard would apply to the AV operating system to ensure that the controlling software performs as designed.

Functional safety is a well-known process by which a product is designed, developed, manufactured and deployed to ensure that the product, as a whole, will function safely, as intended, and will prevent or mitigate misuse which could lead to unsafe conditions. A similar process is currently utilized by the Federal Aviation Administration (FAA) in portions of its regulations to ensure safety while encouraging innovation.[xix]

Additionally, the submission of a Safety Assessment Letter (SAL) must be mandatory and not at the whim or choice of a manufacturer. There is too much at stake to allow optional and discretionary adherence. Under a functional safety standard, a manufacturer must certify to NHTSA through the mandatory submission of a SAL that the AV has been tested to ensure that it will operate properly and safely under the conditions the vehicle is designed to encounter (*i.e.,* congestion, weather and road conditions, human/machine interface and vehicle interaction with other road

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[ix] Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, Pub. L. 106–414 (Nov. 1, 2000).

[x] Anton's Law, Pub. L. 107–318 (Dec. 4, 2002).

[xi] Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA–LU), Pub. L. 109–59 (Aug. 10, 2005).

[xii] *Id.*

[xiii] Cameron Gulbransen Kids Transportation Safety Act of 2007, Pub. L. 110–189 (Feb. 28, 2008).

[xiv] *Id.*

[xv] Moving Ahead for Progress in the 21st Century (MAP–21) Act, Pub. L. 112–141 (Jan. 3, 2012).

[xvi] *Id.*

[xvii] Pub. L. 89–563 (Sept. 9, 1966).

[xviii] Title 49, U.S.C. Sec. 30102.

[xix] See, *e.g.,* 14 USC Subpart F—Equipment, §§ 25.1301, *Function and installation,* and 25.1309, *Equipment, systems, and installations.*

users). The mandatory submission of the SAL should include all information required by the Secretary of Transportation including test results and data to support the conclusion that the AV system functions as designed. This submission should also include any negative test results and data that may indicate the AV system did not always function as designed along with information and data indicating how these issues were resolved by the manufacturer. In addition, any and all documentation regarding how cybersecurity threats were addressed should be included.

Prior to introduction of the AV system into the stream of commerce, NHTSA would review the SAL, test results and data, and then consult with the manufacturer. The manufacturer would be required to respond to any questions or concerns from the agency. This process is intended to allow NHTSA to bring to the manufacturer's attention any issues and/or problems the agency identifies in the SAL information, tests results and data supplied by the manufacturer prior to introduction of the AV system into the marketplace. This process would provide NHTSA with technical information about products coming to market and provide AV manufacturers with technical feedback in an efficient and effective process. The SAL and the questions raised by NHTSA, however, are not intended as pre-market approval. The manufacturer, after having responded to the agency's inquiries, may introduce the AV system into the stream of commerce.

Additional Authorities and Resources are Critical

Regulating AVs presents unique challenges for NHTSA, and those issues warrant the agency being given additional tools to protect against potentially catastrophic defects. Flaws or viruses in computer software of AVs could adversely affect thousands of vehicles simultaneously. The NHTSA, therefore, must be given imminent hazard authority in order to expedite the grounding of vehicles that the agency has identified as having a potentially dangerous software problem that could lead to crashes, deaths and injuries. Also, because of the potential serious nature of any software problem that could affect thousands of vehicles and result in deaths and injuries, the ability to levy criminal penalties is essential. Criminal penalties will deter manufacturers and suppliers from knowingly and willfully permitting the manufacture and sale of AV systems with flawed software operating systems that could pose a danger to human life in the event of a crash.

Providing further broad statutory exemptions from the FMVSS for AVs is both unnecessary and unwise. There is already a statutory process in place for manufacturers to seek an exemption from the FMVSS that Congress enacted only two years ago. Pursuant to Section 24404 of the Fixing America's Surface Transportation (FAST) Act[xx] codified at 49 USC Section 30112(b)(10), manufacturers of AVs are permitted an unlimited number of vehicles that can be exempt from one or more of the FMVSS for testing or evaluation. Exempt vehicles under this provision may not be sold or resold to the public. Furthermore, under 49 USC Section 30113 a manufacturer may receive an exemption from compliance with the FMVSS for the sale of a vehicle for not more than 2,500 vehicles to be sold in the United States in any 12-month period. Until a functional safety standard is applied to AVs, this cap should not be raised from its current level.

Manufacturers may seek appropriate exemptions under the current process until NHTSA revises the FMVSS for level 4 and 5 AVs. However, while level 4 and 5 AVs may be exempt from parts of certain FMVSS or other regulations, much of the performance standards for safety systems would still apply. For example, even if a brake pedal is not needed for AV control, the rest of the brake system requirements in FMVSS 135 will still be needed to ensure the AV controls can stop the vehicle within the required stopping distance. Even for level 4 and 5 AVs, manufacturers will still have to certify to most performance requirements of the existing FMVSS. However, because level 2 and 3 AVs will still require significant operation by a human driver, these vehicles should not be exempt from compliance with the current body of FMVSS and regulations.

Vehicle and technology companies are already putting some AVs out on public roads and beginning to market these systems to the public. The development of AV technology is not just taking place in the United States. In fact, AVs are being tested throughout the globe in places such as the United Arab Emirates and Singapore.[xxi] Vehicles imported from overseas have to meet the requirements of the

[xx] Pub. L. 112–141 (Dec. 4, 2015).

[xxi] 2025 AD Newsletter, MIDDLE EAST COMBATS ROAD DEATHS WITH DRIVERLESS CARS (Nov. 2016) available at: *https://www.2025ad.com/the-week-in-ad/arab-emirates-driverless-cars/; Andrew Hawkins, One of Europe's largest carmakers will test its self-driving cars in Singapore,* The Verge (May 3, 2017).

FMVSS. However, if only voluntary guidelines are in place for AVs, foreign companies and entities may export products that are dangerously unsafe and NHTSA will have little recourse. In addition, some in the motor carrier industry have predicted that automated technology will be placed in trucks before passenger vehicles.[xxii] The potential for an 80,000 pound rig using untested and unregulated technology on public roads is a very real scenario if NHTSA continues to merely rely on voluntary guidelines and the "good intentions" of manufacturers introducing automated technology.

It is essential that NHTSA immediately adopt a functional safety standard to minimize public exposure to unreasonable risks of motor vehicle crashes involving these experimental systems. For example, the fatal crash of a Tesla Model S in Florida in May 2016, could have been averted had a functional safety standard required due diligence testing of the Autopilot System prior to deployment. The driver was using the Tesla Autopilot system when the vehicle passed under the side of a truck trailer that was turning across the highway, resulting in the fatality of the driver. After the crash, Tesla admitted to NHTSA that it had considered misuse of the Autopilot system including distracted driving and the use of the system outside preferred environments and conditions. Under a functional safety standard, if the misuse was foreseeable, Tesla would be required to address the misuse prior to confirmation to NHTSA that the vehicle was safe.

Recommendations:

- *NHTSA must require that manufacturers meet a "functional safety standard" to guarantee safety of AVs before they are introduced into the marketplace.*
- *Manufacturers must be required to submit a Safety Assessment Letter (SAL) that confirms that the AV has been tested to ensure it operates safely. The SAL should include all of the test results and data to support the conclusion that the AV system functions as designed.*
- *NHTSA should be given the additional tools of imminent hazard authority to protect against potentially catastrophic defects with AVs and criminal penalties to ensure manufacturers do not willfully mislead or misinform the agency.*
- *Providing further broad statutory exemptions from the FMVSS for AVs is both unnecessary and unwise. Until NHTSA revises the FMVSS for level 4 and 5 AVs, manufacturers may seek appropriate exemptions under the current process.*

Autonomous Vehicles Must Have Adequate Cybersecurity and Privacy Standards to Protect the Public and Must Share Information on Critical Events

A failure to adequately secure AV systems and to protect against cyber-attacks could endanger AV passengers, non-AV motorists, pedestrians, bicyclists and other vulnerable roadway users. It could also clog roads, stopping the movement of goods and hindering the responses of emergency vehicles. NHTSA should identify cybersecurity problem areas and require specific responses from manufacturers as to how those are being addressed. Problem areas could include subjects such as global position system (GPS) signal loss or degradation, spoofing, and off-line and real time hacking of single vehicles or fleets of vehicles. AV cybersecurity should be tested as part of the functional safety standard to ensure that the vehicle cybersecurity system operates as designed. The potential and real risk of a malevolent computer hack impacting hundreds or thousands of AVs, perhaps whole model runs, makes strong cybersecurity protections a crucial and essential element of AV design.

Additionally, data sharing among manufacturers is essential to improve overall safety among AVs. Data and information about known flaws or problems encountered during development and while in use must be shared among manufacturers and with NHTSA and the public to ensure that all AV systems are learning about problems in real time and can benefit from the experience of other AV systems. This type of collaborative development is already taking place in the industry with the creation of the Automotive Information Sharing and Analysis Center (ISAC). Data sharing will expedite solutions to unusual or unique safety problems and ensure they are readily identified and corrected.

Similarly, AVs should be subject to binding privacy standards to ensure that data is not abused. The recording and sharing of data will be critical to achieving the safest performance of AVs. Keeping the public informed as to the importance of sharing data and ensuring their privacy will also be critical to ensure public partici-

[xxii] Seth Clevenger and Eric Miller, *ATA's Chris Spear Calls for Industry to Embrace Technology,* Transport Topics (Mar. 2, 2017).

pation and acceptance. The industry and regulators must guarantee that data is protected and only used for the purposes of improving safety, and not for other commercial uses, such as the marketing of products based on vehicle location, which could turn the public against data sharing.

Recommendations:

- *AVs must have adequate cybersecurity and privacy standards to protect the public.*
- *AVs should be subject to binding privacy standards to ensure that consumer data is not used for purposes other than improving the safety and security of AVs.*

The Development of Autonomous Vehicles Must Be Transparent or Public Confidence in the Technology Will Suffer

The development and deployment of AVs as well as NHTSA's role in regulating this technology must be open and transparent. All non-propriety communications and responses between the agency and a manufacturer as it relates to any issues involving AVs must be made available for public review and scholarly research. All data generated from the testing and deployment of AVs, except for trade secrets and private individual information must also be made public. Lack of transparency will severely undermine the public's confidence in this new technology and inhibit its widespread adoption.

Opinion polls already show strong public skepticism and hesitation about AVs and those doubts are surely warranted. Over the last few years, automakers have hidden from the American public and regulators safety defects that have led to numerous unacceptable and unnecessary deaths and injuries as well as the recall of tens of millions of vehicles. Consumer acceptance of this technology is critical to the success of fully realizing the lifesaving potential of AVs. Trial by error on public roads and risking public safety is neither the appropriate nor the responsible approach to encouraging the development and deployment of AVs. In fact, a national survey commissioned by Kelley Blue Book found that a large portion of the public is resistant to accepting AVs. Fifty-one percent of respondents replied that they prefer to have full control of their vehicle, even if it's not as safe for other drivers. Additionally, awareness of the higher levels of vehicle autonomy is limited, with 6 out of 10 people saying they know little or nothing about AVs. For half of the respondents, the perception of safety and personal comfort with autonomous technology diminished as the level of autonomy increased. In fact, 80 percent believed that people should always have the option to drive themselves, and nearly one in three respondents said they would never buy a level 5 vehicle.[xxiii]

A recent study conducted by the Massachusetts Institute of Technology garnered similar results. Only 13 percent of those polled reported that they would be comfortable with vehicle "features that completely relieve the driver of all control for the entire drive."[xxiv] In addition, 59 percent of respondents reported that the maximum level of automation that they would be comfortable with were "features that actively help the driver, while the driver remains in control."[xxv] The reluctance and hesitation of the public to embrace AVs will not be abated if the technology fails, the government regulators are viewed as standing on the sidelines and manufacturers have not done due diligence in conducting adequate testing before rushing to the marketplace. Consumers expect, and in fact, demand that the Federal Government prohibit the introduction of dangerous products to the marketplace whether it be drugs, food, toys, or driverless cars.

Recommendations:

- *All non-propriety communications and responses between the agency and a manufacturer as it relates to any issues involving AVs must be made available for public review and scholarly research.*

States Must Not be Preempted from Acting to Protect their Citizens Especially in Light of NHTSA's Failure to Regulate Automated Vehicles to Date

Advocates agrees with the statutory mission of NHTSA to regulate the design and performance of motor vehicles to ensure public safety which, in modern day terms,

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[xxiii] Kelly Blue Book, Future Autonomous Vehicle Driver Study (Sept. 2016).

[xxiv] H. Abraham, B. Reimer, B. Seppelt, C. Fitzgerald, B. Mehler & J. Coughlin, *Consumer Interest in Automation: Preliminary Observations Exploring a Year's Change,* Massachusetts Institute of Technology, AgeLab, White Paper (2017–2), p. 6 (May 2017).

[xxv] *Id.*

includes autonomous vehicles and technology. However, unless and until NHTSA issues comprehensive standards and regulations to govern the AV rules of the road, states have every legal right, indeed a duty to their citizens, to fill the regulatory vacuum with state developed proposals and solutions for ensuring public safety. NHTSA, by issuing only guidelines, has left the field of AV safety open to the states to fulfill their traditional role of protecting the health and welfare of their citizens. As the National Conference of State Legislatures (NCSL) noted in its comments to NHTSA's guidelines, "Without any indication on forthcoming Federal regulations regarding the safe operation of HAVs, states may be forced to fill the gap in order to ensure the safety of public roadways."[xxvi] Moreover, the Pennsylvania Department of Transportation stated in its comments to the guidelines that "Yes, there should be consistent treatment of highly automated vehicles nationwide. However, where the adoption of 'safety standards' being applied to highly automated vehicle testing is totally voluntary (as opposed to self-certifying as against a regulatory framework in the FMCSS) [sic], what level of comfort does that give to the states and their citizens that their transportation and law enforcement agencies are properly discharging their duty to ensure that highly automated vehicles are in fact safe?"[xxvii]

Recommendations:

- *Until NHTSA issues comprehensive standards and regulations to govern the AVs, states must not be precluded from filling the regulatory void with state developed solutions to protect their citizens.*

NHTSA Needs Additional Resources

The increase in motor vehicle fatalities combined with the demands being placed on NHTSA with regards to the advent of AV technology necessitates an increase to the agency budget. While the FAST Act did provide some additional resources, it is still inadequate to manage the myriad of challenges facing the agency. Today, 95 percent of transportation-related fatalities, and 99 percent of transportation injuries, involve motor vehicles on our streets and highways. Yet, NHTSA receives only one percent of the overall U.S. Department of Transportation (DOT) budget. NHTSA will face even greater challenges in the future as AVs continue to develop and are introduced into the market. For NHTSA to exercise proper oversight over AVs, the agency will need to hire more staff with technical expertise. Moreover, given that crashes impose a comprehensive cost to society of $836 billion, $242 billion of which is direct economic costs such as lost productivity, medical costs and property damage, it is critical to advance serious measures to combat a serious problem.[xxviii]

Recommendation:

- *NHTSA must be given additional funding in order to meet demands being placed on the agency with regard to the advent of AV technology.*

Conclusion

Autonomous vehicles have the potential to change our Nation's ability to protect motorists and other road users. It is critically important that we do everything possible to advance this life-saving technology in as safe and expeditious manner possible. Advocates believes that autonomous vehicles will not only change our lifestyles but it may, once and for all, change our ability to achieve meaningful and lasting reductions in the death and injury toll on our streets and highways.

SUMMARY OF STATEMENT OF JACQUELINE S. GILLAN

Each year motor vehicle crashes kill tens of thousands and injure millions more at a cost to society of over $800 billion. Advocates for Highway and Auto Safety (Advocates) firmly believes that autonomous vehicle (AV) technology has the potential to make significant and lasting reductions in this mortality and morbidity toll.

The National Highway Traffic Safety Administration (NHTSA) has a statutory duty to ensure the safety of AVs. Unfortunately, NHTSA has chosen to issue only "voluntary guidelines" for the development of AVs. Voluntary guidelines are not le-

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[xxvi] William T. Pound, Executive Director, National Conference of State Legislatures, *Public Comments on Federal Automated Vehicles Policy,* Docket No.: NHTSA–2016–0090 (Nov. 21, 2016).

[xxvii] Leslie R. Richards, Secretary of Transportation, Commonwealth of Pennsylvania, *Letter to Secretary Foxx and Administrator Rosekind,* Docket No.: NHTSA–2016–0090 (Nov. 21, 2016).

[xxviii] NHTSA Cost of Motor Vehicle Crashes Report.

gally binding, are unenforceable, and are inadequate to ensure safety and protect the public.

Vehicle and technology companies are already putting some AVs out on public roads and beginning to market these systems. The development of AV technology is not just taking place in the United States. In fact, AVs are being tested throughout the globe in places such as the United Arab Emirates and Singapore. Under current law, vehicles imported from overseas have to meet the requirements of the Federal Motor Vehicle Safety Standards (FMVSS). However, with only Federal voluntary guidelines, foreign companies and entities may export products that could be dangerously unsafe and NHTSA will have little recourse. In addition, some experts predict that automated technology will be placed in trucks before passenger vehicles. The potential for an 80,000 pound truck using untested and unregulated technology on public roads is a very real scenario if NHTSA relies on voluntary guidelines and the "good intentions" of AV manufacturers.

A functional safety approach is essential to provide the framework for the design, development and deployment of autonomous vehicle technology. A similar process is currently utilized by the Federal Aviation Administration (FAA) in portions of its regulations to ensure safety while encouraging innovation.

Advocates agrees with the statutory mission of NHTSA to regulate the design and performance of motor vehicles to ensure public safety which, in modern day terms, includes AVs and technology. However, unless and until NHTSA issues comprehensive standards and regulations to govern the AV rules of the road, states have every legal right, indeed a duty to their citizens, to fill the regulatory vacuum with state developed proposals and solutions for ensuring public safety. NHTSA's voluntary guidelines have left the field of AV safety open to the states to fulfill their traditional role of protecting the health and welfare of their citizens. Other commenters to NHTSA on voluntary guidelines expressed a similar criticism about this regulatory vacuum including the National Conference of State Legislatures (NCSL) and the Pennsylvania Department of Transportation.

Advocates' Recommendations:

- *NHTSA must require that manufacturers meet a "functional safety standard" to guarantee safety of AVs before they are introduced into the marketplace.*
- *Manufacturers must be required to submit a Safety Assessment Letter (SAL) that confirms that the AV has been tested to ensure it operates safely. The SAL should include all of the test results and data to support the conclusion that the AV system functions as designed.*
- *NHTSA should be given the additional tools of imminent hazard authority to protect against potentially catastrophic defects with AVs and criminal penalties to ensure manufacturers do not willfully mislead or misinform the agency.*
- *Providing further broad statutory exemptions from the FMVSS for AVs is both unnecessary and unwise. Until NHTSA revises the FMVSS for level 4 and 5 AVs, manufacturers may seek appropriate exemptions under the current process expanded by Congress in the FAST Act (Pub. L. 114–94).*
- *AVs must have adequate cybersecurity and privacy standards to protect the public.*
- *AVs should be subject to binding privacy standards to ensure that consumer data is not used for purposes other than improving the safety and security of AVs.*
- *All non-propriety communications and responses between the agency and a manufacturer as it relates to any issues involving AVs must be made available for public review and scholarly research.*
- *Until NHTSA issues comprehensive standards and regulations to govern the AVs, states must not be precluded from filling the regulatory void with state developed solutions to protect their citizens.*
- *NHTSA must be given additional funding in order to meet demands being placed on the agency with regard to the advent of AV technology.*

ADVOCATES FOR HIGHWAY AND AUTO SAFETY
December 2, 2016

DOT Docket No. NHTSA–2016–0090
Docket Management Facility
U.S. Department of Transportation
Washington, DC.

Request for Comment on "Federal Automated Vehicles Policy"
Notice and Request for Comments
81 Federal Register 65703, September 23, 2016

Advocates for Highway and Auto Safety (Advocates) files these comments in response to the National Highway and Traffic Safety Administration (NHTSA) notice and request for public comment on the "Federal Automated Vehicle Policy."[1] (NHTSA AV Policy). Simply because AV technology has the potential to evolve rapidly over time does not justify NHTSA abdicating its statutory mission of regulating motor vehicles to ensure public safety.[2]

Fifty years ago, Congress passed the National Traffic and Motor Vehicle Safety Act of 1966 because of concerns about the death and injury toll on our highways. The law required the Federal Government to establish Federal motor vehicle safety standards (FMVSS) to protect the public against "unreasonable risk of accidents occurring as a result of the design, construction or performance of motor vehicles."[3] While cars have changed dramatically and will continue to do so in the future, the underlying premise of this prescient law and the NHTSA's safety mission has not.

Advocates has always enthusiastically championed technology and for good reason. It is one of the most effective strategies for reducing deaths and injuries. NHTSA has estimated that since 1960, hundreds of thousands of lives have been saved by motor vehicle safety technologies.[4]

In 1991, Advocates led the coalition that succeeded in having the airbag mandate included in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.[5] As a result, by 1997, every new car sold in the United States was equipped with a front seat airbag and the lives saved have been significant. In fact, airbags save over 2,000 lives annually.[6] Advocates continued to build on our success by pushing lifesaving technologies in other bills and regulatory proposals. These efforts included tire pressure monitoring systems,[7] rear outboard 3-point seat belts,[8] electronic stability control,[9] seat belt reminder systems,[10] rear video cameras,[11] brake transmission interlock,[12] seat belts on motorcoaches,[13] electronic logging devices[14] as well as other important safety improvements such as rollover crash avoidance and automatic emergency braking. These safety advances have saved countless lives.

According to the latest statistics from the National Highway Traffic Safety Administration (NHTSA), 35,092 people were killed on our Nation's roads in 2015.[15] This represents a 7.2-percent increase from 2014 and is the largest percentage increase in nearly fifty years.[16] Injuries resulting from crashes also increased to 2.44

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[1] Request for Comment on "Federal Automated Vehicles Policy," 81 FR 65703 (Sept. 23, 2016).

[2] In general the term AV refers to all autonomous vehicles including those vehicles that NHTSA refers to as highly autonomous vehicles (HAVs) except as noted.

[3] Title 49, U.S.C. Sec. 30102.

[4] Lives Saved by Vehicle Safety Technologies and Associated Federal Motor Vehicle Safety Standards, 1960 to 2012, DOT HS 812 069 (NHTSA, 2015); See also, NHTSA AV Policy, *Executive Summary,* p. 5 endnote 1.

[5] Pub. L. 102–240 (Dec. 18, 1991).

[6] National Center for Statistics and Analysis, *Lives Saved in 2015 by Restraint Use and Minimum-Drinking-Age Laws,* National Highway Traffic Safety Administration, Report No. DOT HS 812 319 (Aug. 2016).

[7] Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, Pub. L. 106–414 (Nov. 1, 2000)

[8] Anton's Law, Pub. L. 107–318 (Dec. 4, 2002).

[9] Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA–LU), Pub. L. 109–59 (Aug. 10, 2005)

[10] *Id.*

[11] Cameron Gulbransen Kids Transportation Safety Act of 2007, Pub. L. 110–189 (Feb. 28, 2008).

[12] *Id.*

[13] Moving Ahead for Progress in the 21st Century (MAP–21) Act, Pub. L. 112–141 (Jan. 3, 2012).

[14] *Id.*

[15] National Center for Statistics and Analysis, *2015 motor vehicle crashes: Overview,* Report No. DOT HS 812 318, National Highway Traffic Safety Administration (Aug. 2016).

[16] *Id.*

million from 2.34 million in 2014.[17] Advocates is hopeful that automated vehicle technology has the potential to significantly reduce this carnage. However, the safety benefits of AVs will be realized gradually as the widespread adoption of the technology will take years.

Introduction/Overview[18]

The NHTSA AV Policy points out that under current law and regulation, vehicle and equipment manufacturers are under no legal duty to provide information to the agency about a new technology, in advance of production and sale into the U.S. market, unless it fails to comply with an applicable FMVSS or raises a compliance question regarding existing regulations.[19] The NHTSA AV Policy does nothing to change the legal responsibility or duty that vehicle and equipment manufacturers owe to NHTSA or the public. The NHTSA has the authority, however, to require motor vehicle manufacturers, and other entities supplying auto equipment, parts and electronic systems for AVs, to conduct tests and perform analyses to document and verify that an AV system performs safely and as designed. That type of documentation should be required by rule rather than as part of the voluntary safety assessment letter that the agency now requests manufacturers to voluntarily submit to the agency.

Furthermore, the development and deployment of automated vehicles as well as the agency's role in regulating this technology must be open and transparent. Therefore, all communications and responses between NHTSA and a manufacturer as it relates to any issues involving automated vehicles must be made available for public review and scholarly research. In addition, all data generated from the testing and deployment of AVs, except for trade secrets and private individual information must be made public. In the past few years, automakers have hidden from regulators and the American public safety defects that have led to unnecessary deaths and injuries as well as the recall of millions of vehicles. This troubling lack of transparency should not be allowed to infect the development of driverless vehicles. Lack of transparency will severely undermine the public's confidence in this new technology and inhibit its adoption by the public regardless of its perceived benefits.

I. Vehicle Performance Guidance for Automated Vehicles

The Guidance

Advocates' two main objections to the proposed performance guidance are that the guidance is not mandatory and that there is a lack of specificity. In its current state, the non-mandatory guidance is such that any information willingly provided by industry in the safety assessment letters regarding compliance with the guidance may be incomplete, sparse, or at best so varied from letter to letter as to render the information collected useless in terms of agency review and developing future regulation. As detailed below, the guidance should be reconfigured around the concept of a functional safety approach to the design, development, and deployment of autonomous vehicles of all levels.[20] The guidance must be specific in terms of minimal reporting requirements and should establish those requirements based on a planned path toward future regulation. Failure to do this will only leave the Federal agency charged with ensuring motor vehicle and public safety further behind the technology.

Scope

As indicated "all individuals and companies manufacturing, designing, testing, and/or planning to sell automated vehicle systems in the United States"[21] must consider the guidance. Similarly, the guidance must be applied to all AVs, including light-, medium-, and heavy-duty vehicles. The guidance must apply to both test-and production-level vehicles, specifically those which are sharing the road with the gen-

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[17] *Id.*

[18] Due to the complexity of the issues involved and the length of the NHTSA AV policy, Advocates' comments exceed the 15 page limit pursuant to Title 49, C.F.R. § 553.21.

[19] Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety, 12507–091216-v9, p. 48 (NHTSA, Sept. 2015) (NHTSA AV Policy), available at *http://www.nhtsa.gov/nhtsa/av/index.html.*

[20] Levels in this case refer to the levels of automation as defined by SAE J3016 and adopted by the NHTSA. Although the NHTSA distinguishes between SAE Level 0–2 and 3–5 AVs, the agency acknowledges that "this distinction does not change many of the areas in which the manufacturers . . . should apply elements of this Guidance during product development, testing, and deployment." NHTSA AV Policy, p. 31.

[21] NHTSA AV Policy, p. 11. These comments use the term "manufacturers" to represent all entities intended to be covered by the scope of the NHTSA AV Policy.

eral public.[22] The reality is that while testing of AVs on public roads is a necessity, to increase real-world data collection and improve development, AVs are sharing the road with other highway users who have not been informed of the testing, are unwitting participants to the testing, and may be exposed to crash risks without prior informed consent. AVs that are being tested as well as the routes they will travel should be conspicuously marked so that they are easily identifiable to the public. For these reasons, AVs used for research and testing on public roads, as well as AVs sold to the public, must all be subject to a rigorous functional safety process and requirements to ensure that the public will not be exposed to an unreasonable crash risk.

Overview: DOT's Vehicle Performance Guidance

In terms of content, the NHTSA AV Policy covers many of the important aspects necessary to achieve safety of AVs. However, the organization of the guidance appears disjointed and should be revised to conform more closely to a functional safety approach. In its present format, the guidance could be read as indicating that the individual guidance sections could be tackled as separate, independent issues when, in reality, a comprehensive and cohesive systems engineering approach must be taken in order to achieve the safe deployment of AVs.

Almost all portions of the guidance represent, to some degree, aspects of functional safety. Functional safety is a process by which a system is designed, developed and deployed to ensure that the system, as a whole, operates correctly and safely in response to inputs, errors, and failures. Functional safety is applied throughout the life-cycle of a system, from hazard analysis during design through auditing of performance after deployment. Only through ubiquitous adoption of a functional safety approach to the development of AVs can the safety and benefits of this technology be achieved. Advocates recommends that NHTSA reorganize the guidance into a framework focusing on a functional safety approach that identifies how each of the guidance components fit into the functional safety framework. The following is an example of how different sections of the guidance could be reorganized into a functional safety approach:

- System Design
  - Operational Design Domain[23]
  - Object and Event Detection and Response[24]
- Hazard Analysis
  - Mechanical
- User
  - Human Machine Interface (HMI)
  - Consumer Education and Training
- External
  - Cybersecurity
  - Federal, State, Local Laws
  - Ethical Considerations
- Risk Reduction
  - Post-Crash Behavior
  - Fall Back (Minimal Risk Condition)
- Design Validation
  - Validation Methods (simulation, track, on-road testing)
- Performance Verification/Auditing
  - Data Recording and Sharing

[22] The public must be given the opportunity to give meaningful informed consent to the testing of AVs on public roads. Among other things, AVs that are being tested as well as the routes they will travel should be conspicuously marked so that they are easily identifiable to the public. In addition, as required by Federal regulation for research involving human subjects, cities and states that permit testing of AVs should have in place an Institutional Review Board to monitor that the testing of AVs to protect the rights all of the subjects involved in the testing. See: 45 CFR 46 (2009).

[23] Operational design domain (ODD) refers to how the AV system will detect and respond to the driving environment.

[24] Object and event detection and response (OEDR) refers to how the AV system will perform when a problem with the system itself is encountered.

Safety Assessment Letter to NHTSA

The NHTSA must make the reporting of AV information mandatory. Voluntary submission of information will not succeed because AV manufacturers are under no legal duty to report completely and fairly. While Advocates agrees with the underlying concept of the proposed Safety Assessment submission, there are three major problems with the Safety Assessment guidance as proposed in the NHTSA AV Policy. First, at the outset, the NHTSA undermines its effort by describing the Safety Assessment information to be provided as merely "outlining" how the manufacturer submitting the information is meeting the areas of concern in the NHTSA AVPolicy guidance.[25] The agency then refers to the Safety Assessment submission as a "summary letter."[26] In fact, the agency guidance allows manufacturers to merely check-off a box for each area of requested information that indicates whether the manufacturer's AV system "Meets", "Does not meet", or "is not applicable" to each particular guidance area of the NHTSA AV Policy. In essence, if a manufacturer voluntarily responds at all, it could just check the appropriate response in each area without providing any substantive information or content whatsoever. Although the agency states that it expects responses to be "concise and complete[,]"[27] nothing in the guidance indicates that the agency is seeking detailed information in an initial response.

Second, as proposed, the request for the Safety Assessment submission lacks specificity as to what type of information the agency wants and that the manufacturer should submit. Requests for information contain only vague descriptions that may or may not receive accurate and complete responses. The agency approach to the Safety Assessment submission letter is to allow the manufacturer to provide as much or as little information as the manufacturer deems to be in its self-interest. In fact, the agency states that, after the initial submission, the agency "might request more detailed information on Guidance areas to better assess safety aspects of the HAV systems."[28] It is critical that the agency should try to obtain complete and detailed information from the outset. In its present non-mandatory form, the agency will have little recourse to compel manufacturers to provide additional information if the agency is not satisfied with the initial response. Follow-up requests may well extend beyond the four-month lead-time that the NHTSA AV Policy suggests is needed to review manufacturer submissions prior to testing on public roads.[29] In addition, such requests impose additional burdens on NHTSA's resources.

Third, the NHTSA does not seek any uniformity of the substantive content for the Safety Assessment information. Responses from manufacturers can take many forms and use distinctive nomenclature that will slow down if not stymie the agency's evaluation of the information. The agency should categorize the types of information it seeks in each guidance area in order to better be able to compare implementations of industry standards, guidance, best practices, testing, protocols, and analyses.[30] Doing so will make the information gathered more useful to the public, industry, and government alike.

Finally, regarding the timeline for Safety Assessment responses, four months is excessive to develop a Safety Assessment letter for products already on the road, and for which all documentation should readily be available. This is particularly important as the initial response may not be sufficiently detailed and may require the agency to make an additional follow up request for more information. Likewise the demand that letters be provided four months prior to testing should be evaluated to ensure that the agency and the public have ample time to review the documents, especially if a vehicle is to be tested on public roads. For similar reasons, Advocates concurs that updates to the Safety Assessments are needed, and should be required, when updates are made to AV systems. However, the process and requirements for updating Safety Assessments should be specific and uniform to ensure that the information gathered is beneficial to the public, industry and regulators.

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[25] NHTSA AV Policy, p. 15.
[26] NHTSA AV Policy, p. 16
[27] NHTSA AV Policy, p. 16.
[28] NHTSA AV Policy, p. 16.
[29] NHTSA AV Policy, p. 16.
[30] The lack of specificity with the Early Warning Reporting (EWR) perfectly illustrates what can happen when the agency fails to provide proper specification for the information it seeks. The vague categories of the EWR have enabled the industry to hide questionable performance and dangerous defects. (EWR: Elective Warning Reports—When Manufacturers Don't Report Claims, Safety Research & Strategies, Inc., Apr. 8, 2014, available at *http://www.safetyresearch.net/blog/articles/ewr-elective-warning-reports-when-manufacturers-dont-report-claims)*

Cross-Cutting Areas of Guidance

Data Recording and Sharing

The collection and sharing of data with the public, the NHTSA, and within the industry will be critical to achieving the highest levels of safe AV performance. Similar to the way in which current crash databases are used to inform current safety regulation and vehicle design, an AV performance database would benefit all parties. NHTSA should maintain a public database that details any and all crashes involving an AV. The sharing of both incident (crash) and near incident (near-miss) data would enable the industry to review performance of other AV systems and improve their own performance, especially for edge cases.[31] Likewise, the agency should use the data to develop specific sets of scenarios which AV systems must be able to address as part of future guidance and eventual regulation. The data to be collected and shared must be more specific than "all information relevant to the event and performance of the system."[32] This vague description leaves too much room for interpretation which could result in disjointed and unusable information from which limited insights could be gained. Importantly, specification of data to be recorded and shared should address industry concerns around intellectual property. For example, making sure that the data from an incident where an AV fails to see the side of a white truck crossing its path is of critical importance to the development of all AV systems as it identifies a scenario which could cause problems and lead to risks. This sharing of data or feedback loop, must be done to ensure that each AV system does not have to learn only from its individual failures but can be improved based on the failures or successes experienced by other AV systems.

Essential to gathering accurate and reliable technical data on AV system performance and failure is the need to require all such data to be captured and collected. While each manufacturer may voluntarily provide information that is collected for internal use, information about AV system performance on public roads must be provided to the NHTSA on a real time basis and made available to the public. In the meantime, the NHTSA must also require that Event Data Recorders (EDR) or other systems are able to collect and record all essential data on AV systems so that in the event of a crash or other failure the vehicle systems status data will be available to the agency, crash investigators, researchers and the vehicle owner. Advocates recommends that the agency complete the rulemaking to mandate EDRs in all passenger vehicles, and revise the current requirements in the EDR rule, 49 C.F.R. § 563, to require additional data collection on all AV systems.

Privacy

Privacy will be a key factor in ensuring acceptance of AVs by the public. As noted above, the recording and sharing of data will be critical to achieving the safest performance of AVs as quickly as possible. Keeping the public informed as to the importance of sharing data and ensuring their privacy will be similarly critical to ensure participation. The industry and regulators must guarantee that data is protected and only used for the purposes of improving safety, and not for other commercial uses which could turn the public against data sharing.

System Safety

Functional safety should provide the framework for the overall approach to the guidance and future regulation. In almost all areas of the guidance, it will benefit all parties involved if the requirements of the safety assessment were more specific in terms of standards, guidance, best practices, and design principles about which the agency would like information. The industry could then respond as to whether and how they have implemented any of those practices. Requiring the specific and uniform reporting of data by manufacturers will enable the agency to understand how each of the guidance areas, practices, standards, etc., are being implemented across the industry. It will also allow the agency to work towards establishing regulation to require their implementation.

Vehicle Cybersecurity

Cybersecurity is an important aspect of AV development which must be addressed as part of functional safety. Again, the guidance is vague on the information it would like to receive from the industry. Specificity and uniformity will be the keys to evaluation of AV system information by the NHTSA and to informing the public. The agency should identify problems areas and require specific responses from man-

[31] Edge Cases are those problems or situations that occur very infrequently or at the operational boundary. These are cases each manufacturer's vehicles may only see once, but the information about that situation would benefit all systems because of its rarity.

[32] NHTSA AV Policy, p. 18.

ufacturers on how those are being addressed. Problem areas could include subjects such as GPS signal loss/degradation/spoofing, and off-line and real time hacking of single vehicles or fleets of vehicles. As with all other performance data, the sharing of data in terms of cybersecurity will improve overall safety and ensure that all vehicles, regardless of manufacturer, are afforded the same level of security. This is even more important when the aspect of connected vehicles is concerned as any weak link in the chain could leave many more vehicles vulnerable to programming errors or hacking. The potential risk of a single software error, or malevolent computer hack impacting hundreds or thousands of AVs, perhaps whole model runs, makes appropriate cybersecurity a crucial and indispensable element of AV design.

Human Machine Interface

The user interface is an essential aspect of the development and deployment of AVs. In the functional safety approach, the human/machine interface (HMI) presents both a source for and means of addressing hazards stemming from the user. As some products currently on the road have demonstrated, poor HMI design can lead to dangerous and deadly situations. For example, if an AV requires a human occupant to participate in the driving process, it must be designed to ensure that the human occupant is engaged, aware, and informed of the operational status of the vehicle particularly in time critical settings. Simply informing drivers that they must remain engaged or placing information in the owner's manual as to the limitations of the AV system are not a sufficient or acceptable substitute for engineering solutions that are effective in maintaining the engagement of the human operator. This is true even if the operator signs a statement indicating that they have read the manual. In a functional safety approach the hazard of driver engagement should be managed through monitoring and warning systems to ensure drivers are engaged to the level necessary for the system to operate safely. A system which fails to account for all sources of risk and hazard, especially the transition from or to a human operator, would not be functionally safe and should be evaluated by the agency before the AV system is certified by the manufacturer for use on public roads.

Crashworthiness

Compliance with the FMVSS is mandatory and should remain so. In the future, as new seating configurations are proposed, the NHTSA may be required to adapt the FMVSS to ensure that occupants are provided the same minimal levels of crashworthiness protection currently afforded by all vehicles. Leaving occupant safety in AVs to the "due care" of the industry is a step backward that is fraught with problems and opens the door for making trade-offs with safety. Furthermore, concerning AV compatibility, the agency should establish regulatory requirements rather than relying on voluntary agreements. In the end, it is foreseeable that AVs will share the road with traditionally operated vehicles with human drivers for an extended time and, despite any AV advances, will likely still be involved in crashes which will require the vehicle design to ensure that it protects occupants and crash partners alike.

Consumer Education and Training

Consumer education and training are imperative to ensure safe deployment of AVs. Failure to fully familiarize consumers with needed operational and safety information, or to properly train vehicle owners who may have to take over operation of the AV at some point, could result in rejection of AVs by the public and more importantly lead to crashes. As end users of the product, even if they are not involved in the driving task at all, consumers will ultimately decide the fate of AVs. Consumer education and training in all aspects of AV operation are critical to success.

Advocates agrees with the NHTSA's statements and observations in the guidance that manufacturers develop education and training programs for employees, dealers, distributors and consumers.[33] This is especially necessary for Level 3 (and lower) AVs in which the driver may need to take over control of the vehicle when the operational limits of the AV system have been reached. The suggestion in the NHTSA AV Policy that consumers who purchase AVs should receive training on the operational capabilities and limitations of the AV system they purchase, along with an on-the-road demonstration prior to taking possession of the AV would be beneficial. However, the agency should take the next step and offer specific solutions and develop prototype program materials to guide manufacturers in this effort.

[33] Advocates is aware of instances in which dealership sales personnel were unfamiliar with the capabilities of the AV systems they were demonstrating to customers.

The agency must also consider the need for standardizing the operation of AVs or their functions, and requiring training and education/information from the manufacturers or as part of the state policy for licensing to ensure that, until such time as drivers are no longer required, that lack of education or training do not undermine the safety benefits of AVs.

Furthermore, while all relevant information must be included in the vehicle owners' manual, there is a clear need, especially for vehicles that may require the intervention of a driver or which can have their operational capabilities updated significantly, for important features of the AV system operation to be delivered to consumers in other ways. The agency should consider requiring instrument panel instructions/notifications that must be read and accepted before the AV can begin operating, and a separate AV system tutorial that can be viewed on board the AV when not in operation or on other personal data devices. A comprehensive approach to AV education and training is essential for the success of AV adoption.

Certification

Manufacturers will still be responsible to self-certify that their AV meets all Federal and state requirements as well as operates safely and as designed. Manufacturers and other responsible entities will need to keep both the NHTSA and consumers aware of the operation, capabilities, and limitations of AV systems that are on the road. With the possibility of over the air (wireless) updates which could change the operation of AVs overnight, it will be essential for manufacturers to provide updated Safety Assessments to the NHTSA regarding any changes that affect the certification of the vehicle. Clear instructions regarding any changes must also be conveyed to the vehicle owner and operators.

Post-Crash Behavior

As part of functional safety, AVs must be able to recognize failures and address them or enter a failsafe mode. Controlling post-crash behavior to prevent the operation of AVs systems after damage to sensors is part of addressing a crash which is a known hazard. Similarly, it is important for the repair and re-certification of AV systems to be well established to ensure only safe AV systems are allowed back onto public roads.

Federal, State and Local Laws

In terms of functional safety, complying with Federal, State, and local laws is a known aspect of an AV systems design and expected operation. Variation in laws between jurisdictions is another known operational parameter that must be considered and addressed by AV manufacturers. It would appear that compliance with Federal, State, and local laws would be part of the operational design domain (ODD) and the object and event detection and response (OEDR), rather than a stand-alone topic of the guidance. Additionally, the NHTSA should consider the impact of the variation in transportation laws, road designs, lane marking, signage, etc. on the implementation of AVs and the benefits which could be derived from seeing uniformity across the country.

Ethical Considerations

Conflicts between the objectives of safety, mobility, and legality could occur in the operation of AVs; however, the guidance is vague on the specific means by which these conflicts will be resolved. Merely stating that solutions to these issues "should be developed transparently using input from Federal and State regulators, drivers, passengers and vulnerable road users . . ."[34] is not sufficient to ensure that dangerous products are not placed on the road now. Until such time as these "algorithms" are developed and proven, the safety objective should guide decisions. It is for this reason that the collection and sharing of data on vehicle operation will be important. The NHTSA must be more forthcoming with regard to how it will approach AV designs in which the manufacturers have opted to make different decisions in balancing these ethical considerations.

Automation Function

Specification of the conditions under which an AV system will operate (ODD), how the AV system will detect and respond to the driving environment (OEDR), and how the AV system will perform when a problem with the system itself is encountered (fall back (minimal risk conditions)), are all part of the design aspect of a functional safety approach. For each system and the system overall, specifying which conditions a system can operate within, what the expected response is, and what happens when all else fails are essential parts of the design, hazard analysis, and hazard

[34] NHTSA AV Policy, p. 26.

mitigation/elimination aspects of functional safety. The NHTSA must ensure that it collects sufficient information and test data/results to confirm that the manufacturer has done its safety due diligence and to validate that these aspects of the AV system are operating safely and as designed.

Operational Design Domain

Defining an ODD and translating that information to the NHTSA and specifically the consumer will be important to ensure that user error is reduced and that limitations in the operation of AV systems both within and outside of the ODD can be identified. Specificity and uniformity in reporting will improve the ability for this information to be used to develop future regulation and inform the public. It is also important that manufacturers consider specifying not only the ODD (where the system will work) but to clearly define the operational boundaries for the consumer. As discussed in previous sections, simply informing the consumer is not adequate from a functional safety stand point and should be supplemented with engineering solutions, including properly designed HMI, to ensure that opportunities for error or misunderstanding that could pose a crash risk are eliminated.

Object and Event Detection and Response

Within its ODD, each AV system must be expected to detect and respond to all scenarios which could affect safe operation. This includes interactions with other vehicles, pedestrians, cyclists, animals, and other objects. The NHTSA provides a limited list of behavioral competencies for normal driving and references a number of scenarios for crash avoidance and other hazards (construction, disabled vehicles, etc.). Advocates believes that this type of specific listing of scenarios which all AVs, as appropriate based on each particular AV system ODD, should be addressed as part of the safety assessment. With sufficient, uniform data sharing, manufacturers should be aware of all scenarios that AVs should address as part of their safety assessment. The agency should work towards a functional safety requirement which would include specifications of scenarios which must be addressed by an AV system, depending on the ODD, and which could be tested to ensure compliance.

Fall Back (Minimal Risk Condition)

As noted above in the discussion of post-crash behavior and in other sections, establishing fail safe conditions and operation is yet another part of functional safety. Once hazards and risks are identified and then eliminated, mitigated, or guarded against, and warnings are provided, the final step is to ensure that a system can recognize a failure or when it is operating outside of its ODD and return the system to a failsafe operation. However, having a failsafe design should not just be a recommendation. As with nearly all other parts of the guidance, AVs must be functionally safe, including having failsafe modes. These modes will be especially important in the early rollout of AVs when unknown risks have not yet been adequately identified through data collection and sharing.

Validation Methods

Performance validation is another step in the functional safety process. The NHTSA Safety Assessment must include specific tests and validation methods which the AV manufacturers must confirm have or have not been used, with a description and documentation of the methods the manufacturer did use to validate its AV system. Manufacturers should be required to provide information on all methods beyond those listed by the agency which will inform and enable the agency so it can update future versions of the list. Again, data collection and sharing will also be critical to performance validation to ensure that performance on the road and in the hand of the public is matching the performance predicted by the design.

Guidance for Lower Levels of Automated Vehicle Systems

All manufacturers of AV systems should be required to meet functional safety requirements for the design, development, and deployment of AVs. Almost all of the current guidance fits into what should be required in a comprehensive functional safety approach. Lower levels of automation should not be exempt from having to thoroughly apply the process.

Advocates supports ODD, OEDR, and minimal risk conditions applying to lower level AV systems. Every AV system has conditions under which it is designed to operate and its operation is specified. While the details may not be as extensive as that of a higher level (3–5) system, this is not an exception but rather a modification. Finally, a failsafe mode is still necessary even if it is not as drastic as those for higher level AVs. Uniformity in application of the functional safety process across all levels of AVs is necessary to ensure safety and inform the agency and the public.

Next Steps: Activities to Improve, Expand and Oversee the Guidance

It is critical that the NHTSA move swiftly towards effective regulation before the technology becomes ubiquitous. Abandoning the regulatory process is not a solution. A concerted and coordinated effort between agencies, branches of government, industry and the public will be necessary to achieve the goals of bringing AVs to market and doing so safely.

II. Model State Policy

The stated purpose of the model state policy is to "create a consistent, unified, national framework" for AV regulation, yet the framework is so loose it is difficult to envision consistent outcomes.[35] In fact, this framework, because it lacks so many necessary details, will create a patchwork of state standards which stands in stark contrast to the stated goals of the model policy. The NHTSA fails to include a timeline for suggested evaluations and actions that states need to complete. While the model policy acknowledges that states must undertake changes and improvements to transportation infrastructure in order to ensure the safe operation of AVs, it fails to instruct the states on what specific upgrades are needed. In addition, the model policy does not set any standard for crash reporting deadlines or data requirements which will be crucial to state regulation of the testing and deployment of AVs. Not only are the paucity of details contained in the model policy of great concern, the proposal also contains several critical shortcomings on its face that must be rectified.

Introduction

Advocates agrees with the statutory mission of NHTSA to regulate the design and performance of motor vehicles including AV technology and vehicles to ensure public safety. However, so long as the agency chooses to issue merely voluntary guidance to address safety and regulatory issues on emerging AV technology, states have every legal right to fill the regulatory vacuum with state developed solutions. NHTSA, by issuing only guidelines, has left open the field of AV safety that can and must be filled by the states. As such, each state can currently dictate (and some already are) what tests it deems acceptable and what constitutes an acceptable or successful result. This decentralized process leaves an incredible amount of variability in standards and interpretation. Advocates urges the agency to issue regulations to govern the safety assessment process and other regulatory appropriate aspects of AVs that the agency has exercised with respect to the safety of non-automated motor vehicles.

NHTSA should partner with states to properly train and educate drivers on the proper use of AV systems; however, specific focus should be placed on training dealership sales personnel and vehicle buyers and drivers on the capabilities and limits of AVs including when a driver must retake control of an AV after disengagement of the autonomous system.

NHTSA should take a leadership role and work with the states to ensure enhanced requirements for AVs. The inadequate maintenance of an AV, particularly out of date software, could have disastrous consequences on its operation and public safety. These concerns merit that AVs receive a heightened standard of care from state regulators tasked with ensuring that all vehicles registered in a state are properly maintained.

Model State Policy

The NHTSA must require, and recommend that state law reinforce, the need for AVs to be designed to comply with all aspects of state motor vehicle and traffic laws. Furthermore, NHTSA should work with the Federal Highway Administration, the Federal Motor Carrier Safety Administration and the states to ensure that AVs are compliant with all highway and traffic requirements. Mandating this uniformity will greatly reduce the opportunity for errors by AVs when dealing with the current patchwork of state requirements or guidelines such as lane widths, road markings, and signage.

In terms of defining who the "driver" of an AV is the NHTSA AV Policy contains an apparent inconsistency. For level 3 AV systems, where the human driver has to be able to take over control of the vehicle, states should define the "driver" of the vehicle as the human operator of the vehicle not the AV system as proposed in the model state policy. NHTSA asserts that States should generally deem the AV system to be the "driver" of the vehicle for SAE Levels 3–5.[36] Later in the guidance, however, the NHTSA indicates that States should continue to regulate the "human"

[35] NHTSA AV Policy, p. 37.
[36] NHTSA AV Policy, p. 39.

driver for AV "technologies that are less than fully automated, SAE levels 3 and lower."[37] For a level 3 vehicle where a driver is still tasked at various times with the operation of the vehicle, when the vehicle reaches its operational limits, the driver of such a vehicle must continue to be defined as the human operator.

Administrative

Advocates supports the establishment of a jurisdictional automated safety technology committee in each state as outlined in the model policy. However, the committees should be balanced and include strong representation from safety and consumer representatives as permanent official members. Placing these representatives on the Committee will foster public confidence in the testing and deployment of AVs in their state and will encourage acceptance of the technology as it becomes more prevalent. In addition, these representatives can provide a unique and invaluable perspective to the Committee as they consider numerous issues affecting consumers and public safety.

Jurisdiction Permission to Test

The lead state agency tasked with regulating AVs should prohibit the testing of AVs in safety sensitive areas such as school and construction zones as outlined in the model state policy. The malfunction of an AV while testing in such areas would be catastrophic. In addition, authorizations given for testing should be renewed on an annual basis due to the number of issues that could evolve during the course of a year involving experimental vehicles using such rapidly developing technology that could receive and require programming changes and updates at any time. Moreover, any authorization should immediately be reviewed after a notice of a crash involving an AV covered by the permit.

Testing by the Manufacturer or Other Entity

As outlined in the model state policy, not only should all crashes involving test vehicles be reported to the applicable state regulatory body, but any and all safety critical events such as near misses or operational malfunctions should also be disclosed to state regulators and the public. State regulatory bodies cannot accurately assess the progress of AVs and their ability to operate on public roads without this full and accurate picture of the performance of AVs during testing.

Law Enforcement Considerations

Advocates concurs with NHTSA's statement that "[f]or vehicles that offer less than full automated capabilities, there is potential for increased distracted driving."[38] Despite these obvious concerns, the agency continues to merely issue guidelines rather than regulations to govern in-vehicle and nomadic electronic devices that contribute to distracted driving, an issue that has long been identified by the safety community and the agency and supported by numerous research studies as a major public health epidemic.[39] For AVs that are less than fully automated, states must be encouraged to enact robust laws to govern any and all in vehicle distractions.

III. NHTSA's Current Regulatory Tools

Rulemaking Authority

The NHTSA's most broad-ranging authority to influence and govern motor vehicle safety, and to eliminate unreasonable risks to the public, is through proposing a standard to govern conduct and performance through a public rulemaking process. This is, and has been since the inception of the agency, the approach used to "adopt new standards, modify existing standards, or repeal an existing standard."[40] The establishment through regulation of safety standards for motor vehicle safety and related technology performance requirements is the standard and established agency procedure. The current body of lifesaving Federal motor vehicle safety standards (FMVSS) has been constituted through this process and procedure.

Public notice-and-comment rulemaking provides a number of important benefits. The regulated industry and the public receive a concise, detailed statement of agency plans and proposed rules, including testing procedures and performance requirements. It requires the agency to master detailed technical issues and to organize the analysis of benefits and costs of a proposed rule. The regulated entities and the public are afforded an opportunity to evaluate and analyze the proposal and provide focused feedback to the agency, including posing questions regarding matters that

[37] NHTSA AV Policy, p. 43.
[38] NHTSA AV Policy, p. 45.
[39] Distraction.gov, NHTSA.
[40] NHTSA AV Policy, p. 49.

may require greater clarity as well as critical feedback on technical aspects of the rule. Rulemaking affords all stakeholders, including the public and the regulated industry, the platform for making broad, general philosophical statements regarding the agency proposal, as well as the avenue to address narrow, technical issues. The regulatory process clarifies the agency's intent as to what will be subject to a particular regulation and how the agency intends to regulate an aspect of motor vehicle equipment or operation. This is important to reach a general agreed understanding of the issue and assure only sound, well-reasoned requirements are imposed on the regulated industry. While rulemaking may, by its nature, take longer than other existing regulatory tools (*e.g.,* interpretation letters or exemption petitions), rulemaking according to the agency "enables the Agency to make the broadest and most thorough changes to governing regulations, and gives the public the greatest opportunity to participate in the Agency's decision-making process."[41] In fact, the NHTSA states that rulemaking may be the best approach to address "a motor vehicle or equipment design [that is] substantially different from anything currently on the road [for which] compliance with standards may be very difficult or complicated . . ."[42] This description directly applies to the development and installation of AVs.

The future reliability and public acceptance of AVs would benefit greatly from regulatory action that sets a fair and level playing field for industry and, at the same time, provides transparency and oversight for the introduction of AVs into the motor vehicle fleet. While the NHTSA has not regulated every aspect of motor vehicles, crucial safety and operating systems have been regulated as part of the FMVSS or other pertinent regulations for decades. There is no clear and compelling reason why AV technology should be treated any differently or given greater leeway than previous mechanical or electronic technological innovations. Furthermore, there is no reason to believe that AV technology differs in any meaningful degree from the developments and improvements that have been routinely regulated over the past 50 years of automotive development. The agency cannot evade its statutory duty simply because the new technology seems complicated or highly technical.

The NHTSA has expressed its view that "only after new technology is developed and proven does the Agency establish new safety standards. * * * Strong safety regulations and standards are a vital piece of NHTSA's safety mission and the Agency will engage in rulemaking related to automated safety technologies in the future."[43] While Advocates understands that, at present, there may not be sufficient information and data to establish minimum performance requirements for some aspects of AV systems, that does not mean that the agency should defer from regulating those aspects of AV performance that are already known but which are not yet regulated, such as autonomous emergency braking (AEB) systems. Moreover, NHTSA is not precluded from requiring manufacturers to adopt a functional safety process that will ensure appropriate testing of AV systems will be conducted to prove the systems' safe performance within the design parameters of the particular AV system.

The NHTSA has an obligation to the public to ensure that new, highly complex AV systems will perform safely. At this time the NHTSA should require each vehicle manufacturer, or other company producing the computer logic and software, to adopt a functional safety process that requires comprehensive testing of AV systems that the agency can review. This would ensure that the manufacturers are under a legal obligation to perform appropriate due diligence to disclose the results to the agency prior to motor vehicles equipped with AV system's being placed in the stream of commerce.

The agency can and should require manufacturers, as part of the self-certification requirement, to certify that sufficient functional safety testing and analysis has been performed to establish that the AV system will perform safely and as designed. To accomplish this, the agency should require all AV system manufacturers, by regulation, to adopt a functional safety process to conduct state-of-the-art testing and analysis to establish that the AV system performs safely and meets or exceeds all aspects of the systems design parameters. Such a requirement is intended to allow the manufacturer to document that its AV system(s) has been fully and extensively tested and that all critical features, including the programming software, operate properly. There must be a modicum of regulatory oversight by NHTSA to ensure that the AV system manufacturers are acting responsibly and have not taken any short-cuts in the rush to market.

Advocates' call for a regulation to require functional safety testing and analysis is based on empirical evidence. The May 7, 2016 crash of a Tesla Model S equipped

[41] NHTSA AV Policy, p. 50.
[42] NHTSA AV Policy, p. 49.
[43] NHTSA Enforcement Guidance Bulletin 2016–02: Safety-Related Defects and Automated Safety Technologies, Final Notice, NHTSA, 81 FR 65705, 65706 (Sept. 23, 2016).

with the Autopilot AV system feature is a real world example of why such regulatory action is necessary as well as the timely notification to NHTSA is essential.[44] Tesla has stated that it required drivers to acknowledge that they would remain engaged in the driving task. A functional safety analysis would have required Tesla to evaluate what happens when the system fails to identify a road hazard, when the driver is not engaged in the driving task, or when both failures occur simultaneously all of which are foreseeable. Functional safety requires consideration of all foreseeable and feasible failure modes, as well as unlikely and low probability failure modes. Blaming the driver for failing to heed a warning, or for over reliance on the AV system, is inexcusable when technological means of mitigating the risks of sensor failures and human behavior are available.

The risk classification for failures in this and similar systems being developed must be very stringent since failure of the Autopilot sensors or the detection algorithm while travelling would present an unreasonable crash risk. Such an analysis, likely, would have led to requirements that additional sensors be added to the vehicle to mitigate the sensor "blind spot" created by using visual data from a camera with limited input from additional technologies such as radar or lidar. Tesla subsequently announced that it had fixed the problem through a new software update to the Autopilot System.[45] This flaw would have and should have been detected by Tesla during a functional safety analysis of the Autopilot System. Without such a required analysis, there may be other instances where readily detectible and foreseeable problems were not identified until after a crash occurs.

The functional safety analysis might also have resulted in additional driver engagement requirements such as driver monitoring and warning systems, and stronger driver reengagement methods to ensure driver readiness to retake control of the vehicle. In the functional safety analysis, Tesla would have been required to research, test, and examine not just the Autopilot sensor array, but driver reengagement readiness to prove that the design enabled drivers to either remain engaged in the driving task (as Tesla stated was necessary) or that re-engagement could be successfully accomplished in a safe manner. In fact, after the fatal crash the company instituted more warnings to the driver to remain alert while the Autopilot System is engaged.[46] It is the NHTSA's responsibility to require functional safety certification to eliminate the types of system failures that resulted in a fatality and eliminate the need for "after the fact" improvements which should have been anticipated.

While the NHTSA's proposed voluntary submission of a letter (addressed above) has many of the hallmarks of what is needed to be reported to the agency, a regulation must, first and foremost, require manufacturers of AV systems for motor vehicles to adopt a functional safety process that will ensure that the manufacturer tests its AV system appropriately and comprehensively. Second, documentation of all test results, those that establish the functional safety of the system, as well as any information that indicates the failure of the AV system to fulfill functional safety parameters, must be provided to NHTSA in advance of placing the AV system or AV equipped vehicle in the stream of commerce. Finally, these aspects must be made mandatory, rather than voluntary, in order to ensure that the manufacturers are legally obligated to adopt an effective functional safety process and to supply all relevant information to the agency.

Enforcement Authority

In relation to the NHTSA's enforcement authority, the NHTSA AV Policy states that "when vulnerabilities of [automotive] technology or equipment pose an unreasonable risk to safety, those vulnerabilities constitute a safety-related defect"[47] that can spur the agency to investigate and take remedial action including ordering the manufacturer to conduct a safety recall.[48] Moreover, the agency's enforcement authority applies "'notwithstanding the presence or absence of an FMVSS for any particular type of advanced technology.'"[49] Advocates strongly supports the NHTSA's enforcement efforts to investigate, identify and recall noncompliant or defective vehicles. Advocates views the enforcement role played by the agency as critical to en-

[44] The Tesla Autopilot System has been the subject of investigation in other crashes, including another fatal crash in China in January of 2016, Neal Boudette, *Autopilot Cited in Death of Chinese Tesla Driver,* The New York Times (Sep. 14, 2016).

[45] Louis Hansen, *Tesla turns to radar in upgrade of Autopilot,* The Mercury News (Sept. 11, 2016). In fact, Tesla has not provided any evidence that the problem has been fixed.

[46] *Id.*

[47] NHTSA AV Policy, p. 50.

[48] NHTSA AV Policy, p. 50.

[49] NHTSA AV Policy, p. 50, citing NHTSA Enforcement Guidance Bulletin 2016–02: Safety-Related Defects and Automated Safety Technologies, 81 FR 65705, 65707 (September 23, 2016).

suring that motor vehicles, once in use, perform safely. However, the agency position begs the question as to why the agency would forego issuing a prospective regulation to improve the safety performance of production models and eliminate safety flaws in AV systems before they are sold to the public. The NHTSA's enabling statute recognizes that the agency must act in a proactive manner to avoid and reduce crashes, injuries and deaths in the first place.[50] Rather than relying entirely on its enforcement authority, the agency should also be actively ensuring through regulatory, as opposed to only voluntary, action that AV systems are produced without production flaws before the AV systems are sold to the public, placed in the stream of commerce, and then subsequently have to be recalled.

The historic and well-founded approach of the NHTSA has been to require, in the first place, specific minimum performance requirements or standards that vehicle manufacturers must certify that each vehicle meets. These standards raise the quality and safety performance of motor vehicles before sale to the public. While its enforcement authority does permit the agency to investigate and recall vehicles for safety defects even if there is no underlying performance standard, the lack of an underlying performance standard may complicate the exercise of the agency's enforcement authority. This is a significant concern for electronically controlled systems and software where a specific flaw or malfunction may be more difficult to identify. If there is no underlying requirement or process, manufacturers will be far less cautious about ensuring the operating safety of the vehicle prior to sale.

Finally, although the NHTSA's enforcement authority is extensive, safety flaws may take years to identify and recall. This has been the situation with a number of safety recalls. In 2000, congressional hearings and the media revealed hundreds of needless deaths and injuries caused by the Firestone/Ford Explorer defective tire fiasco because of delayed agency action. Again, for the same reason, in 2009, families were put at unacceptable risk due to the Toyota sudden acceleration problem. In the past several years, the public has learned about the cover-ups and deception by General Motors which knowingly used faulty ignition switches that have been linked to at least 169 deaths and many more injuries because of long delayed agency action.[51] Furthermore, the defective air bags manufactured by Takata have resulted in millions of vehicle recalls and have caused at least 11 deaths in the U.S. and numerous injuries because, in part, of delayed agency action.[52]

Although its enforcement powers are necessary, they are not executed immediately after a safety defect involved crash occurs. It may then take months or years to establish that a defect exists and what the defect is and then more time to convince the manufacturer that a recall is appropriate and, even then, further negotiation to ensure that the scope of the recall is adequate, and all that time assumes that a remedy is available. Thus, while the agency's enforcement authority is necessary and essential, to identify safety defects, it does not provide the prophylactic safety effect of standards and regulations.

Exemption Authority

Advocates is concerned with the NHTSA AV Policy's discussion of the use of exemption authority and proposed expansion of that authority. Compliance with safety standards must be maintained to ensure that all consumers are afforded a minimal level of safety. Advocates concurs with the agency statement that "[g]eneral exemptions do not excuse non-compliance with applicable standards simply because doing so would be inconvenient or inconsistent with the manufacturers' preferred vehicle design."[53] However the agency in its discussion regarding expanding its general exemption authority considers not only increasing the number of vehicles and duration of the exemptions, but also mentions the possibility of moving towards relaxed limitations or even eliminating numerical limits for exempt vehicles altogether.[54] Advocates strongly opposes this idea which will compromise safety.

As Advocates' comments on countless past general exemptions have shown, particularly from the FMVSS, the standard for proving that an alternative approach represents an equivalent level of safety to the existing regulatory requirement is murky.[55] Furthermore, Advocates is concerned that expansion of the exemption authority would lead to an alternative path around FMVSS compliance. Advocates con-

[50] 49 U.S.C. § 30101.

[51] Angelo Young, *General Motors Ignition Switch Flaw Death Toll Rises To 169 Following Personal Injury Settlement; Penalty Costs Top $2.1B,* International Business Times (Sept. 17, 2015)

[52] Ryan Beene, *11th U.S. death related to Takata airbags reported by Honda,* Automotive News (Oct. 20, 2016).

[53] NHTSA AV Policy, p. 55.

[54] NHTSA AV Policy, p. 76.

[55] Most exemption requests are supported by little or no substantive data that meets the equivalent level of safety legal standard.

curs with the agency's expressed concern that "it would be important to guard against overuse of the exemption authority which might displace rulemaking as the ***de facto*** primary method of regulating motor vehicles and equipment."[56] For this reason alone, the expansion of exemption authority should be avoided. This is not the intent of the agency's organic statute, its current exemption authority, or the preferred means by which the agency should ensure public safety. Advocates recommends that the agency focus on efficiently addressing current regulatory shortcomings and adapting current requirements through rulemaking rather than eviscerating the rules through exemptions.

IV. Modern Regulatory Tools

Safety Assurance

The discussion of Safety Assurance in the NHTSA AV Policy document confirms that the NHTSA could establish, by rule, a mandatory Safety Assurance requirement "to demonstrate that motor vehicle manufacturers' and other entities' design, manufacturing, and testing processes apply NHTSA performance guidance, industry best practices, and other performance criteria and standards to assure the safe operation of motor vehicles, before those vehicles are deployed on public roads."[57] This could apply to level 0–2 vehicles as well as level 3–5 AVs as well. The agency makes clear that "NHTSA could implement many safety assurance tools without additional statutory authority."[58] Advocates completely agrees and urges the agency to pursue this course of requiring manufacturers to establish a functional safety based assessment process to be reviewed by the agency. The adoption of a required safety assurance process for AVs would still be consistent with the manufacturer self-certification procedure required by existing law.[59] Manufacturers would have to comply with the safety assessment process and allow NHTSA an opportunity to review the AV documentation and request additional information. However, following the agency review the manufacturer would be able to self-certify the AVs as under current law. The agency would not itself pre-test prototype AVs to ensure that they conform to the FMVSS and the verifications contained in the manufacturer safety assessment.

Pre-Market Approval Authority

Pre-market approval would allow the agency to conduct testing on prototype vehicles and to ensure no AVs are marketed without approval. This may be particularly important for highly complex electronic aspects of vehicle control and to allow examination of computer programming and logic. However, it is an entirely different regulatory system that exists currently at the NHTSA. Regardless, the safety assessment aspect of the agency guidance could be put into place by rule, without the need for pre-market approval legislation.[60]

Cease and Desist Authority

Advocates strongly supports the enactment of legislation to afford the NHTSA cease and desist authority to immediately remediate imminent hazards. This authority, possessed by other regulatory administrations, including the Federal Motor Carrier Safety Administration, would allow the agency to expedite taking action in the event that a serious problem or defect poses an immediate danger to public safety. In a number of previous and recent safety recalls, the agency might have invoked such authority to ground vehicles that pose a significant unreasonable risk to public safety. Imminent hazard authority would still require some measures of due process and court review to ensure that the agency does not act impetuously, but would allow a faster response to address a serious safety problem.

Post Sale Authority to Regulate Software Changes

Advocates agrees with the NHTSA that the agency currently has authority to regulate software changes that update vehicle programming and could affect the basis for the original vehicle certification. As the software governing an AV is part of the vehicle or vehicle equipment, the agency has authority to regulate changes that could affect vehicle safety systems and that could result in a defect or give rise to an unreasonable risk to safety. The agency should require by regulation any post

[56] NHTSA AV Policy, p. 76 (emphasis added).
[57] NHTSA AV Policy, pp. 70–71.
[58] NHTSA AV Policy, p. 71.
[59] Title 49, U.S.C., § 30115.
[60] The NHTSA's discussion of a hybrid approval process that would combine self-certification of existing FMVSS and pre-market approval by the NHTSA, or a third party expert supervised by the agency, for AV features that are not subject to an FMVSS or regulation, still require Congress to pass pre-market legislation.

sale software update be submitted to NHTSA and made available for public review with a summary of the changes that were implemented.

JACQUELINE S. GILLAN,
President.

JOAN CLAYBROOK,
Consumer Co-Chair,
Former NHTSA Administrator.

STATEMENT OF AMERICAN CAR RENTAL ASSOCIATION

The American Car Rental Association (ACRA) respectfully submits this statement for the record of the Senate Commerce, Science and Transportation Committee's hearing on "Paving the Way for Self-Driving Vehicles" on Wednesday, June 14, 2017.

ACRA is the national representative for over 98 percent of our Nation's car rental industry. ACRA's membership is comprised of over 300 car rental companies, including all of the brands you would recognize such as Alamo, Avis, Budget, Dollar, Enterprise, Hertz, National and Thrifty. ACRA members also include many system licensees and franchisees mid-size, regional and independent car rental companies as well as smaller, "mom & pop" operators. ACRA members have over two million registered vehicles in service, with fleets ranging in size from one million cars to ten cars.

ACRA's members strongly support the development and gradual deployment of "Highly Automated Vehicles" (HAVs) to improve transportation safety and reduce property damage and personal injury and deaths associated with vehicle accidents. However, the introduction of HAVs is a complex technical and public policy challenge. This challenge will require policymakers to address and incorporate existing safety, consumer protection, privacy and liability issues into a changing vehicle population that includes HAVs—while at the same time maintaining flexibility to accommodate new and evolving legal issues unique to HAVs that may not be apparent today.

The members of the ACRA purchase one out of every nine new cars sold in the United States each year—almost 2 million vehicles in 2016. To the extent that HAVs are introduced into the private passenger motor vehicle fleet in the next decade, ACRA members will be at the forefront of HAV deployment and on the front lines of the education of car rental customers with respect to interacting with HAVs safely.

The Promise and Challenges of Autonomous Vehicles—The widespread introduction of HAVs promises to reduce the number of deaths (about 40,000/year in the United States) and injuries (hundreds of thousands every year in the United States) caused by motor vehicle accidents—over 90 percent of which are caused by human error. But this promise is not without challenges in many complex areas, including thorny public policy issues that have been debated by many interested parties for decades, including:

- *Liability*—Federal and State liability statutes generally hold the driver of a motor vehicle liable for injuries and property damage caused by that driver's negligence. With respect to HAVs, there is no "driver" per se and thus determining responsibility for injuries and other harm become problematic. Federal and State policymakers should consider assigning liability for accidents caused by HAVs to the entities most capable of addressing design and functionality shortcomings in HAVS—in most cases, the vehicle and software designers and manufacturers, rather than the humans occupying the vehicle or the fleet owners.
- *Ownership of Motor Vehicles*—As we move towards an era of widespread HAV deployment, our notions of motor vehicle ownership likely will undergo a revolutionary change. Instead of owning our personal automobile, or renting a minivan for a family vacation, or boarding a bus for a ride to school, or hailing a taxi—all of these activities may be undertaken with different types of HAVs which may or may not be owned by an individual, a school district, or a fleet operator. Resolving vehicle ownership issues, including maintenance, accident reporting, data recording and sharing, and other heretofore unaddressed issues with respect to HAVs will need to be discussed and resolved.
- *Taxes and Fees*—HAVs hold the promise of eliminating distinctions between rental cars, taxis, ride-hailing services and individual motor vehicle ownership. With the introduction of HAVs, responsibilities must be apportioned for paying

Federal and State motor fuel excise taxes, State and Local fees on car rentals, ride-hailing services and taxis, and State and Local vehicle registration and sales taxes.

- *Harmonization*—The customers of ACRA members cross state lines in their current rental cars without restrictions and likely will anticipate the ability to do the same with respect to HAVs rented from ACRA members. As a result, a myriad of complex and perhaps contradictory State laws or regulations with respect to technical, safety or operational standards for HAVs should be avoided wherever possible. Continued State regulation of HAVs in traditional areas such as licensing, registration and insurance requirements would not in most instances pose impediments to the introduction of HAVs in ACRA's opinion.
- *Privacy*—Federal and State regulators have started to wrestle with the difficult challenges of maintaining individual privacy with respect to data generated by today's increasingly complex and technologically advanced motor vehicles and promoting transportation safety and enforcement of Federal and State laws. Such thorny privacy issues will only be multiplied with HAVs, and ACRA urges policymakers to preserve the right of vehicle owners to control and own the data generated by HAVs.
- *Cybersecurity*—The increased automation of motor vehicles, leading ultimately to deployment of HAVs, heightens the risk of cyber-attacks on single cars or groups of vehicles. Such risks must be managed by vehicle manufacturers and designers. However, the same technology that opens HAVs to cyber-attacks may hold the promise of reducing motor vehicle theft and other crimes involving vehicles. The cybersecurity issues related to HAVs must be balanced between protection of the vehicle's occupants and aiding law enforcement agencies in crime prevention and the apprehension of criminals.
- *"Training" of HAV Users*—Unless an individual purchases an HAV and is briefed by the seller on the operation of the vehicle (much as is done at many vehicle dealerships today when a vehicle is purchased), most consumers' first interaction with an HAV likely will be in a car rental transaction or other short-term use scenario such as a taxi or ride-hailing use. Manufacturers of the HAVs' hardware and software must assume responsibility for providing consumers with a training manual or user interface presentation upon entry into the HAV. Placing this training requirement on the manufacturer will be much more efficient and effective than a requirement that the owners—whether individuals or fleet management companies—of the HAVs provide this training on the use and operation of the HAV.

Special Attention to Data/Information Ownership and Control—ACRA posits that the owners of HAVs—whether an individual, a corporate entity, or a fleet management company—and their agents (such as property and casualty insurers) must retain full, real-time access and control over the personal and vehicle information associated with and generated by HAVs.

Such information access and control must include data "read" and "write" capabilities, as well as authenticated, remote command and control of a stationary vehicle. In addition, owners of HAVs with multiple users, such as consumers with multiple drivers in the same family, or car rental companies with many customers using one HAV, must be provided with a secure and simple means of erasing personal information from the info-entertainment systems of all vehicles, including HAVs.

Currently, the owner of a motor vehicle has full ownership over the personal information stored in that vehicle and the vehicle information generated by and stored by the vehicle. Such a data ownership construct must continue as we transition to HAVs to protect consumer privacy, to ensure that the safety promise of HAVs is fully realized, to promote competition, and to permit owners of HAVs to manage the information generated by their vehicles—whether it is one HAV owned by an individual or 100,000 HAVs owned by a car rental company.

Some stakeholders may suggest that access to personal and vehicle data must be limited to hardware or software providers in order to fully deploy HAVs. Such a closed silo of access to vehicle information would represent a complete public policy reversal of decades of consumer and privacy protection. The proponents of such a closed data system have not advanced convincing arguments as to why they should be granted a monopoly on this data—a monopoly that would be in place even when the hardware or software company doesn't own the HAV in question.

ACRA looks forward to working with the Committee and all stakeholders to formulate a personal and vehicle information and data access public policy for HAVs that is consistent with consumer protection and privacy principles while at the same time achieving the safety goals promised by HAVs.

Thank you for the opportunity to present this statement for the record at this hearing. ACRA stands ready to work with the members of the Committee and all State and Federal legislators and regulators, as well as the many stakeholders interested in the development and introduction of HAVs, in the months and years ahead.

STATEMENT FROM CONTINENTAL

Continental is a leading Tier 1 supplier that develops intelligent technologies for transporting people and their goods. We provide our automotive customers with sustainable, safe and affordable solutions that enhance automotive safety. In 2016 we generated more than $43 billion in sales within our five divisions, Chassis & Safety, Interior, Powertrain, Tires, and ContiTech. Continental employs more than 20,000 employees in the U.S. at more than 80 facilities located in 27 states and has more than 220,000 employees in 55 countries worldwide.

In 2015 there were more than 35,000 lives lost in the U.S. due to traffic crashes. Projections for 2016 are expected to increase to more than 40,000 fatalities, a level we haven't seen in a decade. While this is an alarming number, it is even more startling at a global level—more than 1.2 million people die in roadway crashes and another 50 million are injured. This is unacceptable and reversing this trend is what motivates each and every employee at Continental.

In the last 45 years the U.S. has experienced a relative declining trend in traffic fatalities with respect to an increased number of vehicles on the road and number of miles driven. This is due in large part to improved vehicle safety technologies. In the early 1970s the number of injuries and fatalities were at an all-time high. The introduction of the seat belt helped to reduce the total number of traffic fatalities by 10,000 in a few short years. In 1983, the number of fatalities was the lowest in 20 years due to the introduction of anti-lock braking systems. As numbers began to rise again, the airbag became standard in vehicles reducing injuries and fatalities down to its lowest number in 30 years. The introduction of electronic stability control in the mid-1990s helped to reduce traffic accidents to the lowest number in 50 years. Continental projects new crash-avoidance technologies will once again reverse the recent increase in fatalities as the auto industry moves toward a more widespread implementation of Advanced Driver Assist Systems (ADAS).

Innovation has always been at the heart of the automotive industry. From the original concept of the automobile in the late 1800s, the mass production lines pioneered in Detroit, to today, the automotive industry has always invested in research and development to make their products safer, more reliable and more affordable. Today, we are witnessing the automotive industry evolve from a crashworthiness mindset, where manufacturers try to make the passenger cabin more survivable in the event of an accident towards a crash avoidance mindset—after all, the best way to survive a crash is to avoid one in the first place.

Continental, and our dedicated employees, are committed to developing Safe and Dynamic Driving technologies towards Vision Zero. Vision Zero means a future with zero traffic fatalities, injuries and ultimately zero accidents. Such a future can only be achieved with the help of innovative active and passive safety, driver assistance, and automated driving technologies. As Continental brings these technologies to market, we exhaustively test products, and subsystems, as part of a larger system of advanced driving assistance technologies that will be integrated with a variety of components by original equipment manufacturers.

Our Vision Zero philosophy is embedded in each technology we develop as we continue to enable automated driving. At Continental, we describe our systems approach through three primary actions—sense, plan, and act. Whether the technology simply assists the driver like many systems on the road today, or ultimately takes over the driving task completely, it first must SENSE the surrounding environment and gather the necessary data that can be interpreted. Sophisticated sensor systems can help eliminate human error and distractions by providing 360-degree awareness of the road at all times. The data gathered from the sensors is then analyzed to identify obstacles or hazards. Our systems then dynamically develop a PLAN to determine how to assist the driver. Once that plan is in place, the systems will ACT to execute the plan to safely and comfortably pilot the vehicle and in certain cases avoid a hazard or crash situation. Our Sense, Plan, Act approach is the foundation behind Continental's active safety and Advanced Driver Assistance System technology, and is a key component to advancing automated driving systems. We believe that when fully automated driving is possible, traffic fatalities can be reduced by 90 percent because that is the percentage of accidents that are caused by human error.

Continental has been an active participant globally in policy discussions and initiatives with governments, automotive industry partners, trade associations and other standard setting organizations. The collaborative efforts to help establish consistency within the emerging self-driving market has been crucial to the advancement of automated driving technologies. Continental is currently engaged with the Department of Transportation's Smart Cities Program. Several of our divisions are working together to develop a highly sophisticated intersection in Columbus, Ohio, with vehicle and integrated infrastructure technologies that will help save the lives of vehicle occupants as well as pedestrians while improving transportation efficiency in urban environments. We support the National Highway Traffic Safety Administration's recent adoption of the SAE International definitions of automation, as we believe it is beneficial to helping educate the public in order to distinguish between different automated technologies and garner public acceptance.

Continental is one of the leading suppliers in this market, with a complete portfolio of technologies for all defined levels of automation. Each innovative safety feature undergoes an extensive testing process before becoming available to the market. As a supplier, we currently develop a multitude of innovative technologies that can save lives and enhance the driving experience under the Level 0 to Level 2 definitions of automation. These products are designed based on the needs of our customers to assist the driver in interpreting the surrounding environment and control the vehicle in order to prevent an accident from occurring.

Continental has been integral in the deployment of current crash avoidance technologies such as lane keep assist, rear back up assist, automatic emergency braking, and adaptive cruise control, to name a few. These crash avoidance technologies are the building blocks to higher levels of automated driving and need to be embraced as crash avoidance technologies that save lives. All of these technologies can be found throughout the fleets of most vehicle manufacturers.

As the industry moves forward towards Level 3 automation technology and beyond, Continental is positioned to supply public and personal transportation needs with the safest and most advanced technology available on the market. The world and the behavior of drivers within it are ever changing, and the vehicle must adapt to these changing trends. Our children seem to rely on smartphones more so than vehicles. Living in a world of distractions has become commonplace. Automotive technology must be developed accordingly. That is why Continental has put a great deal of effort into Human Machine Interface technology. We want the driver to be aware of their surroundings, be aware of what the systems in the vehicle are doing, and be aware of when it is safe to relinquish control of the vehicle and when to reengage with the vehicle. In addition to informing the occupants, keeping them safe, and pedestrians safe, we must also secure the systems within the vehicle. As part of system development for Highly Automated Driving, we focus on redundancy of vehicle safety systems. That is why we are developing complimentary systems and technologies that support existing safety systems in the vehicle's architecture.

Since 2011, we have continued a pursuit of testing and developing highly automated driving with next generation technologies like automated parking, cruising chauffeur and a complete self-driving vehicle in combination with V2V/V2X technology. We were the first supplier in the U.S. to be awarded a testing license for automated vehicles in Nevada and are currently testing our third generation automated vehicle on highways and roads throughout the country and around the world. We are currently integrating sophisticated technologies such as high resolution flash lidar, which will expand the vehicle's detection capabilities. This is the same technology that has been deployed on space shuttles at the most advanced technical level, and we are working to utilize its potential for road applications. But, our continued efforts in this direction would benefit greatly from an investment in infrastructure that promotes vehicle to X communication, a dedicated spectrum communication band that can be utilized by current and future safety systems, and harmonization of safety laws that allows for the full real world testing of these technologies.

The challenges in broadly testing this new and innovative safety technology across the country are great. The industry currently faces considerable uncertainty on state and Federal requirements that would require clarification from the Federal Government's exclusive authority to regulate all motor vehicles. The safe commercial deployment of potential life saving technology depends on the ability to extensively test on public roads under all conditions. In order to envision a future of full automation, the government must review Federal motor vehicle safety standards that would allow for vehicles that may not be under the full control of a driver at all times. Similar to the need of improved road conditions as automobiles transitioned from rural landscapes to metropolitan areas in the early 1900s, we

need a road infrastructure that complements automotive advancements, and a legal framework that supports a new system of mobility.

The automotive world is one of excitement. Software developers are becoming automotive suppliers, automotive companies are becoming software developers, and our vehicles are becoming our smart-device. The world of mobility has the capability of expanding to unimaginable independence and personal freedom without sacrificing the safety of future generations. Continental stands at the ready, alongside our industry colleagues, to work with the Committee and Congress in helping construct laws that foster innovation, enable mobility, and create a safer environment for the public.

STATEMENT OF PROPERTY CASUALTY INSURERS ASSOCIATION OF AMERICA

The promise of "self-driving" vehicles to improve road safety and mobility continues to generate debate about the appropriate regulatory framework for the testing and deployment of such vehicles. While determining how our existing vehicle regulatory systems need to change is very important, there is a fundamental mismatch between the public perceptions that auto accidents and insurance costs are decreasing with the stark reality that our roads are becoming increasingly dangerous resulting in rising costs. Auto accident deaths have increased by 14 percent over the last two years, and the number of people injured on our roads has increased by more than 12 percent since 2014. Someday in the future self-driving cars may reduce the number of accidents and deaths. However, the potential of automated vehicle technology stands in sharp contrast to what is happening on our roads today. The Property Casualty Insurers Association of America (PCI) is composed of 1,000 member companies, representing the broadest cross section of insurers of any national trade association. PCI members write $202 billion in annual premium, 35 percent of the Nation's property casualty insurance. That figure includes over $97 billion, or 42 percent of the auto insurance premium written in the United States. PCI's has analyzed the recent increase in auto insurance claim frequency and found strong correlations with traffic congestion and distracted driving, weaker correlations from increasing populations of novice and older drivers, and some correlation with liberalized marijuana laws. While it is important to prepare for the automated vehicle of the future, we urge policymakers to continue to focus on the auto safety challenges that face us today such as distracted and impaired driving. The FAST Act provides for continuing efforts to increase public awareness and improving enforcement as well as establishing an enforceable impairment standard for drivers under the influence of marijuana. These are critically important measures for reducing accidents, injuries and deaths on our Nation's roads. The importance of addressing these issues was also the subject of a 2016 bipartisan letter from 23 members of congress urging prompt implementation of these provisions of the FAST Act by the Department of Transportation.

Increasing automation of driving functions will mean that some motor vehicle laws and regulations will need to be changed to accommodate the testing and deployment of self-driving cars. Testing requirements, guidelines and standards for use on public roads should set clear expectations for the public and provide clear direction for technology developers and manufacturers for compliance. Modifications to existing auto safety laws and motor vehicle safety standards should be rare and limited to only the highest levels (*i.e.,* fully autonomous) of automated driving and should clearly define the levels of automation to which the modification applies. Clear and effectively enforced auto safety laws and vehicle standards can save lives on our roads today and, when applied to automated driving systems, develop public confidence that will ultimately determine if the technology realizes its potential.

The National Highway Traffic Safety Administration's (NHTSA) "Federal Automated Vehicle Policy," is intended to provide guidance for states on the testing and deployment of highly automated vehicles (HAV's). This policy guidance briefly references insurance yet does raise issues that are important to the automobile insurance market as it seeks to adapt and develop new products to meet consumer's needs that should be considered in any policy discussion of self-driving vehicles.

Recognition of State Regulation of Insurance and Liability Issues

NHTSA's policy identifies as Federal responsibilities: setting and enforcing safety standards for motor vehicles, recalls, promoting public awareness and providing guidance for the states. NHTSA's policy also recognizes that it is the state's role to license drivers and vehicles, enforce traffic laws and regulate motor vehicle insurance, tort and criminal liability issues as they pertain to automated vehicles. PCI shares the view that the states should continue to have primacy on motor vehicle

insurance and liability issues as they do today, and we support NHTSA's recognition of that role.

NHTSA's policy also repeats the recommendation from its 2013 guidance that entities testing automated technology should provide proof of financial responsibility coverage of at least $5 million. PCI has not taken a position on this coverage requirement. But as highly automated vehicles (HAV's) are deployed for public, states will need to consider what, if any, changes need to be made to the states existing motor vehicle financial responsibility laws.

Data Collection and Access

As policymakers consider what data should be collected and retained by automated vehicles it is essential for providing customer service that the rules provide for reasonable access to that data for insurers for claims handling and underwriting purposes. In many auto accidents, apportionment of liability is likely to hinge upon whether a human driver or the vehicle itself was in control and what actions either the driver or the vehicle did or did not take immediately prior to the loss event. Access to data for insurers will speed claims handling and potentially avoid disputes that could delay compensation to accident victims. Access to historical anonymized data on the different automated vehicle systems will also be important to help insurers innovate and develop new insurance products as the nature of the risk changes.

Conclusion

Automated driving technology holds great promise for the future, and implementing clear policies on the Federal and state roles in regulating automated vehicle technology and ensuring that insurers have access to vehicle data on reasonable terms to efficiently handle claims, develop products and underwriting methods are an essential first step toward that future. However, policymakers must not lose site of the auto safety issues that face us today. We look forward to working with policymakers at the Federal and state level to reduce accidents on our roads today and in future.

UBER
June 13, 2017

Hon. JOHN THUNE, Chairman,
Committee on Commerce, Science, and Transportation,
United States Senate,
Washington, DC.

Hon. BILL NELSON, Ranking Member,
Committee on Commerce, Science, and Transportation,
United States Senate,
Washington, DC.

Dear Chairman Thune, Ranking Member Nelson, and members of the Committee:

We appreciate the opportunity to provide written testimony on the future of self-driving or automated vehicle technology.

Self-driving cars have the potential to bring unimaginable benefits to cities, and drastically improve quality of life for millions of people around the world. But it is a relatively young and rapidly changing field. How policymakers choose to regulate this space will play a critical role in determining whether the full potential of this technology will be realized.

About Uber

Uber is a technology company with a simple vision: make safe and affordable transportation available everywhere, for everyone and everything at the push of a button. Since our founding, we have worked to change the way people think about mobility, and continue to use technology to connect people and goods to places. Today, 75 percent of the U.S. population lives in a county where they have access to Uber.

Two years ago, we established our Advanced Technologies Group in Pittsburgh, Pennsylvania. And today, we employ one of the strongest self-driving engineering groups in the world, with the practical experience that comes from 1.2 billion miles traveled on roads every month through our ridesharing and delivery services in hundreds of cities, and world-class manufacturing partners.

Our goal is to make safe self-driving cars available to people everywhere. After thorough testing and evaluation in closed settings—and on-road testing with employees—we began operating Self-Driving Ubers on public roads in Pittsburgh last

September, giving uberX riders an opportunity to experience self-driving technology for themselves. In February, our Self-Driving Ubers started picking up passengers in Tempe, Arizona.

Before any rider experiences our technology, we validate it in simulation, monitor it on a closed test track, and test it on-road without passengers. In addition, we ensure that trained operators are in the driver's seat for each release of the nascent technology to continually monitor and learn from the performance of the system. We believe that the deployment of self-driving cars will only succeed if we are able to learn from real-word situations. It also provides us with an opportunity to gain and preserving user trust. Through our Pittsburgh and Tempe operations, we are accomplishing both.

While we have not yet deployed fully self-driving cars—i.e. vehicles that operate without a driver—we hope to do so in the coming years. Our hope is that by transitioning to fleets of self-driving cars, we can help save more than a million lives each year around the world, reduce parking and traffic on roads, open up more land for commercial and residential development, reduce carbon emissions overall, and reduce the cost of transportation for average households.[1,2] According to the University of Texas, these self-driving-led improvements could lead to cost savings of over $1.4 trillion per year in avoided car crashes, reduced congestion delays, and productivity gains en route.[3]

To unlock these outcomes, it's critical that our regulatory environment does the following:

1. Enables and encourages shared vehicle operation and use (through ridesharing or commercial vehicle fleets) in addition to the traditional direct-to-consumer sales model for passenger vehicles;
2. Acknowledges the differences between self-driving software and traditional vehicle equipment software and sets the appropriate rules for each;
3. Does not fundamentally re-balance powers between local and Federal authorities that regulate vehicle safety or tie the industry to standards that are still evolving.

Encouraging shared vehicle operation and use

To date, policies addressing passenger vehicle operation and use have largely been based on a traditional manufacturer-sold, owner-operated model. But that is not the approach that many technology companies and automakers are taking for self-driving cars. Rather, companies are investing in shared, self-driving fleets because the model creates far more potential for the faster and safer development of self-driving technologies for several reasons:

- First, the sheer expense of owning and operating a self-driving car, which is expensive and difficult to build, makes the technology cost-prohibitive for most households. The vast majority of people will encounter, experience, and become familiar with this technology through shared self-driving fleets that are deployed through a ridesharing network. In addition to gaining access at a more affordable cost, a fleet approach will also provide access to higher quality sensing and computing features that will be continually updated.
- Second, a world where people simply trade the cars they have today for self-driving ones will neither reap the benefits of less congestion and pollution, nor eliminate the expense of owning a car. The International Transport Forum has studied the potential of shared self-driving cars, and proposed that a city that moves to a shared, self-driving future will require a vehicle fleet less than 10 percent its current size.[4]
- Third, fleet operators will be better equipped to ensure the safe use of self-driving cars than individual owner-operators. In a direct-to-consumer model, an owner-operator would be responsible for maintaining hardware and downloading software updates to improve the safety of his or her vehicle. He or she would also be responsible for making decisions about when, where, and how to operate the vehicle. By contrast, a fleet operator has the ability to hire qualified professionals, perform vehicle maintenance on a daily basis if necessary, update

[1] ITF study, SDV future requires vehicle fleet less than 10 percent of its current size: *http://www.itf-oecd.org/sites/default/files/docs/15cpb_self-drivingcars.pdf*

[2] UC Berkeley study, SDVs with EVs could reduce emissions per vehicle mile by more than 90 percent *https://drive.google.com/a/uber.com/file/d/0BzdDAOtdz76gUTFlX0x1bERnN2M/view?usp=sharing*

[3] *https://mobilitylab.org/2017/03/20/autonomous-vehicles-safety-add-traffic/*

[4] *http://www.itf-oecd.org/sites/default/files/docs/15cpb_self-drivingcars.pdf*

both software and hardware, and impose operational restrictions on use of all the vehicles in the fleet. For example, if a fleet operator understood that a particular route was difficult for self-driving cars, that operator could mandate navigational paths around that route; similarly, an operator could restrict the use of self-driving cars during difficult weather conditions.

- Finally, a fleet approach allows companies to control how cars are deployed to ensure they only operate in conditions that the cars are capable of handling. Companies are then able to adjust the operating conditions and improve the software as-needed. Today, Self-Driving Ubers only run along certain roads that have been pre-selected based on software capabilities and corresponding road conditions; these roads have been mapped in advance and programmed to take road signs and other infrastructure into account. By contrast, self-driving cars sold to individuals must be able to operate on all roads and under all conditions before they are distributed.

Our decision to operate self-driving cars using a ridesharing fleet, rather than following the end-consumer model traditionally used by automotive manufacturers, is a natural byproduct of these facts.

To be clear, this vision of the future does not reflect a dispute between technology companies and traditional automakers. Many traditional automakers have also indicated they are interested in pursuing various types of fleet models—such as Mercedes Boost and GM Maven. So as policymakers consider legislation addressing self-driving and automated technologies, it is critical they take the benefits of a paradigm shift from private car ownership to shared self-driving cars into account.

Self-driving software cannot be regulated the way other vehicle equipment is

The embedded software (*e.g.,* Ford SYNC or cruise control technology) in today's motor cars sold to end consumers is installed once and rarely—if ever—updated. By contrast, self-driving software (*e.g.,* maps, routes, sensing and perception) must be updated frequently for safety and security. NHTSA's guidance last year demonstrated a desire to regulate self-driving technology under its authority over motor vehicle equipment and embedded software, but the proposed approach overlooks the fundamental difference between self-driving software and the software traditionally embedded in motor vehicle equipment.

A regulatory development and enforcement process that takes months or years to complete may be sensible for embedded software that cannot be easily updated after a vehicle is sold. But this process should not prohibit companies from upgrading their self-driving software daily. Given the speed of our learnings, and the safety/security concerns each software update may address, voluntary standards imposed by industry groups will prove more effective than regulatory enforcement (more on those standards below). Overly burdensome restrictions on software updates will only reduce the pace at which safety/security improvements are deployed, and NHTSA is neither equipped nor staffed to keep pace with how rapidly these updates must roll out. Ultimately, this will prevent the safest technology from making its way onto the roads as quickly as possible.

As a parallel example, most technology companies already have security teams focused on identifying vulnerabilities and preventing them from being exploited by patching each flaw quickly after it is discovered. If a software review process is required each time a vulnerability in self-driving software is discovered, that would impede developers' abilities to keep self-driving cars secure by pushing timely updates.

While we appreciate that NHTSA's proposed process (Federal Automated Vehicles Policy (Docket No. NHTSA–2016–0090) may have been motivated by a goal to develop a flexible framework that would adapt to the rapidly changing technology, we believe it will have the opposite effect. Their approach treats this software as one would a rigid product with infrequent (if any) changes, instead of a constantly evolving technology. It also does not take into consideration the idea that self-driving cars may only be deployed in certain pre-defined scenarios that companies deem their software ready to address (*e.g.,* specific routes). Instead of establishing a burdensome oversight process, the agency's focus should be on defining *what* results companies must achieve for a specific use-case instead of *how* they are achieved.

Self-driving technology does not warrant re-balancing state and Federal powers

In the United States, Federal authorities have always regulated motor vehicle equipment, while regulating drivers who operate vehicles has always been in the purview of individual states. The states, as a result, have long been an incubator for innovative regulatory approaches to improve driver safety. For example, states

have enacted laws combating driver distraction by setting rules around cell phone use and texting, which apply to the driver's behavior while operating the vehicle. States determine what rules of the road are most appropriate for their constituents and their environment, and tailor their own regulation of driver behavior and vehicle use to meet local needs.

Uber has experienced first-hand how innovation at the state and local level allows for the creation of rules tailored to the local environment. We were able to work with regulators in Florida to develop a framework that suited the state's needs—one that was ultimately very different from the framework used in New York City, and different still from the one used in Chicago. As a result, within five years over 75 percent of the U.S. population has access to ridesharing, and has enjoyed the benefits that come with greater access to affordable, reliable transportation.

Similarly, as self-driving software begins to take the role of the human driver, states should be allowed to continue to investigate, innovate, and pilot different approaches as they deem appropriate. States have always defined the standard by which humans are licensed to drive on state roads, and evaluate a human's ability to maneuver driving tasks. For example, some (but not all) states require drivers to demonstrate an ability to parallel park a vehicle. In keeping with that approach, states should evaluate a self-driving car's ability to successfully maneuver those tasks.

However, some entities have argued that self-driving cars will cross state borders and that a national framework is necessary. We believe that self-driving software should be able to determine a vehicle's location and adapt to local requirements as needed—particularly if there are specific local dynamics at play like inclement weather conditions. In addition, we recognize the role of Congress and NHTSA in setting high-level, universal standards, and look forward to working with officials and other industry stakeholders on that process.

Relatedly, industry itself often quickly settles on best practice safety standards in working groups. For example, ISO 26262, an international standard for road vehicle functional safety, is currently being updated to address self-driving technology. In addition, a new standard called SoTIF or Safety of the Intended Function has been drafted specifically to address the complexities of self-driving systems. And as former Administrator Rosekind himself highlighted during the November 16, 2016 U.S. Senate Appropriations Committee hearing on "The Automated and Self-Driving Vehicle Revolution," over 20 automakers agreed to emergency braking features well ahead of the regulatory requirement, and industry came together to develop best practices on cybersecurity. This approach is preferable, not only because technology changes so rapidly, but also because it ensures one technology is not favored over another.

This is also why commonly-used standards like the levels of automation set by the SAE must be allowed to shift as technology changes—with industry input—rather than be codified in law. The SAE levels were intended to describe the various levels of automation so that developers could self-classify the types of technology they were building. They were never intended—and were not drafted—to be binding legal standards. Companies are already working simultaneously on technologies that fall under different levels of automation. For example, refining street maps and routing information for human drivers to use while operating vehicles that require human input and monitoring does not preclude a company from developing high-definition maps and autonomy software that allows vehicles to perceive their surroundings and navigate without human driver input. Multiple investments allow companies to leapfrog certain levels as they become obsolete. It's possible that in the future, none of the levels of automation will require human input as technology advances.

Recommendations

Even under relatively optimistic scenarios, we likely will not see self-driving cars become a significant portion of the U.S. vehicle fleet for many years. In the coming years, 17 million new vehicles will be sold per year, only a small number of which will be self-driving cars; self-driving cars will only be a small proportion of the overall U.S. fleet of over 250 million vehicles for years to come. These facts suggest that—despite the heavy interest among regulators, media, and the public—elaborate guidance or hasty regulation of self-driving cars would be inappropriate. The tremendous potential of this technology—for instance, to remove the human choice or error tied to 94 percent of crashes—can best be achieved through alternative approaches.

Since conventional vehicles will occupy the vast majority of new vehicles for the foreseeable future, we encourage Congress and the DOT to focus their attention and limited agency resources on higher-impact efforts that can serve all road users re-

gardless of levels of automation. For example, ensuring that funding is going toward adopting Complete Street Design Standards, building uniform pavement without potholes, and creating protected bike lanes or separations for pedestrian walkways that calm traffic and reduce potential interactions between vehicles and bikers or pedestrians.

To be clear, a dramatic 'smart infrastructure' overhaul is not necessary for self-driving deployment. Rather, Congress should focus on doing what it already does best: maintaining our road infrastructure, which has been underfunded for some time, and needs $3.6 trillion in repairs by 2020.[5] In fact, focusing too heavily on 'smart infrastructure' could generate costly investments and will slow down the adoption of self-driving cars and limit their use to only those places able to afford costly connected infrastructure adoption.

Finally, to the extent Congress and NHTSA choose to allocate resources specifically to self-driving matters now, we recommend that the agency investigate amending outdated FMVSS to address self-driving cars. Nearly half of the FMVSS have some reference to the driver, driving controls, or driver seating position, and NHTSA has not laid out a time-frame for amending them. If they remain unchanged, these likely will be an impediment to the development and design of self-driving cars, make product planning more difficult, and potentially force companies to include equipment that could make self-driving cars less safe.

Uber thanks Chairman Thune, Ranking Member Nelson, Senator Peters and other members of the Committee for highlighting the importance of policy frameworks that enable companies able to deploy self-driving cars safely and rapidly. We appreciate the opportunity to provide input on how governments and companies can work together to maximize the benefits of this technology, and look forward to working with members of the Committee and others to make it a reality.

Sincerely,

ERIC MEYHOFER,
Head of Advanced Technologies Group (ATG),
Uber Technologies, Inc.

cc: Hon. Gary Peters, Commerce Committee Member

March 29, 2016

MOODY'S FORECASTS U.S. ADOPTION OF SELF-DRIVING CARS 'SEVERAL DECADES' AWAY

Reuters Staff

WASHINGTON (Reuters)—Near-universal adoption of self-driving cars in the United States is likely by around 2055 and poses a long-term threat to auto insurance companies, Moody's Investors Service said in a research report released Tuesday.

The report forecasts that fully autonomous or driverless cars could be a common option on U.S. vehicles by about 2030 and is likely to be standard on all new vehicles sold around 2035.

That would lead to the technology being in a majority of cars on U.S. roads by around 2045.

"Accident frequency will fall sharply over time, and will ultimately translate into significantly

lower premiums and consequently lower profits for auto insurers," the report said.

The Moody's report estimates that over the next five to 10 years, automotive technologies like automatic emergency braking are likely to boost insurance profitability as they may reduce crashes but not lead to an immediate reduction in rates.

http://www.reuters.com/article/us-moody-s-autos-selfdriving/moodys-forecasts-u-s-adoption-of-self-driving-cars-several-decades-away-idUSKCNOWV220

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[5] American Society of Civil Engineers, *http://www.infrastructurereportcard.org/*

ELECTRONIC PRIVACY INFORMATION CENTER
Washington, DC, June 13, 2017

Hon. JOHN THUNE, Chairman,
Hon. BILL NELSON, Ranking Member,
U.S. Senate Committee on Commerce, Science, and Transportation,
Washington, DC.

RE: HEARING ON "PAVING THE WAY FOR SELF-DRIVING VEHICLES"

Dear Chairman Thune and Ranking Member Nelson:

We write to your regarding the upcoming hearing "Paving the Way for Self-Driving Vehicles,"[1] on the privacy and safety risks of connected and autonomous vehicles. For more than a decade, the Electronic Privacy Information Center ("EPIC") has warned Federal agencies and Congress about the growing risks to privacy resulting from the increasing collection and use of personal data concerning the operation of motor vehicles.[2]

EPIC was established in 1994 to focus public attention on emerging privacy and civil liberties issues. EPIC engages in a wide range of public policy and litigation activities. EPIC testified before the House of Representatives in 2015 on "the Internet of Cars."[3] Recently, EPIC urged the Ninth Circuit of Appeals to protect the right of consumers to pursue safety issues with connected vehicles.[4] As EPIC explained in that case:

> "Connected vehicles" expose American drivers to the risks of data breach, auto theft, and physical injury. The internal computer systems for these vehicles are subject to hacking, unbounded data collection, and broad-scale cyber attack. Despite this extraordinary risk, car manufacturers are expanding the reach of networked vehicles that enable third party access to driver data and vehicle operational systems.[5]

EPIC will also be participating in the FTC/NHTSA workshop on privacy and security issues in connected cars later this month.[6]

Connected vehicles pose substantial safety and privacy risks. To date there have been several high-profile accidents involving self-driving car including:

- A bicyclist was struck by an autonomous driving car after it suddenly activated its brakes;[7]

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[1] *Paving the Way for Self-Driving Vehicles,* 115th Cong. (2017), S. Comm. on Commerce, Science, and Transportation, *https://www.commerce.senate.gov/public/index.cfm/press releases?ID=B7164253-4A43-4B70-8A73-68BFFE9EAD1A* (June 14, 2017).

[2] *See generally* EPIC, "Automobile Event Data Recorders (Black Boxes) and Privacy," *https://epic.org/privacy/edrs/*. *See also* EPIC, Comments, Docket No. NHTSA–2002–13546 (Feb. 28, 2003), available at *https://epic.org/privacy/drivers/edr_comments.pdf* ("There need to be clear guidelines for how the data can be accessed and processed by third parties following the use limitation and openness or transparency principles."); EPIC, Comments on Federal Motor Vehicle Safety Standards; V2V Communications, Docket No. 2016–0126 (Apr. 12, 2017), *https://epic.org/apa/comments/EPIC-NHTSA-V2V-Communications.pdf* [hereafter "V2V comments"]; EPIC, Comments on the Benefits, Challenges, and Potential Roles for the Government in Fostering the Advancement of the Internet of Things, Docket No. 160331306–6306–01 (June 2, 2016), *https://epic.org/apa/comments/EPIC-NTIA-on-IOT.pdf;* EPIC, Comments on Federal Motor Vehicle Safety Standards: "Vehicle-to-Vehicle (V2V) Communications," Docket No. NHTSA–2014–0022 (Oct. 20, 2014), *https://epic.org/privacy/edrs/EPIC-NHTSA-V2V-Cmts.pdf;* EPIC, Comments on the Privacy and Security Implications of the Internet of Things (June 1, 2013), *https://epic.org/privacy/ftc/EPIC-FTC-IoT-Cmts.pdf;* EPIC *et al.,* Comments on the Federal Motor Safety Standards; Event Data Recorders, Docket No. NHTSA–2012–0177 (Feb. 11, 2013), *https://epic.org/privacy/edrs/EPIC-Coal-NHTSA-EDR-Cmts.pdf;* EPIC, Comments, Docket No. NHTSA–2004–18029 (Aug. 13, 2004); *https://epic.org/privacy/drivers/edr_comm81304.html.*

[3] Statement of Khaliah Barnes, hearing on *The Internet of Cars* before the House Committee on Oversight and Government Reform, November 18, 2015, *https://epic.org/privacy/edrs/EPIC-Connected-Cars-Testimony-Nov-18-2015.pdf.*

[4] Brief of *Amicus Curiae* EPIC, *Cahen v. Toyota Motor Corporation,* No. 16–15496 (9th Cir. Aug. 5, 2016), *https://epic.org/amicus/cahen/EPIC-Amicus-Cahen-Toyota.pdf.*

[5] *Id.*

[6] *Connected Cars: Privacy, Security Issues Related to Connected Automated Vehicles,* Federal Trade Commission, *https://www.ftc.gov/news-events/events-calendar/2017/06/connected-cars-privacy-security-issues-related-connected.*

[7] Patrick May, *Robot-Human Smackdown: Self-Driving Car and Bicyclist Collide in San Francisco,* The Mercury News, Jun. 9, 2017, *http://www.mercurynews.com/2017/06/09/robot-human-smackdown-self-driving-car-and-bicyclist-collide-in-san-francisco/.*

- Uber recently suspending its "self-driving" program in Arizona after one of the company's vehicles struck a car with passengers inside.[8] The Uber vehicle was in self-driving mode, presumably "Level 3";
- A self-driving car failed to stop at a red light at a busy intersection;[9] and
- A Tesla owner was recently involved in an accident when the autopilot failed recognize a lane shift in a construction zone, resulting in a collision with a construction barrier.[10]

These accidents should alarm the Committee and the public, but they are only one of myriad issues with autonomous vehicles. Wide-scale malicious automobile hacking is no longer theoretical.[11] Although a full-scale remote car hijacking is certainly a serious risk to car owners and others,[12] hijacking is not the only risk posed by connected car vulnerabilities.[13] Connected cars leave consumers open to car theft, data theft, and other forms of attack as well. These attacks are not speculative; many customers have already suffered due to vulnerable car systems. For example, criminals have exploited vulnerabilities in connected cars to perpetrate car "ransomware" scams, "where a car is disabled by malicious code until a ransom is paid."[14]

Car manufacturers must adopt data security measures. Early mitigation of threats to public safety may reduce auto fatalities, spur innovation, and result in safer vehicles.[15] There should be great concern that each of autonomous car maker wants to be the first to have their vehicle available to the public can poses substantial safety risks.[16] A functioning autonomous vehicle does not mean security and the race to be the first with a functioning, marketable autonomous vehicle jeopardizes the safety and security of consumers.

Recently, Charlie Miller, whose research led Chrysler to recall 1.4 million vehicles after he hacked into a Jeep,[17] stated the danger in self-driving ridesharing and taxi services stating that "Autonomous vehicles are at the apex of all the terrible things that can go wrong . . . Cars are already insecure, and you're adding a bunch of sensors and computers that are controlling them . . . If a bad guy gets control of that,

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[8] Mike Isaac, *Uber Suspends Tests of Self-Driving Vehicles After Arizona Crash,* New York Times, Mar. 25, 2017, *https://www.nytimes.com/2017/03/25/business/uber-suspends-tests-of-self-driving-vehicles-after-arizona-crash.html;* Steven Overly, *Uber Self-Driving Car Flipped On Side In Arizona Crash,* Chicago Tribune, Mar. 25, 2017, *http://www.chicagotribune.com/bluesky/technology/ct-uber-self-driving-car-crash-20170325-story.html.*

[9] Mike Isaac & Daisuke Wakabyashi, *A Lawsuit Against Uber Highlights the Rush to Conquer Driverless Cars,* New York Times, Feb. 24, 2017, *https://www.nytimes.com/2017/02/24/technology/anthony-levandowski-waymo-uber-google-lawsuit.html.*

[10] Antti Kautonen, *Tesla Driver Blames Autopilot for Barrier Crash,* Autoblog, Mar. 3, 2017, *http://www.autoblog.com/2017/03/03/tesla-autopilot-barrier-crash/.*

[11] Brief of *Amicus Curiae* EPIC, *Cahen v. Toyota Motor Corporation,* No. 16–15496 (9th Cir. Aug. 5, 2016), available at *https://epic.org/amicus/cahen/EPIC-Amicus-Cahen-Toyota.pdf.*

[12] *See, e.g.,* Andy Greenberg, *Hackers Remotely Kill a Jeep On the Highway—With Me in It,* Wired (July 21, 2015), *https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/.*

[13] *See* Bruce Schneier, *The Internet of Things Will Turn Large-Scale Hacks Into Real World Disasters,* Motherboard (July 25, 2016), *http://motherboard.vice.com/read/the-internet-of-things-will-cause-the-first-ever-large-scale-internet-disaster* (explaining that information systems face three threats: theft (*i.e.,* loss of confidentiality), modification (*i.e.,* loss of integrity), and lack of access (*i.e.,* loss of availability)).

[14] Nora Young, *Your Car Can be Held for Ransom,* CBCradio (May 22, 2016), *http://www.cbc.ca/radio/spark/321-life-saving-fonts-ransomware-cars-and-more-1.3584113/your-car-can-be-held-for-ransom-1.3584114.*

[15] *See generally,* Ralph Nader, *Unsafe at Any Speed* (1965).

[16] Mike Isaac, *Lyft and Waymo Reach Deal to Collaborate on Self-Driving Cars,* New York Times, May 14, 2017, *https://www.nytimes.com/2017/05/14/technology/lyft-waymo-self-driving-cars.html?rref=collection%2Fsectioncollection%2Ftechnology&action=click&contentCollection=technology&region=stream&module=stream_unit&version=latest&contentPlacement=3&pgtype=sectionfront;* Alex Davies, *Detroit Is Stomping Silicon Valley in the Self-Driving Car Race,* Wired, Apr. 3, 2017, *https://www.wired.com/2017/04/detroit-stomping-silicon-valley-self-driving-car-race/.*

[17] Andy Greenberg, *After Jeep Hack, Chrysler Recalls 1.4 Million Vehicles for Bug Fix,* Wired, Jul 24, 2015, *https://www.wired.com/2015/07/jeep-hack-chrysler-recalls-1-4m-vehicles-bug-fix/;* Andy Greenberg, *Hackers Remotely Kill A Jeep on the Highway—With Me In It,* Wired, Jul. 21, 2015, *https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/;* Andy Greenberg, *The Jeep Hackers Are Back To Prove Car Hacking Can Get Much Worse,* Wired, Aug. 1, 2016, *https://www.wired.com/2016/08/jeep-hackers-return-high-speed-steering-acceleration-hacks/.*

it's going to be even worse."[18] The potential risks that connected cars pose to the driver, as well as the potential risk to the public, cannot be understated.

In paving the way for the development and deployment of self-driving cars this Committee should be aware of the National Highway Traffic Safety Administration's recent proposals that would pre-empt states from being involved in this process. Historically, Federal privacy laws have not preempted strong state protections or enforcement mechanisms.[19]

However, NHTSA recently proposed issuing a new Federal Motor Vehicle Safety Standard for vehicle-to-vehicle communications[20] and the Federal Automated Vehicle Policy envisions NHTSA issuing FMVSS's as connected cars are developed.[21] However, under the Vehicle Safety Act the states are pre-empted from issuing any standards for vehicle performance if it is not identical to an existing FMVSS that regulates the same aspect of performance.[22] As EPIC recently explained to the NHTSA:

> States have a unique perspective allowing them to develop innovative programs to protect consumers. As [connected car] technology evolves, the states should be allowed to operate as laboratories of democracy—a role they have traditionally held in the field of privacy.[23]

The Committee must make clear that the states must continue to have the same pivotal role for developing privacy regulations that they have traditionally held.

EPIC urges this Committee to take these accidents and security flaws into account as it examines the future of transportation as it relates to these vehicles. In addition to the substantial privacy concerns that connected cars present,[24] these recent incidents show that there are substantial safety concerns to everyone on the road. *National minimum standards for safety and privacy are needed to ensure the safe deployment of connected vehicles.*

Auto manufacturers have a particular responsibility to ensure the safety of drivers. Mr. Mitch Brainwol from the Alliance of Automobile Manufacturers should be asked:

- What are automobile manufacturers doing to ensure data security in connected cars?

Mr. Rob Csongor from NVIDIA Corporation should be asked:

- What information is NVIDIA collecting on drivers?
- What is NVIDIA doing to secure driver data?
- What cybersecurity measures has NVIDIA adopted to minimize the risk that its cars can be hacked?

We ask that this Statement be entered in the hearing record. EPIC looks forward to working with the Committee on these issues.

Sincerely,

MARC ROTENBERG
EPIC President

CAITRIONA FITZGERALD
EPIC Policy Director

KIM MILLER
EPIC Policy Fellow

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[18] Andy Greenberg, *Securing Driverless Cars From Hackers Is Hard. Ask The Ex-Uber Guy Who Protects Them,* Wired, Apr. 12, 2017, *https://www.wired.com/2017/04/ubers-former-top-hacker-securing-autonomous-cars-really-hard-problem/.*

[19] *See e.g.,* Electronic Communications Privacy Act; Right to Financial Privacy Act; Cable Communications Privacy Act; Video Privacy Protection Act; Employee Polygraph Protection Act; Telephone Consumer Protection Act; Driver's Privacy Protection Act; Gramm-Leach-Bliley Act.

[20] *Federal Motor Vehicle Safety Standards; V2V Communications,* 82 Fed. Reg. 3,854 (Jan. 12, 2017).

[21] Nat'l Highway Traffic Safety Admin., *Federal Automated Vehicles Policy* (Sep. 2016).

[22] "When a motor vehicle safety standard is in effect under this chapter, a State or a political subdivision of a State may prescribe or continue in effect a standard applicable to the same aspect of performance of a motor vehicle or motor vehicle equipment only if the standard is identical to the standard prescribed under this chapter." 49 U.S.C. § 30102(b)(1).

[23] V2V comments at 10.

[24] 8 U.S. Gov. Accountability Office, GAO–14–649T, Consumers' Location Data: Companies Take Steps to Protect Privacy, but Practices Are Inconsistent, and Risks May Not be Clear to Consumers (2014), *http://gao.gov/products/GAO-14-649T;* Jeff John Roberts, *Watch Out That Your Rental Car Doesn't Steal Your Phone Data,* Fortune, Sep. 1, 2016, *http://fortune.com/2016/09/01/rental-cars-data-theft/.*

PREPARED STATEMENT OF JOHN BOZZELLA, PRESIDENT AND CEO, ASSOCIATION OF GLOBAL AUTOMAKERS, INC.

On behalf of the Association of Global Automakers ("Global Automakers"), I am pleased to provide the following statement for the record of the Senate Committee on Commerce, Science, and Transportation hearing entitled "Paving the Way for Self-Driving Vehicles." We commend Chairman Thune, Ranking Member Nelson, and Senator Peters for their commitment to pursue bipartisan legislation on automated vehicles as reflected in their recently released principles.

Global Automakers represents international automobile manufacturers that design, build, and sell cars and light trucks in the United States. Our automaker members have invested $56 billion in U.S. facilities and directly employ 98,500 employees located throughout the United States. Global Automakers' members have 28 manufacturing facilities in twelve states and built 4.6 million vehicles in the United States in 2016, a 41 percent increase in production in the last decade. Global Automakers and our member companies are committed to creating the safest, cleanest and most technologically advanced vehicles on the road.

The automotive industry is making major investments in the research and development of automated vehicle technology here in the United States, and Global Automakers thanks the Committee its interest and proactive approach to vehicle automation. As you know, the Department of Transportation (DOT) has demonstrated Federal leadership and established a process to provide assurance that safety is being addressed at the national level through the issuance of its Federal Automated Vehicles Policy. At the same time, a number of states around the country are pursuing policies to regulate automated vehicles. Therefore, it is important and timely that the Committee is focusing its attention on this subject. With the right policies, the United States can continue to lead in the development of these technologies and bring their benefits to the American people as quickly as possible.

Automated vehicle systems can save lives, enhance mobility, improve transportation efficiency, and reduce fuel consumption. Public policy should spur this innovation, encourage testing, and permit nationwide deployment of vehicles across all levels of automation. Decisions made today will determine how fast and how far our systems evolve, and inconsistent policy approaches—particularly as they relate to vehicle characterization, performance, and design—could have long-lasting consequences. Only the Federal Government can ensure a framework that encourages and enables the development of highly automated vehicles, and it should work with state and local policymakers to provide guidance and establish clear policy roles and responsibilities.

The United States has long recognized that the automobile market is a national market and that manufacturers' success rests on the ability to sell vehicles that can be operated in all fifty states. The U.S. further recognizes that vehicle safety is a national priority, and the Motor Vehicle Safety Act has set clear limits on the role of states in regulating the design of motor vehicles. As opposed to the regulation of conventional vehicles comprised primarily of mechanical systems, automated vehicles have systems that rely as much on software as on hardware. This presents new challenges for policymakers and regulators. To address these emerging issues, DOT has established a nimble and flexible approach to oversee the safe testing and deployment of automated driving systems. In addition to the Federal Policy, the National Highway Traffic Safety Administration (NHTSA) maintains existing authority over motor vehicle safety to exercise recall and enforcement powers to address areas where there is deemed to be an unreasonable risk to safety. Unfortunately, while NHTSA examines potential future regulatory action for automated vehicle systems, the current scope of the Motor Vehicle Safety Act does not explicitly prevent states from developing disparate requirements in the absence of Federal standards.

Global Automakers support efforts by Congress and the Administration to ensure that there is a consistent national approach to automated vehicle policy in the United States and clarify the respective roles of federal, state and local governments. As stated in the Federal Automated Vehicle Policy, the primary roles and responsibilities of the Federal Government include setting Federal Motor Vehicle Safety Standards (FMVSS), ensuring compliance with standards, investigating defects, and issuing guidance for manufacturers and other entities. In contrast, state responsibility focuses on issues related to the operation of those vehicles on their roads, such as driver licensing and responsibility, vehicle registration, and insurance. This approach has supported decades of improvement in motor vehicle safety. Preempting state laws and regulations that prescribe design and performance standards for automated vehicles would help spur the further development, testing and deployment of this life-saving technology.

Congress can also help expedite automated technology deployment by providing NHTSA with authority to exempt an increased number of highly automated vehicles from standards that would otherwise limit their deployment. Existing regulations, understandably, did not envision the emergence of automated vehicle technology, and as a result there is uncertainty when seeking to certify a vehicle that is designed to operate without the engagement, or possibly the presence, of a driver. As noted in a March 2016 report by the U.S. DOT Volpe Center, there are a number of FMVSS that may limit the deployment of automated vehicles due to either explicit or implicit references to the presence of human driver.

Similarly, while expanded exemptions may provide greater opportunities for the deployment of automated vehicle systems in the short-term, it may not provide the necessary long-term certainty for manufacturers. It is therefore important that the Federal Government identify any outdated standards that may unnecessarily limit innovation and work collaboratively with industry and other stakeholders to update those standards to accommodate automated systems.

Global Automakers and our member companies believe that automated vehicle technologies can provide significant benefits, and we look forward to working with the Committee to help bring these benefits to the American people. If policymakers can ensure an environment where innovation is permitted to thrive, automated vehicles can truly transform vehicle transportation.

STATEMENT OF THE NATIONAL ASSOCIATION OF MUTUAL INSURANCE COMPANIES

The National Association of Mutual Insurance Companies (NAMIC) is pleased to provide comments to the Senate Committee on Commerce, Science, and Transportation as it considers the hurdles for testing deployment of successful automated driving systems (ADS) deployment and the roles state and Federal governments will play in promoting innovation and American competitiveness. We appreciate the Committee's focus on this important matter with the potential to greatly impact the domestic U.S. property/casualty insurance industry.

NAMIC is the largest property/casualty insurance trade association in the country, with more than 1,400 member companies representing 39 percent of the total market. NAMIC supports regional and local mutual insurance companies on main streets across America and many of the country's largest national insurers. NAMIC member companies serve more than 170 million policyholders and write more than $230 billion in annual premiums. Our members account for 54 percent of homeowners, 43 percent of automobile, and 32 percent of the business insurance markets.

NAMIC fully supports ADS innovation and competitive development that enhances safety. In this context, ADS innovation will be the deliberate application of information, imagination, and initiative by which new ideas are generated and converted into greater driving safety. It is important to note, however, that while technology is a key part of ADS innovation, it is not the only part. Especially in the case of a revolutionary change in mobility as will occur with ADS, successful and fruitful outcomes will only materialize when innovative approaches to cybersecurity, regulation, consumer behavior, and market practices. Integrating innovative practices, operations, rules, and regulations will be just as necessary to ADS innovation as technology.

With respect to ADS, NAMIC has participated in National Highway Traffic Safety Administration (NHTSA) panels relating to state jurisdiction and pre-market approval, serves as a Board Member of the Advocates for Highway and Auto Safety, and is working with the Insurance Institute for Highway Safety supporting the Virginia Tech Transportation Institute as part of the National Cooperative Highway Research Program.

Automated Driving Technology

Enthusiastic advocates of ADS contend that its ability to address driver error is its greatest purpose. NHTSA attributes 94 percent of all car crashes on human error, and ADS advocates infer or directly state that ADS will eliminate that human error, and thus the overwhelming majority of car crashes. That oft-cited 94 percent comes from NHTSA's "Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey", which reported data from The National Motor Vehicle Crash Causation Survey conducted from 2005 to 2007. The critical reason, which is the last event in the crash causal chain, was assigned to the driver in 94 percent (±2.2 percent) of the crashes in that survey. NHTSA defines the 'critical reason' as only the immediate reason for the critical pre-crash event, and simply the last failure in the causal chain of events leading up to the crash.

Critical reasons were broadly classified into recognition errors, decision errors, performance errors, and non-performance errors:

- Recognition error, which includes driver's inattention, internal and external distractions, and inadequate surveillance, was the most frequently assigned critical reason (41 percent ±2.2 percent).
- Decision error, such as driving too fast for conditions, too fast for a curve, false assumption of others' actions, illegal maneuver and misjudgment of gap or others' speed accounted for about 33 percent (±3.7 percent) of the crashes.
- In about 11 percent (±2.7 percent) of the crashes, the critical reason was performance error such as overcompensation, poor directional control, etc.
- Sleep was the most common critical reason among non-performance errors that accounted for 7 percent (±1.0 percent) of the crashes.
- Other driver errors were recorded as critical reasons for about 8 percent (±1.9 percent) of the drivers.

These above definitions are relevant to the proposed application of ADS as a remedy to these specific errors. The central premise behind the development and broad application of ADS technology is that ADS will have fewer of these specific recognition errors, decisions errors, performance errors and other errors than human drivers represented by the survey. ADS function that results in significant reductions in these specific errors should have a corresponding reduction in crashes and result in greater vehicle and personal safety.

The Hurdles for Testing and Successful ADS Deployment

ADS may have the potential to be much safer than human drivers, and could result in a dramatic decrease in crashes and highway deaths. But ADS are also under development, complex, and include numerous known and unknown hazards as well as unintended consequences. There are literally millions of related technological and policy questions as well as questions related to liability, cybersecurity, vehicle connectivity, and infrastructure.

Possibly the most challenging area is how ADS technology will deal with the transitional period, when human drivers share the road with ADS and continue to make the same and new recognition errors, decisions errors, performance errors and other errors. As policies and regulations are made toward enabling this ambitious ADS safety environment, communicating relevant data and analysis is critical to verify the safest transition from human-controlled to automated driving.

The technical challenges to ADS testing and successful development are vast and complex; too vast and complex to even begin to enumerate here. But even if these thousands of technical challenges can be successfully addressed, ADS will not be adopted unless consumers can be convinced that ADS use will be safe and reliable. Recent surveys by both the Massachusetts Institute of Technology (MIT) and J.D. Power have indicated that consumer comfort or trust in full automation appears to actually be declining. A shift away from trust in automation was observed across all age groups, and most notably in younger age ranges (which had been most open to ADS in the past). Roughly half of those surveyed stated that they would never purchase an ADS vehicle.

As consumers learn more about ADS, they appear to have more questions rather than answers. A critical hurdle for ADS deployment is that consumers lack relevant information to adequately gauge the performance and potential benefits of ADS. Consumers will require objective assessment and evaluation of just how much safer ADS are than human drivers, and in what conditions. Consumer acceptance will require expert collection and evaluation of data and analysis on the ADS as designed, as well as objective data and analysis from crashes involving ADS.

The history of the auto insurance industry provides ample evidence of that experience and expertise, as well as the commitment of the insurance industry to enhancing driving safety. A critical requirement for the testing and successful development of ADS will be insurers using their decades of expertise to provide objective data-based safety evaluations. This will require ADS companies to collect uniform ADS design and safety information and make that information available to insurers to enable an objective assessment of ADS safety. Insurers will also need access to ADS information and data—including crash and incident information and data—that is timely, complete, and useful.

The insurance industry also supports organizations dedicated to understanding crash risk and furthering safety enhancements. The Insurance Institute for Highway Safety is the premier organization dedicated to reducing the losses—deaths, injuries, and property damage—from crashes on the Nation's roads. The Highway Loss Data Institute provides scientific studies of insurance data representing the

human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model. Advocates for Highway and Auto Safety is an alliance of safety groups and insurance companies working together to make America's roads safer.

State and Federal Roles to Ensure Safety While Promoting Innovation and American Competitiveness

Promoting innovation and competitiveness will require joint development of state and Federal rules and regulations. NAMIC advocates that the roles of states and Federal authorities would best facilitate ADS safety development as follows:

1. The Federal Government—through NHTSA—should have the authority to make determinations for the required performance and safety, as well as data integrity, of ADS.
2. States and localities should have the authority to make the determinations of the registration, licensing, and operation of ADS in that state/locality.
3. States should retain the regulation of ADS insurance for the vehicle and/or operator.
4. States should define and address ADS personal liability issues in state/tort law and regulation in line with existing liability constructs. States and Federal authorities should have the authority to define and address ADS liability issues in law and regulation.
5. States and Federal authorities working together should make clear and workable data security and privacy requirements for vehicles with ADS.

In summary, NAMIC supports ADS development, and insurers are leading advocates toward 100 percent adoption of safe ADS. The realistic support of the potential for greater safety requires that the business of insurance put forth significant effort to objectively identify and analyze facts and data that comes naturally in the business of insurance. The development and adoption of ADS will require substantial policy and structure changes, which will also require the same factual analysis and review. As the primary rationale for ADS development is reducing vehicle crashes, injuries and fatalities, it is important that insurers have an active role in the assessment and communication of those benefits.

NAMIC greatly appreciates the opportunity to provide this testimony to the Committee and looks forward to working with the Committee in the development of ADS policy and regulation.

CONSUMER WATCHDOG
June 14, 2017

Sen. JOHN THUNE, Chairman
Sen. BILL NELSON, Ranking Member
Senate Committee on Commerce, Science, and Transportation
Washington, DC.

Re: Hearing: "Paving the Way for Self-Driving Vehicles"

Dear Chairman Thune and Ranking Member Nelson,

We are writing on behalf of Consumer Watchdog, a national nonpartisan, nonprofit public interest group to submit our just-issued report, "Self-Driving Vehicles: The Threat to Consumers," into the formal written record of the Commerce Committee's public hearing titled "Paving the Way for Self-driving Vehicles."

We must also express our deep dismay at the Committee's failure to include any representatives of consumer groups among the witnesses called to speak at the hearing. The witness panel includes a spokesman for auto manufacturers, a representative of a company developing robot car technology, and organization developing a test center for robot car technology. A spokesman for MADD has the laudable, but narrow, agenda of combating drunk driving. This is an industry-dominated panel with no representatives of auto safety or consumer protection organizations.

As our report shows, robot cars operating without mandatory safety, security, privacy and ethical standards will pose unprecedented risks to the American public. Lost in the hyperbole over robot cars is a realistic assessment of the likely costs to both consumers and taxpayers particularly over the coming decades, when robot cars and human drivers will share a "hybrid highway."

That period will feature complex interactions between people, computers, cars and public streets and freeways, during which today's liability protections and rules restraining insurance rates and unfair practices by insurance companies will become

especially important. To deal with the challenge posed by autonomous vehicle technology, Consumer Watchdog believes six principles must be adopted. They are:

1. *Protect the civil justice system.* The state-based civil justice system—open courts, impartial judges and citizen juries—is fully equipped to handle the determination of legal responsibility as our transportation system evolves over the coming decades. Disputes over who is at fault in a crash involving a self-driving car or truck will require the full power of civil justice system, with its procedural safeguards of an impartial judge, full public transparency, and trial by citizen juries, to investigate and publicly expose the cause of crashes, compensate the victims for deaths, injuries and property damage, punish the wrongdoer, and force manufacturers to make changes in their products to prevent future harm. When their autonomous technologies fail, hardware and software manufacturers must be held strictly liable. Lawmakers should reject legislation to limit or restrict state consumer protection laws. Manufacturers must not be permitted to evade these consumer protections by inserting arbitration clauses, "hold harmless" provisions or other waivers in their contracts.

2. *Enact stronger state consumer protections against insurance company abuses.* According to a 2013 report by the Consumer Federation of America, "California stands out from all other states in having the best insurance regulatory system for protecting consumers." Enacted by California voters in 1988, California's insurance reform law provides precisely the stronger protections consumers will require in the era of robot vehicles. The reforms, known as Proposition 103, have protected motorists (along with homeowners, renters, businesses and medical providers) against unjust insurance rates (including product liability insurance rates) and anti-consumer and discriminatory practices. The law's emphasis on rewarding drivers with lower insurance premiums based on their safety record, their annual mileage, their driving experience, and other rating factors within their control that are "substantially related to the risk of loss," will be critical in the new automotive era. Proposition 103's mandate for public disclosure and public participation in regulatory matters are essential components of a system that will be trusted by consumers.

3. *Enact auto safety standards.* Private companies cannot be trusted to develop and deploy robot cars and trucks without rules. The Federal auto safety agency or other relevant Federal agencies, or in their absence, state auto safety agencies, must develop standards for the testing and deployment of the multiple technologies required by robot vehicles. These standards must address safety; security; privacy and the software that determines the robot's actions in the event of an impending collision and as it makes life and death decisions. They must be enforceable by consumers in courts of law.

4. *Stronger laws are needed to protect consumers' privacy.* The laws have not kept pace with the evolution of technology and the collection and monetization of consumers' personal data. Hardware and software manufacturers and insurance companies must be barred from utilizing tracking, sensor or communications data, or transferring it to third parties for commercial gain, absent separate written consent (which should not be required as a condition of accessing the services of the vehicle/manufacturer, and which should be revocable by the consumer at any time).

5. Bar Federal interference in state consumer protection laws. Neither Congress not Federal agencies should be permitted to preempt or override stronger state based civil justice, insurance reform or auto safety laws.

6. *Respect democratic and human values.* The sponsors of self-driving vehicles have promoted the myth that machines are infallible in order to justify the wholesale departure from a panoply of norms that form founding principles for the nation, beginning with the rule of law; individual and corporate responsibility; long held legal principles that distinguish between human beings and property; and the transparency of public officials and institutions that is a hallmark of democracy. The strategy of substituting robot values for human values has reached its apotheosis in the determination by robot car company executives to program computers to make life and death decisions, and to keep that decision-making process secret. Lawmakers will need to impose the rule of law and other attributes of American democracy upon the executives of the hardware and software companies that manufacture self-driving cars.

In conclusion, Congress must not succumb to the siren song of the autonomous car developers who are over promising what autonomous vehicle technology can do today. We call on you to require the development of enforceable Federal safety performance standards. Responsible regulation goes hand-in-hand with innovation. Vol-

untary "standards" in the auto industry have repeatedly been proven to be weak and insufficient. Safety must come before the automakers' bottom lines. Consumer Watchdog calls on you to enact the necessary regulations to protect the safety of our highways.

Sincerely,

HARVEY ROSENFIELD *Founder*	JOHN M. SIMPSON *Privacy Project Director*	JOAN CLAYBROOK *Former President Public Citizen and Former NHTSA Administrator*

SELF DRIVING VEHICLES

THE THREAT TO CONSUMERS

By Harvey Rosenfield

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1.0 Introduction

Self-driving vehicles have become a cultural and political phenomenon. To peruse the breathless headlines is, like a ride in Marty McFly's DeLorean, to experience the sensation of visiting a wondrous future. Millions of hours previously wasted in traffic, searching for a parking spot or waiting in line at the DMV, will be restored to us, while we sit back in our passenger seats, dine, work or watch movies as robots whisk us around. It's a world in which there are virtually no car accidents, because infallible computers will replace impatient, emotional, tired, distracted, all too error-prone human beings.

And, wondrously, there will be no need to write another check to the auto insurance company. In the highly unlikely event that anything goes wrong, the robot car manufacturers will stand behind their products and pick up the tab, no questions asked.

Not so fast.

America is decades away from a completely "self-driving" transportation system. But the insurance and auto industries are already preparing to exploit the prospect of self-driving robot cars and trucks so they can force Americans to pay *more* for insurance on the cars they own or lease, and roll back state consumer protection laws so that when their self-driving vehicle gets in a crash, it will *always* be the consumer's fault.

The sparkly chimera of robots replacing human drivers—freeing people to spend their drive time more enjoyably and productively—has captivated the public and media, driven by self-interested auto manufacturers and software developers. But there has been very little public discussion of whether self-driving vehicles will coexist or collide with long-standing principles of accountability, transparency, and consumer protection that collectively constitute the Personal Responsibility System.

The Personal Responsibility System is a set of state-based liability and insurance laws that dispenses justice: First, by regulating insurance companies to mandate fair auto insurance premiums and rate setting practices that emphasize a motorist's safety record rather than surrogates for wealth, race or creed. Second, by encouraging the safe manufacture, marketing and operation of cars and trucks. Third, by determining fault and compensation for, deaths, injuries and property damage caused by defective cars or the negligent operation of vehicles. Fourth, by making sure that auto insurance companies handle crash claims fairly by paying promptly and fully.

At the intersection of the Personal Responsibility System, insurance laws and robot cars, California is of particular interest. Sweeping reforms passed by the voters in November 1988, known as Proposition 103, have protected motorists (along with homeowners, renters, businesses and medical providers) against excessive rates, and discriminatory practices by insurance companies that have historically targeted individuals they deem "undesirable" based on their race, religion, or income. Thanks to Prop 103, California is the only state in the Nation where the average auto insurance premium went down between 1989 and 2010, according to a report by the Consumer Federation of America, saving motorists alone over $100 *billion* in premiums since 1989;[1] CFA's report concluded that "California stands out from all other states in having the best regulatory system for protecting consumers."

Dating back to the American Revolution and enshrined in the Bill of Rights, the Personal Responsibility System has made the American marketplace a paragon of safety, fairness and prosperity.

But insurance companies and automakers now say that it's outdated and incompatible with self-driving vehicles.

They argue that America can dispense with the civil justice system—open courts, impartial judges and citizen juries—because these core consumer protections will "chill this promising technology [autonomous vehicles] and the huge advances in overall public safety it promises," as the leading lobbying group for corporate defendants recently put it.[2] That the manufacturing and insurance industries are exploring ways in which they can limit or shift their responsibility is not particularly surprising, given that safety-related costs and claims are likely to increase as the result of the new, riskier and so-far unregulated technologies. However, these strategies—historically employed by industries seeking a government bailout of risks—undermine competition and distort incentives in the marketplace.

The insurance industry is also opportunistically targeting consumer protections against insurance company abuses like overcharging consumers and discrimination, claiming they will be unnecessary once self-driving vehicles arrive. In California, insurance companies are using robot cars as the excuse to challenge Proposition 103. As a recent report explained, "Over three decades, insurance companies have spent millions of dollars trying to chip away at Prop 103's regulations both through litigation and at the ballot box—with little success. Now, however, the industry has found a new source of optimism in a different phrase: driverless cars."[3]

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[1] "What Works? A Review of Auto Insurance Rate Regulation in America," Consumer Federation of America, November 12, 2013.

[2] U.S. Chamber of Commerce Institute for Legal Reform, "Torts of the Future: Addressing the Liability and Regulatory Implications of Emerging Technologies," March 2017, p.2

[3] C. Miller, "Driverless Cars Give Insurers New Vehicle to Criticize California's Rates Law," The Recorder, May 19, 2017 (*http://www.therecorder.com/home/id=1202786779265/Driverless-*

Continued

And if history repeats itself, the insurance and auto lobbies may ask the Trump Administration to impose Federal rules that would override the Personal Responsibility Laws of the fifty states.

Even a cursory analysis of the risks that robot cars and trucks will pose over the coming years shows that the industries' argument is wrong. Issues of corporate responsibility, liability and insurance will become far *more important* as self-driving vehicles are rolled out.

To understand the crucial role that the Personal Responsibility System will play in the coming decades, two points are critical.

First, a fully autonomous transportation system is decades away at best. No completely self-driving vehicle is offered for sale today, and notwithstanding a great deal of marketing hype, no manufacturer has set a firm date when it will market a passenger vehicle that is able to operate in all conditions without human intervention, or, importantly, what it will cost to buy.[4] Indeed, the system of vehicle-to-vehicle, vehicle-to-satellite, and vehicle-to-road sensor communications infrastructure that would enable *tens of millions of vehicles* to simultaneously, securely and autonomously operate in proximity to each other on streets and highways without human intervention is barely in the planning stages. Nor is there any consensus on how local, state and Federal governments will pay for it. After all, most municipalities these days are struggling to fill potholes. And it is far from clear that every American consumer is going to be ready to abandon America's love affair with the open highway, or to surrender the steering wheel to a machine that is going to cost many thousands of dollars more than today's vehicles.

Even if we assume that someday fully autonomous vehicles will be safe enough to deploy, *and* that all Americans will be ready and able to surrender the steering wheel,[5] for the *foreseeable future* traditional vehicles driven by humans will share a "hybrid highway" filled with cars and trucks of widely varying degrees of automation and autonomy. Relatively few of them will be truly self-driving.

Second, the argument that robot cars and trucks will virtually eliminate crashes is based on a fallacy: that machines are infallible. It makes sense that carefully tested automation technologies will improve the safety of cars and trucks in the future. However, completely self-driving cars don't exist yet and we don't know how they will change transportation patterns once they arrive. So for the moment, the claim that robot vehicles will dramatically reduce vehicular deaths, injuries and property damage is simply speculation.

But we know this: machines make mistakes—sometimes catastrophic mistakes. Consider the automation-related mass disasters that have befallen the commercial airline industry in recent years, notwithstanding its self-avowed goal of zero tolerance for failure. Google/Waymo boasts that its computer-controlled test vehicles have logged the equivalent of over 300 years of human driving experience.[6] But the duration of testing that would be required in order to match the safety tolerance of commercial airplanes is 114,000 years.[7]

In any case, even if robot cars and trucks someday become 100 percent safe, we can say with certainty that in the short term, autonomous vehicles will pose new and unprecedented risks as they interact with traditional cars and trucks on the hybrid highway.

The #1 safety threat posed by self-driving vehicles is bugs or biases built into the robots' brains.

A crucial and controversial component of the self-driving car or truck is the set of algorithms that will determine how the vehicle responds when confronted with an unexpected, life-threatening emergency such as children playing in the street, pedestrians, roadside construction, and weather conditions. Initially these rules will be programmed by corporate engineers; eventually the engineers will teach the cars

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Cars-Give-Insurers-New-Vehicle-to-Criticize-Californias-Rates-Law?mcode=1202617072607&curindex=0).

[4] A number of automakers have proclaimed they will sell autonomous vehicles over the next few years, but are short on the specifics. Ford has announced it intends to have a "fully autonomous" vehicle for commercial ride-sharing or ride-hailing applications by 2021, but according to the fine print the vehicle will offer only "high," not "full," automation. (*https:// media.ford.com/content/fordmedia/fna/us/en/news/2016/08/16/ford-targets-fully-autonomous-vehicle-for-ride-sharing-in-2021.html.*)

[5] It is more likely that self-driving vehicles, when they become available, will be initially adopted by commercial enterprises such as ride-sharing operations.

[6] See *https://x.company/waymo/* (last visited June 12, 2017).

[7] See B.W. Smith, *Automated Driving & Product Liability,* 2017 Mich. St. L. Rev. 1, at 31 re "at least a billion hours of testing," also citing Philip Koopman & Michael Wagner, *Challenges in Autonomous Vehicle Testing and Validation,* 4 SAE Int'l. J. Transp. Safety 15, 15–16 (2016).

how to think for themselves using artificial intelligence, so-called "machine learning."

These algorithms will be responsible for life and death decisions that will place their financial interests in conflict with their customers' lives. But Google and other software developers have refused to disclose to the public or regulators the robot values that they are programming into their computers to replace human values and judgment. When Google's self-driving vehicle sideswiped a bus in Mountain View, California, the company called it a "misunderstanding" between the bus driver and the robot.[8] A software "misunderstanding," even at 2 m.p.h., cannot be dismissed. Just as occurs every day on our roadways, the robot will confront situations in which the choice is not whether to smash into someone, but rather who to hit—an oncoming vehicle, a pedestrian in a crosswalk, a mom pushing her infant in a stroller on the sidewalk?

Other risks include failures in the extremely complex hardware (Google and other companies' robot test vehicles have been involved in multiple accidents and hundreds of near-misses[9]); privacy breaches (now endemic in the United States[10]); criminal hacking or even terrorist cyber attacks involving hundreds or thousands of vehicles, as the FBI has warned.[11]

When one or more of these serious risks inevitably results in a crash on the "hybrid highway," the inquiry into what caused the crash and who is responsible will include the manufacturers of the automated vehicle's hardware and software. There is no reason to believe that they or their vendors will respond any differently than they do today: deny their liability and attempt to shift the blame to the human driver. Indeed, in the limited experience so far, the companies that have deployed robot technologies have not readily accepted responsibility for their crashes and near-misses. This is particularly true of Tesla, which has denied responsibility for two fatalities involving its "Auto Pilot" software.[12] While some car companies have stated that they will assume liability for the failure of their robot technologies, nothing's in writing, and their pledge appears to be conditioned on a determination that their technology was *at fault*.[13]

Crashes aside, consumers who own or lease self-driving vehicles will face far greater responsibility for vehicle maintenance than they bear today. Self-driving vehicles will be extraordinarily reliant on external sensors—the eyes and ears of the robot car's brain. An accidental driveway ding in a sensor could have deadly consequences when the vehicle is on the road. What happens if the consumer fails to download a software update? No one has suggested that manufacturers will be prepared to assume liability for a crash caused by the consumer's failure to maintain the vehicle's operational status.

That leads us right back to the Personal Responsibility System of insurance and liability laws.

With the heightened risks that the new automated technologies will pose over the coming years, the legal requirement that manufacturers be held strictly liable for defective products, a mainstay of America's consumer protection regime, will remain essential. Disputes over fault will require the full power of the civil justice system, with its procedural safeguards of an impartial judge, full public transparency, and trial by citizen juries, to investigate and publicly expose the cause of crashes, compensate the victims for deaths, injuries and property damage, punish the wrongdoer, and force manufacturers to make changes in their products to prevent future harm.

For the same reasons, protections against abusive practices by insurance companies will be critical. So long as motorists face legal responsibility for the proper maintenance and safe operation of vehicles they own, lease, rent or control, they will require the same liability insurance coverage that they purchase today. Pointing to the new risks of the Hybrid Highway, and the greater costs of repairing the automation technology, insurance companies will no doubt ask their customers to pay more for it. Preventing insurance companies from overcharging motorists, and from high-tech forms of redlining that rely on manipulation of data about each customer, will necessitate forceful consumer protections such as those contained in Proposition 103.

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[8] M. McFarland, "For The First Time, Google's Self-Driving Car Takes Some Blame For A Crash," Washington Post, February 29, 2016 (*https://www.washingtonpost.com/news/innovations/wp/2016/02/29/for-the-first-time-googles-self-driving-car-takes-some-blame-for-a-crash/?utm_term=.f19f6bdc6f4d*).

[9] See Section 2.4.

[10] See Section 2.2.

[11] See Section 2.2.

[12] See Section 2.4.

[13] See Section 3.1.4.

The proponents of autonomous vehicles like to describe themselves as "disruptors," and take pride in refusing to accept the norms of what they deride as the decrepit status quo. But behind the scenes, industry players are employing decidedly Old World lobbying and political strategies to avoid public and regulatory scrutiny and oversight, while at the same time urging lawmakers to pass legislation that would limit or even eliminate their legal accountability to injured consumers.

Consumer Watchdog, a non-profit founded in 1985, has deep roots working for the public interest on the issues that will be of tremendous concern to consumers as automated vehicles evolve: civil justice and corporate accountability; public safety; the premiums and underwriting practices of the insurance industry; the diminishing privacy of consumers in the digital age; and the importance of government oversight, public scrutiny and participation in decision-making.

This report will discuss the safety, security and other risks posed by robot cars; why the consumer protections of the Personal Responsibility System will be critical in the coming decades as self-driving vehicles come "on line"; and the campaign by insurance companies, automakers and possibly even the Federal Government, already underway, to undermine those essential consumer protections.

2.0 Robot Cars Will Pose Unprecedented Safety, Security, and Privacy Risks

The safety of driverless vehicles should be the paramount concern of the auto and insurance industries, if for no other reason than flaws and failures in automated vehicle systems will impose potentially enormous, even catastrophic liability upon hardware and software manufacturers in the event their products cause harm, and lead to more, and more costly, insurance claims.

In this context, it's worthwhile to consider the current state of American vehicle safety. Car crashes in the United States killed 35,092 and injured over 2.44 million people in 2015;[14] including property damage, the total estimated economic cost of car crashes was estimated at $242 billion in 2010.[15] There were a record 801 separate recalls involving 63.7 million vehicles in 2014, and 613 recalls of 40 million vehicles as of mid-2015.[16] Three of the largest recalls in recent years concern vehicle safety failures—defective GM ignition switches,[17] exploding Takata airbags,[18] and unintended acceleration in Toyota vehicles[19]—that have taken hundreds of American lives.

The unprecedented number of recalls in recent years suggests a dangerously cavalier attitude toward public safety on the part of vehicle manufacturers. It raises serious concerns as to whether manufacturers are presently, or will be, capable of building safe robot cars and trucks, which will far exceed the complexity and sophistication of today's vehicles.

When assessing whether autonomous vehicles will ever be 100 percent safe, consider the transportation sector in which automation is by far the most advanced and the concern for safety is arguably greater than in any other: commercial air travel. Recent airline disasters cast doubt on whether one hundred percent reliance on "fly-by-wire" technology will ever be safe.[20]

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[14] NHTSA, 2015 Motor Vehicle Crashes: Overview (August 2016).

[15] NHTSA, The Economic and Societal Impact Of Motor Vehicle Crashes, 2010 (Revised May 2015).

[16] NHTSA, 2014 Vehicle Recalls by Manufacturer (available at *http://www.safercar.gov/Vehicle+Owners/vehicle-recalls-historic-recap*); 2015 data: Statement Of Joan Claybrook Consumer Co-Chair Advocates For Highway And Auto Safety, on "Examining Ways To Improve Vehicle And Roadway Safety" before the Committee On Energy And Commerce Subcommittee On Commerce, Manufacturing And Trade, October 15, 2015, p. 2.

[17] "NHTSA Admits Faults In GM Investigation," Detroit News, June 5, 2015 (*http://www.detroitnews.com/story/business/ autos/general-motors/2015/06/05/gm-nhtsa-report/2854 0239/*); "Why General Motors' $900 Million Fine For A Deadly Defect Is Just A Slap On The Wrist," Washington Post, September 17, 2015 (*https://www.washingtonpost.com/news/ business/wp/2015/09/17/why-general-motors-900-million-fine-for-a-deadly-defect-is-just-a-slap-on-the-wrist/*).

[18] "Everything You Need to Know about the Takata Airbag Recall," Consumer Reports, December 23, 2015 (*http://www.consumerreports.org/cro/news/2014/10/everything-you-need-to-know-about-the-takata-air-bag-recall/index.htm?loginMethod=auto*).

[19] "Toyota Says It's Settled 338 Cases So Far In Acceleration MDL," Law360, July 22, 2015 (*http://www.law360.com/articles/681915/toyota-says-it-s-settled-338-cases-so-far-in-acceleration-mdl*).

[20] The crash of Asiana Flight 214 at San Francisco airport in 2013 killed two passengers and injured 181 others; investigators have determined that the pilots did not understand the highly automated flight systems and were unable to recover control of the plane when a crash was imminent. (M. Wald, "Pilots in Crash Were Confused About Control Systems, Experts Say," New York Times, December 11, 2013.) An Air France jetliner disappeared into the Atlantic off the coast of South America in 2009, killing 216 passengers and a crew of twelve, including three

To our knowledge, no one has suggested that the manufacturers of robot cars can or will aim for that level of safety; the former head of NHTSA suggested in 2016 that autonomous vehicles will merely be twice as safe as human-driven cars.[21] By definition, that leaves a lot of carnage on America's streets.

No one disputes that the evolution of motor vehicle technology has the potential to prevent deaths, injuries and property damage. New technologies such as automatic emergency braking, lane keeping, collision warning, and assisted parking are already doing so, and indeed should be made standard equipment in all vehicles. The point is that the gradual automation of driving will introduce a new set of risks. These risks will necessarily be far broader than those posed by vehicles today—suggesting that the ramifications for liability and insurance will be significant. A fully autonomous robot-based transportation system will likely reduce the number of crashes caused by human error, but that does not tell us anything about the overall impact of a fully autonomous system.[22]

2.1 Risk: Defective Hardware and Buggy or Biased Software

The core hardware components of an autonomous vehicle are the computer and sensors. An array of electronic devices—presently, radar, lidar, and video—will be responsible for detecting the external conditions that the vehicle must navigate: road signs, and in their absence street markings; other vehicles (including bicycles, motorcycles, trucks); pedestrians (including seniors, and children); pets; traffic lights; street and highway signs; road construction; law enforcement activities; weather (fog, snow or heavy rainfall) and other natural phenomena (such as trees). The on-board computer system will collect the data from these inputs as well as external communications sources such as other vehicles, intelligent highways (more on that below) or satellite based traffic control systems, process the information and make decisions in a few milliseconds (a millisecond is 1/1000 of a second) that are presently executed by humans. Scientists have estimated that the human brain is thirty times faster than the fastest super computer;[23] it takes a neuron 0.5 milliseconds to transmit a signal[24] and 13 milliseconds for the brain to process an image.[25] A truly driverless vehicle must be capable of fully replicating and processing the immense data stream currently processed by the human brain, such as hand gestures, the facial expressions of other motorists and pedestrians, and a virtually infinite number of other variables in the interior and external driving environment.

Software will analyze the sensor and communications data flow and instruct the vehicle how to navigate. A particularly critical function of the software will be to replace the *judgment* of human motorists not just to avoid collisions but also to comply with traffic laws and rules. It will therefore be necessary for the software in driverless vehicles to make the split-second life and death decisions that human drivers make today when a collision is unavoidable. Confronted with the prospect of imminent harm to passengers in other vehicles, pedestrians, or the occupants of the AV itself, how will the self-driving software decide which course to take? On what basis will the software make such decisions? Who will it kill?

These life and death deciding programs will be coded by human engineers working for private corporations, at least initially.

Will engineers program their computers with human ethics as well as a database of traffic laws? When Mercedes announced that its software would protect the occupants of Mercedes vehicles at the expense of everyone else, it provoked a public firestorm that led Mercedes to amend its statement.[26]

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pilots; again, the black box revealed that the pilots did not understand the plane's automated functions, some of which had failed. (See W. Langewiesche, "The Human Factor," Vanity Fair (October, 2014) (*http://www.vanityfair.com/business/2014/10/air-france-flight-447-crash*)).

[21] K. Naughton, "Regulator Says Self-Driving Cars Must Be Twice as Safe," Reuters, June 8, 2016 (*https://www.bloomberg.com/news/articles/2016–06–08/u-s-auto-regulator-says-self-driving-cars-must-be-twice-as-safe.*)

[22] See B. W. Smith, *Automated Driving & Product Liability* 2017 Michigan State Law Review 1 for a careful but admittedly provisional analysis suggesting simplistic assumptions about costs and savings may be incorrect.

[23] H. Hsu, "Estimate: Human Brain 30 Times Faster than Best Supercomputers," IEEE Spectrum, August 26, 2015 (*http://spectrum.ieee.org/tech-talk/computing/networks/estimate-human-brain-30-times-faster-than-best-supercomputers.*)

[24] *http://news.mit.edu/2014/in-the-blink-of-an-eye-0116*

[25] *http://www.makeuseof.com/tag/geeks-weigh-in-does-a-human-think-faster-than-a-computer/*

[26] "Self-Driving Mercedes-Benzes Will Prioritize Occupant Safety over Pedestrians," Car and Driver Blog (*http://blog.caranddriver.com/self-driving-mercedes-will-prioritize-occupant-safety-over-pedestrians/*).

Will companies like Google, that have developed real-time facial recognition software, write algorithms to avoid harm to high net worth individuals, thus limiting their own liability? We simply do not know, because there are no rules that specify the answers to these questions, and software companies like Google consider their algorithms highly proprietary and steadfastly refuse to disclose the decision-making principles, values or formulae that determine the vehicle's actions.

Eventually, the engineers will teach the robot cars and trucks how to learn for themselves, a form of Artificial Intelligence called "machine learning." Once robots are taught how to learn for themselves, their decision-making process will be further removed from human oversight.

What we can say, with certainty, is that bugs in commercial software are frustratingly rampant, and take notoriously long for their manufacturers to eradicate. Consumers are unlikely to tolerate becoming "beta testers" for driverless vehicles, serving as human guinea pigs when the consequences are not a lost page of text but a loss of life.

2.2 Risk: Privacy and Security

Modern cars have become computers on wheels, collecting significant amounts of data about the vehicle and the habits of the motorist that drives them; some insurance companies have installed "black boxes" in the vehicles they insure to track vehicle location, speed and other metrics.[27] By definition, evolving automation technologies will collect, process and communicate vast amounts of information. The recipients of the data stream will include, eventually, other vehicles and likely the government agencies that operate the intelligent transportation grid.

The data is extremely valuable to hardware/software manufacturers and insurance companies, but could prove costly for consumers.

- Auto makers and software designers will want the data for performance monitoring and safety improvement purposes, but also to dispute their liability for crashes.
- Google and other data collection companies will also want to enhance the vast digital dossiers they already compile on each American by including where motorists are going and what they're doing, so advertisers can target their products, and perhaps even subject motorists to continuous locality-based advertising as their vehicle chauffeurs them through the streets.
- Insurance companies will seek data from cars to determine who was at fault in an accident. But, increasingly utilizing "big data," insurance companies will also seek to use the data they collect to make underwriting decisions, enabling them to avoid certain customers they deem too risky—a form of the notorious historical practice of redlining– and to set premiums so as to maximize profits rather than price risks, a highly controversial practice known as "price optimization."[28]

As data becomes increasingly valuable, it increasingly becomes a target. Data breaches involving the accounts of *billions* of users reflect the hacking epidemic in recent years.[29] These incidents demonstrate that only to the extent the legal system imposes significant financial liability for such breaches will data collectors be motivated to undertake the expensive hardening of their systems to prevent third-party data incursions.

It's not just the data that is vulnerable in increasingly automated vehicles. The interconnected vehicles of the future will themselves be subject to criminal and even terrorist hijacking. In 2015, two security researchers managed to remotely hack into a 2014 Jeep Cherokee from a laptop ten miles away and disable critical functions

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[27] Markey, Sen. Edward J., "Tracking and Hacking: Security and Privacy Gaps Put American Drivers at Risk;" *https://www.markey.senate.gov/imo/media/doc/2015-02-06_MarkeyReport-Tracking_Hacking_CarSecurity%202.pdf,* last accessed Nov. 28, 2015. Consumer Watchdog has warned that "black box" data recorders in vehicles could be misused in ways that threaten motorists' privacy. See *http://www.consumerwatchdog.org/feature/pay-you-drive-workshop-comments-california-department-insurance.*

[28] Letter from Robert Hunter, Consumer Federation of America, to state insurance regulators, December 9, 2016 (*http://consumerfed.org/testimonial/cfa-calls-insurance-commissioners-attention-unfair-price-optimization-practices/*); "CFA's Hunter Reacts in Actuarial Battle: Allstate's Plan Is Price Optimization," Carrier Management, November 29, 2016 (*http://www.carriermanagement.com/features/2016/11/29/161466.htm*).

[29] K. Sheridan, "Data Breaches Exposed 4.2 Billion Records In 2016," Information Week, January 25, 2017.

such as the accelerator, paralyzing the car.[30] Fiat Chrysler had to recall 1.4 million vehicles to fix the Jeeps' vulnerabilities.[31] Another research firm reported its was able to remotely take control of a Tesla Model S and unlock the door of the car, take over control of the dashboard computer screen, move the seats, activate the windscreen wipers, fold in the wing mirrors and apply the brakes while the vehicle was in motion—from ten miles away. Tesla uploaded an over-air "software update" to fix the vulnerability—ten days later.[32]

In March 2016, the F.B.I. issued a warning to vehicle manufacturers stating: "it is important that consumers and manufacturers are aware of the possible threats and how an attacker may seek to remotely exploit vulnerabilities in the future."[33] The F.B.I. pointed out that hackers could gain access through a vehicle's cellular, USB, Bluetooth, or Wi-Fi Internet connections: "An attacker making a cellular connection to the vehicle's cellular carrier—from anywhere on the carrier's nationwide network—could communicate with and perform exploits on the vehicle via an Internet Protocol (IP) address."[34]

A wide variety of criminal misconduct could be facilitated via hacking of automated and fully autonomous vehicles, ranging from smuggling, to kidnapping, to homicide. A systemic attack on the intelligent highway system could result in catastrophic loss of life and by orchestrating traffic jams, grind commerce literally to a halt, with serious financial repercussions.

2.3 Risk: Regulatory Failure

Failure to properly regulate the safety of self-driving vehicles is rapidly becoming another serious safety risk. Congress enacted the National Traffic and Motor Vehicle Safety Act of 1966 (NTMVSA) fifty years ago "to reduce traffic accidents and deaths and injuries resulting from traffic accidents." The analysis of the proposed legislation by the U.S. Senate concluded that:

> The promotion of motor vehicle safety through voluntary standards has largely failed. The unconditional imposition of mandatory standards at the earliest practicable date is the only course commensurate with the highway death and injury toll.[35]

The central safety focus of the NTMVSA, and NHTSA's activities since its creation, has been the promulgation, after careful study and a public hearing process, of Federal Motor Vehicle Safety Standards. However, in an unprecedented departure from its statutory mission, NHTSA entered into an unprecedented "voluntary agreement" with twenty auto manufacturers in March 2016 to allow the industry to self-regulate the sale of three safety technologies, known as Automatic Emergency Braking (AEB), that assist cars in braking to avoid or limit the damage from collisions.[36] NHTSA rejected a petition by Consumer Watchdog and other consumer advocates to require manufacturers to install even established safety technologies, such as Automatic Emergency Braking, as standard equipment in light vehicles—which NHTSA itself has acknowledged would prevent tens of thousands of deaths and serious injuries annually.[37]

The decision marked a radical departure from the agency's traditional mission. NHTSA Administrator Mark Rosekind argued that, "the agency cannot make vehi-

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[30] U.S. Says Only Jeeps Had Hacker Vulnerability Via Radios, Associated Press, Jan. 9, 2016 (*http://www.wsj.com/articles/u-s-says-only-jeeps-had-hacker-vulnerability-via-radios-1452372453*).

[31] "Autonomous cars to have 'thousands of security risks,'" Autocar, 12 September 2016 (*http://www.autocar.co.uk/car-news/industry/autonomous-cars-have-'thousands-security-risks'*).

[32] S. Khandelwai, "Hackers take Remote Control of Tesla's Brakes and Door Locks from 12 Miles Away," Hacker News, September 20, 2016 (*http://thehackernews.com/2016/09/hack-tesla-autopilot.html?utm_so. . .e+Hackers+News+-+Security+Blog%29&_m=3n.009a.1326.en0ao0609g.rxj.*)

[33] "Motor Vehicles Increasingly Vulnerable To Remote Exploits," Federal Bureau of Investigation, March 17, 2016 (*http://www.ic3.gov/media/2016/160317.aspx#fn1*).

[34] *Id.*

[35] Committee Report on S. 3005, The Traffic Safety Act of 1966, June 23, 1966, at 274.

[36] "U.S. DOT And IIHS Announce Historic Commitment Of 20 Automakers To Make Automatic Emergency Braking Standard On New Vehicles," NHTSA (Press Release) March 17, 2017(*https://www.nhtsa.gov/press-releases/us-dot-and-iihs-announce-historic-commitment-20-automakers-make-automatic-emergency*). See Consumer Watchdog's letter to NHTSA criticizing this action: *http://www.consumerwatchdog.org/newsrelease/consumer-advocates-demand-federal-agency-act-auto-safety-petition*).

[37] NHTSA, Request for Comments, New Car Assessment Program, Docket No. NHTSA–2015–0119, p. 110–118. In 2016, Consumer Watchdog and other advocates formally petitioned NHTSA to promulgate a safety regulation making AEB standard equipment. Ultimately NHTSA denied the petition. For more information: *http://www.consumerwatchdog.org/search/apachesolr_search/NHTSA%20AEB?filters=type%3Anewsrelease*).

cles safe simply by imposing new regulations and handing down fines. . . . We're going to have to find new tools—that means new collaborations, new partnerships."[38] Referencing the voluntary agreement for the deployment of AEB technology, NHTSA claimed that "bypassing the regulatory process would save three years in making automatic braking systems standard equipment."[39] "The unprecedented commitment means that this important safety technology will be available to more consumers more quickly than would be possible through the regulatory process."[40]

As recently as 2013, NHTSA had adopted a go-slow approach to self-driving vehicles, concluding, "At this point, it is too soon to reach conclusions about the feasibility of producing a vehicle that can safely operate in a fully automated (or 'driverless') mode in all driving environments and traffic scenarios."[41]

But in early 2016, the Secretary of the Department of Transportation told reporters that he "wants to ease some of the regulatory restraints to make it easier for the technology to develop."[42]

In September 2016, NHTSA issued a 116 page "Federal Automated Vehicle Policy," which called upon manufacturers of automated and self-driving vehicles to "self-certify" that they have considered a fifteen point "checklist" of issues related to driverless vehicles.[43] NHTSA's Guidance leaves the evolution and deployment of automated vehicles to hardware and software manufacturers, where it will remain shrouded in secrecy and outside the purview of the public generally, and motorists in particular.

If NHTSA's abdication of its safety responsibilities continues, the introduction and deployment of autonomous technologies will proceed on a manufacturer-by-manufacturer basis, without any enforceable, industry-wide standards. Without industry-wide standards, the cost of safety features will be prohibitive for all but the wealthiest consumers. The deregulated deployment of automated vehicles will exacerbate safety, liability and insurance issues.

2.4 Current Status of Robot Cars

No fully autonomous passenger vehicle is presently approved for sale, much less being marketed. While proponents insist robot cars are right around the corner, more objective observers expect a step-by-step progression toward greater automation of vehicle functions—but with the driver required ultimately to assume control.

Google, whose robot car unit is now known as Waymo, began testing self-driving cars in 2009. California enacted AB 1298 in 2012 requiring the Department of Motor Vehicles to enact self-driving vehicle regulations. Rules covering testing robot cars took effect in 2014 requiring a test driver behind a steering wheel. The regulations required companies to get a permit, report any crashes within 10 days and file annual disengagement reports explaining when the self-driving technology being tested failed. Most of what we know about testing activities in California comes from the reports which the DMV, after pressure from Consumer Watchdog and others, posts on its website. Currently 21 companies have permits to test robot cars in California. The firms have refused requests to disclose other important information, including on board video and telemetry, from their testing.

The disengagement reports demonstrate that the self-driving vehicles are *not ready* to be deployed, at least without human drivers behind a steering wheel who can seize control when the self-driving technology fails. The latest report shows that Google/Waymo's test vehicles logged 635,868 miles and the human test driver had to intercede 124 times.[44] In the past, the company has said that its robot cars had difficulty correctly perceiving commonplace "threats" such as potholes, rain, wind and overhanging tree branches.[45] There were also software glitches and instances

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[38] Exclusive: U.S., Major Automakers to Announce Safety Accord Friday, David Shepardson, Detroit News, January 11, 2016).

[39] J. Peltz, "Automakers agree to make automatic braking a standard feature by 2022," Los Angeles Times March 17, 2016 (*http://www.latimes.com/business/autos/la-fi-hy-auto-safety-20160317-story.html*).

[40] *Id.*

[41] NHTSA, Preliminary Statement of Policy Concerning Automated Vehicles, May 15, 2013, p. 3.

[42] POLITICO, Pro Transportation Report, Friday January 15, 2016.

[43] NHTSA, Federal Automated Vehicles Policy, September 2016, p. 15–16.

[44] "California Robot Car Disengagement Reports Show Technology Not Ready for Safe Deployment Without Human Driver Behind Steering Wheel to Take Control, Consumer Watchdog Says," February 1, 2017 (*http://www.consumerwatchdog.org/newsrelease/california-robot-car-disengagement-reports-show-technology-not-ready-safe-deployment-wit*).

[45] "Consumer Watchdog Cites Shortcomings In Driverless Car Technology; Says DMV Rules For Robot Cars Must Require Steering Wheel So Human Drivers Can Take Over," March 19,

when the human test driver took over because the robot car made an unwanted maneuver.[46] In the February 2016 sideswipe of a city bus by a Google robot test car in northern California, requiring the bus to stop and its passengers to disembark, Google claimed that the accident was a "misunderstanding" and a "learning experience."[47] Delphi's 2016 report stated that its two test robot cars drove 3,125 miles in self-driving mode and had experienced 178 "disengagements." Reasons given for disengaging included: construction zones; problems changing lanes in heavy traffic; poor lane markings; the presence of emergency vehicles, pedestrians, cyclists; failure to detect a traffic light and unexpected behavior from another driver.[48] Mercedes, which has asserted it will deploy an autonomous vehicle by 2020, reported 336 disengagements in 673 miles.[49]

Tesla reported two fatal crashes in 2016 (one in Florida, one in China), both of which occurred while Tesla's "Auto Pilot" feature, which the company famously introduced in 2014, was engaged.[50] Tesla continues to deceptively refer to its automated system "Auto Pilot," though after the fatalities, it reprogrammed its Auto Pilot software to, among other changes, disengage unless the driver touches the steering wheel at regular intervals, indicating they are monitoring the vehicle.[51] Surprisingly, NHTSA later cleared Tesla of responsibility for the Florida fatality, but an agency spokesperson incongruously noted that humans must still manually pilot a Tesla equipped with Auto Pilot: "Autopilot requires full driver engagement at all times."[52]

In the rush to market of so-far unregulated robot technologies, the adequacy of the current testing paradigm is questionable. Google/Waymo claims that its computer-controlled vehicles have logged 300 years of human driving experience. But the testing that would be required in order to match the safety tolerance of commercial airplanes is estimated at over one hundred millennia.[53] A lower level of safety—"a level of 80 percent confidence that the robotic vehicle is 90 percent safer than human drivers on the road," would still require 11 billion miles of testing (or about 5,000 years), according to researchers at the University of Michigan, which is why they are looking to shortcut the testing process, at least partly through computer simulations.[54]

2.5 Current Status of Intelligent Transportation Infrastructure

The system of vehicle-to-vehicle, vehicle -to-satellite, vehicle-to-road sensor communications—collectively referred to as vehicle-to-everything, or "v2e"—infrastructure that would permit *tens of millions of vehicles* to simultaneously and securely operate without human intervention is not even in the planning stage.

Studies of the technology are underway, but NHTSA only just proposed uniform standards needed to ensure that all vehicles can connect with each other regardless of manufacturer in December 2016, and the proposal faces opposition from tele-

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2015 (*http://www.consumerwatchdog.org/newsrelease/ consumer-watchdog-cites-shortcomings-driverless-car-technology-says-dmv-rules-robot-cars*).

[46] See footnote 44.

[47] M. McFarland, "For The First Time, Google's Self-Driving Car Takes Some Blame For A Crash," Washington Post, February 29, 2016 (*https://www.washingtonpost.com/news/innovations/wp/2016/02/29/for-the-first-time-googles-self-driving-car-takes-some-blame-for-a-crash/?utm_term=.f19f6bdc6f4d*).

[48] See footnote 44.

[49] *Id.*

[50] N. Boudette, "Self-Driving Tesla Was Involved in Fatal Crash, U.S. Says," New York Times, June 30, 2016 (*https://www.nytimes.com/2016/07/01/business/self-driving-tesla-fatal-crash-investigation.html*); N. Boudette, "Autopilot Cited in Death of Chinese Tesla Driver," New York Times, September 14, 2016 (*https://www.nytimes.com/2016/09/15/business/fatal-tesla-crash-in-china-involved-autopilot-government-tv-says.html?_r=0*)

[51] F. Lambert, "Tesla Autopilot 'Nags' And Restrictions Under V8.0 Software Update—Breakdown," Electrek, September 22, 2016 (*https://electrek.co/2016/09/22/tesla-autopilot-nags-and-restrictions-under-v8–0-software-update-breakdown/*).

[52] N. Boudette, "Tesla's Self-Driving System Cleared in Deadly Crash," New York Times, January 19, 2017 (*https://www.nytimes.com/2017/01/19/business/tesla-model-s-autopilot-fatal-crash.html*). See Consumer Watchdog's criticism of this decision: *http://www.consumerwatchdog.org/newsrelease/"midnight-action"-nhtsa-ends-probe-fatal-tesla-florida-crash-accepting-company's-propaga.*

[53] See Smith, *Automated Driving & Product Liability,* footnote 22, p. 31.

[54] S. Collie, "Focusing On Tricky Situations Could Accelerate Testing Of Self-Driving Cars," New Atlas, May 29, 2017 (*http://newatlas.com/university-michigan-self-driving-testing-acceleration/49768/*).

communications companies that want to use wireless channels for other purposes.[55] How to include pedestrians in such a system has not been resolved. Nor is there any consensus on how to construct such a system—much less how local, state and the Federal Government will cover the cost of upgrading the 4.12 million miles of roadway in the United States.

2.6 The "Driverless Divide"

The affordability of automated vehicles (and the cost of insuring them) is an important safety issue in its own right, with profound consequences when it comes to assessing the impact of autonomous vehicles on liability and insurance.

Because no autonomous passenger vehicles are presently for sale, any discussion of pricing is speculative. However, the price of robot cars will directly affect the rate of deployment of the vehicles; the higher the price, the fewer the number of people who will be able to afford them. Those who cannot afford them will continue to operate traditional cars that lack at least some safety features, placing them at some correspondingly greater risk in the event of a crash.

Deployment will be further reduced because of NHTSA's abdication of its regulatory responsibilities, discussed above. This is because the Nation's auto safety regulator indicated through its 2016 "Federal Automated Vehicle Policy" that it intended to rely on industry self-regulation for self-driving vehicles, rather than promulgate formal Federal Motor Vehicle Safety Standards (FMVSS) that would require all new vehicles be equipped with the fully autonomous capability as standard equipment.[56]

Mandatory Federal safety standards create manufacturing economies of scale from mass production that dramatically reduce the price of the technology. Automakers resist industry-wide safety standards because they can then treat expensive safety innovations as options to be introduced in their most expensive vehicles, for which such options are priced at a premium. It is not until the features become mandated through the FMVSS process that they are rolled out in all vehicles fleet-wide, and manufacturers drop the price. Thus the cost of cars equipped with higher levels of automation will likely put them out of reach of all but the wealthiest motorists.

Other price factors that will affect broad deployment will be car repair and insurance premiums. Present day automotive electronics, though increasingly complex, are relatively simple compared to the technologies that will be needed to even partly automate passenger vehicles. However, they have significantly raised the cost of repairs (and insurance) for cars of more recent vintage. [57]

In other words, at least for the foreseeable future, there will be the equivalent of what, in the early era of personal computing, was described as a "digital divide": a significant disparity among Americans between those who can afford vehicles with substantial automation capabilities and those who cannot.

2.7 The "Hybrid Highway"

There are diverging estimates of the date when a fully autonomous vehicle—one that requires no human intervention—will be marketed to the American public. However, any objective analysis demonstrates that America is *decades away* from a transportation system that is *completely* automated: one in which *all* vehicles on the road operate *autonomously,* and there are no human drivers, no steering wheels, no brakes, nor other human-based control devices; in which cars are in constant electronic communication with each other, with "intelligent" road systems built and maintained by municipal, state and Federal governments, and with pedestrians equipped with their own electronic devices.

The average age of vehicles on the road today is estimated at 11.5 years.[58] Thus, even if a vehicle capable of operating under all conditions without any human involvement (and absent the assistance of intelligent highway infrastructure) were to

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[55] R. Beene, "Federal V2V Mandate Meets Growing Resistance," April 17, 2017 (*http://www.autonews.com/article/20170417/OEM06/170419865/federal-v2v-mandate-meets-growing-resistance*).

[56] NHTSA, Federal Automated Vehicles Policy, September 2016.

[57] See, *e.g.,* N. Brown, "Conventional Car Repair Costs Increased, While Hybrids Saw a Decrease," CleanTechnica.com, April 13, 2013 (*http://cleantechnica.com/2013/04/15/conventional-car-repair-costs-increased-while-hybrids-saw-a-decrease/*); S. Finlay, "More Technology in Cars Increases Repair Costs," WardsAuto.com, September 17, 2013 (*http://wardsauto.com/dealerships/more-technology-cars-increases-repair-costs*); J. Selingo, "Repair Shops See Roadblocks Set by Dealers," New York Times, October 25, 2006 (*http://www.nytimes.com/2006/10/25/automobiles/autospecial/25repair.html*).

[58] Hirsch, Jerry, "Better Quality Raises Average Age Of Cars On U.S. Roads To 11.5 Years," *Los Angeles Times, http://www.latimes.com/business/autos/la-fi-hy-ihs-average-car-age-2015 0729-story.html* last accessed Nov. 4, 2015.

come to market far sooner, such vehicles will constitute a very modest percentage of the total number of vehicles on the road.

Thus, it is clear that there will be a lengthy period in which motorists and robots will share the roads in a *hybrid* system of human-driven and highly automated, if not autonomous, vehicles.[59]

This "hybrid highway" period will feature complex, potentially dangerous interactions between people (motorists and pedestrians), computer-driven cars, trucks and buses, remote-controlled drone vehicles, and eventually the so-called "intelligent" public streets and freeways that are supposed to help them all navigate safely.

3.0 The Personal Responsibility System and Self-Driving Vehicles

3.1 Tort liability

The judicial branch is responsible for interpreting and applying laws. However, state courts[60] also play a unique legislative role: they are the source of what is known as "common law." Originating from ancient English law, and often dating back to the formation of the United States, common law is a body of case decisions issued by state courts that defines rights and remedies *in the absence of any underlying statutory authority.* State legislatures have the authority to amend or even repeal the state's "common law," and they frequently do so.

A tort is a wrongful act that causes bodily injury or property damage. The common law of torts is a collection of legal rights, responsibilities and remedies developed and applied by civil courts when a wrongful act has caused harm. The purpose of tort law is to expose wrongdoing, compensate victims of the wrongdoing, punish the wrongdoers and deter future wrongdoing.

3.1.1 Negligence

Generally, tort liability is predicated upon the following judicial determinations: (1) the defendant owed to the plaintiff a duty of reasonable care; (2) the defendant breached that duty (3) the breach caused damage to the plaintiff. Under the Personal Responsibility System established by tort law, a person or company who committed a tort is liable for the injuries, property damage, lost wages, physical pain, emotional damage any and other kind losses that arise as a result. Intentional wrongdoing that is considered particularly egregious or oppressive may be punished by punitive damages: the wrongdoer is penalized for such misconduct.

Disputes over torts are typically adjudicated through the civil court system, which is the practical embodiment of the common law right to a trial by jury, one of America's most hallowed traditions. However, as discussed below, auto insurance has evolved as a mechanism for ensuring compensation without necessity of bringing legal action in modest disputes.

3.1.2 Product liability

A separate set of consumer friendly rules has evolved for relatively more rare torts involving products that are considered "inherently" dangerous, such as cars. In California, for example, a defendant is held *strictly liable* for injuries caused by such products, when a product was used in intended or reasonably foreseeable manner (includes reasonably foreseeable misuse, abuse, changes, alterations, etc.); was in defective condition when it left defendant's possession; and the defective product was the legal cause of the plaintiff's injuries or damages.

Unlike regular negligence cases, in product liability disputes the injured consumer is not required to prove that the defendant was negligent, *i.e.,* that the defendant failed to exercise reasonable care, or intended to cause harm. The public policy behind this variation in tort law is that it would be prohibitively difficult and expensive for a consumer to prove that the manufacturer of a product was careless in making the product, nor would a consumer have the ability to determine whether the product was defective prior to purchase. The protections of strict liability rules have been extended to include entities that re-sell or distribute the products. However, defects in road design, construction and maintenance are sometimes governed by more restrictive state statutes.

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[59] The Insurance Institute for Highway Safety and the Highway Loss Data Institute concurs: "Vehicles with humans at the wheel still will dominate the fleet for many years. 'Even if the U.S. Government were to require all new vehicles sold to be autonomous tomorrow, it would take at least 25 years until nearly 95 percent of the vehicles on the road would have the capability.'" "Robot cars won't retire crash-test dummies anytime soon," *Status Report,* Vol. 51, No. 8, November 10, 2016 (*http://www.iihs.org/iihs/news/desktopnews/driver-seat-robot-cars-wont-retire-crash-test-dummies-anytime-soon*).

[60] The sole exception is Louisiana, which is known as a "civil law" state. In Louisiana, courts lack any authority to adjudicate a matter absent a statute.

It is widely assumed that as vehicle automation progresses, and motorists cede driving functions to the vehicle's computer systems, responsibility will shift from motorists to manufacturers of the hardware and software, and claims will be adjudicated under product liability law.

3.1.3 Common Carrier Liability

Another long established common law principle is common carrier liability. Common carriers are companies that transport people (or goods) pursuant to a license provided by a government agency. Common Carriers include taxis, buses and ferries. Common Carriers are held to a very high legal standard. Under California law, for example, "A carrier of persons for reward must use the utmost care and diligence for their safe carriage, must provide everything necessary for that purpose, and must exercise to that end a reasonable degree of skill." "Common carriers are responsible for any, even slightest, negligence to passengers and are required to do all that human care, vigilance, and foresight reasonably can do under all the circumstances."

3.1.4 Liability Scenarios

As noted above, human-operated vehicles will remain the predominant form of personal transportation for the foreseeable future. Vehicles with wide disparities in the level of onboard technology will share the roads with newer vehicles containing an equally wide variety of the more sophisticated automation technologies. The intelligent infrastructure of vehicle, satellite and road communications that many view as integral to the safety of an autonomous transportation system has yet to be planned, much less constructed, and will not play any significant role for the foreseeable future.

This Hybrid Highway will be the product of a hugely complex system of hardware and software built, marketed, maintained and operated by corporations manufacturing hardware and software, engineers, software programmers, public agencies as well as motorists.

Compounding the threat matrix are vehicle security failures, ranging in consequence from privacy breaches to criminal or terrorist hacking; the absence of Federal safety rules to standardize technologies; wealth based disparities in the affordability of autonomous technology. Flaws and failures in any single aspect of this complex environment could lead to death, injury and property damage.

Even in a distant theoretical future in which *all* vehicles are controlled by robots, the same concerns apply.

The table below is based on the taxonomy for self-driving vehicles published by the Society of Automotive Engineers (SAE),[61] which has been broadly endorsed as a tool for discussion of these issues. The table illustrates who will be responsible under some likely risk and liability scenarios; the leftmost column describes the SAE level of automation and the top row lists particular liability risks.

[61] "Surface Vehicle Recommended Practice," Society of Vehicle Engineers (J3016), September 2016.

Legal System – Risk/Liability Matrix

Scenario >	Negligent or intentionally dangerous operation of vehicle.	Defective design, manufacture of vehicle hardware, incl. sensors, computer, communications.	Defective design, manufacture of vehicle software.	Defective design, construction, maintenance of roads, "intelligent highway" communications system.	Security breaches, invasion of privacy, criminal or terrorist hacking of vehicle or "intelligent highway."	Defects in maintenance, operation of public transportation services (buses, trains, taxis).
Automation Level (Society of Automation Engineers)						
Human Driver No Automation (Level 0)	Driver: tort liability. Private services (Uber): Possible liability for driver hiring or training. Possible common carrier liability.	Manufacturer: strict products liability.	N/A	Govt. agency: negligence, subject to statutory limitations.	Manufacturer: strict products liability. Govt. agency: negligence, subject to statutory limitations.	Common carrier liability.
Partial Automation (Levels 1-4) Human driver required to perform some driving tasks; at Level 3, driver must be prepared to intervene upon request of the computer. At level 4, car is autonomous in certain circumstances; it may delay a request by human driver for control.	"	"	Manufacturer: strict products liability.	"	"	"
Car is autonomous in all circumstances; it may delay a request by human driver for control. (Level 5)	Operator: Tort liability for failure to properly maintain vehicle, possibly for failure to request control from vehicle.	"	Manufacturer: strict products liability.	"	"	"

As the table illustrates, there is no scenario in which disputes will not require resolution through the civil justice system. Note the SAE taxonomy explicitly assumes that the vehicle may issue a "request to intervene" to a human occupant of a fully self driving vehicle (though in the highest automation modes, the robot car or truck will not have an "expectation that a user will respond" to such a request). It is implicit in this analytical framework that the vehicle will contain the necessary equipment (steering wheel, brake pedal, etc.) that will enable the occupant to seize control. In other words, the SAE framework envisions no scenario in which a human cannot ultimately obtain control of a robot car. No company planning to sell robot vehicles has stated whether they will come equipped with the complement of control devices present in traditional vehicles today. (For purposes of shifting liability to consumers, manufacturers of self driving vehicles may choose to retain those devices.)

Assume, for example, that a vehicle is capable of operating autonomously, but a passenger is still *expected* to seize control of the vehicle in some circumstances (Level 3–4 under the SAE taxonomy). That person, presumably clearly designated as such by the vehicle itself, will remain subject to liability for failure to intercede properly.

Assume a vehicle is capable of full autonomous operation, but a person in the vehicle is still *able* to request that the vehicle "surrender control" (SAE Level 5). Or assume that the vehicle issues a request for the user to intervene—even though the user is not expected to. In the event of a crash, a person's failure to demand control, or agree to accept control, could itself be the basis for liability.

And as automated technologies become more sophisticated, and cars and trucks are able to operate autonomously from human intervention, manufacturers of the hardware and software will face strict liability for design or manufacturing defects that caused a crash.

In all of five of the SAE scenarios, third parties, *including manufacturers,* will be permitted to dispute whether the vehicle, or the motorist, was responsible. Facing strict liability for crashes, manufacturers will certainly have an incentive to dispute their responsibility. And it's worth noting that in several of the most highly publicized crashes involving Tesla to date, the company has been reluctant to accept full responsibility. In a highly-publicized accident in which a Tesla owner died when his Tesla, on Autopilot, failed to recognize a truck crossing the road, Tesla went so far as to release "black box" data from a vehicle to support Tesla's position that the driver was at fault, not the car.[62] Similarly, the ridesharing firm Uber blamed test drivers when its vehicles, illegally operating in self-driving mode, were caught running red lights in San Francisco.[63]

While a self-driving vehicle will collect vast amounts of data that will potentially offer enormous insight into the reasons for a crash, key questions may not be answered by that data. For example, did the vehicle correctly inform the designated passenger of the status, such that the passenger should have known to assume control? Did the vehicle fail to request human intervention? Did the vehicle improperly reject a user's demand for surrender of control? Would it matter to the inquiry what the passengers were doing at the time of the crash? It is not clear to what extent the vehicle will collect all the data necessary to determine what happened in the seconds before a crash. Will there be a continuously recording camera and microphone in the passenger compartment, such that third parties could argue the passenger was distracted?

Consumers who own or lease self-driving vehicles will face far greater maintenance responsibilities than they bear today. For example, self-driving vehicles will be reliant on external sensors—the eyes and ears of the robot car's brain. A scrape or dent that impairs a sensor while the vehicle is in the driveway could lead to deadly consequences when the vehicle is on the road.

Moreover, the computer brains of robot cars will inevitably require software updates. What happens if the consumer fails to download a software update, or visit the dealership if that is required? No potential manufacturer of a self driving vehicle has offered to assume liability for a crash caused, even partly, by the consumer's failure to maintain the vehicle's operational status.

Each of these scenarios confirms that an inquiry into a consumer's "fault" will be necessary even in the era of fully autonomous vehicles.

Complicating these scenarios is the fact that hardware and software manufacturers consider their technology proprietary; indeed, for security reasons, it may be impossible for even the owner to access any vehicle data.

Finally, the manufacturers of automated vehicles acknowledge their self-interest when it comes to liability. Not one manufacturer has agreed to assume *all* liability for the harm caused by their automated vehicles. Three companies have been quoted as stating that they will accept legal liability when their cars are in fully autono-

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[62] See, for example, D. Shephardson, "Google Takes the Blame—Sort of—for Its Self-Driving Car Crash," Reuters, February 29, 2016 *http://time.com/money/4242030/google-self-driving-car-crash-fault/*); "Tesla Says Autopilot Not to Blame in Crash With Bus in Germany," Reuters, September 29, 2016 (*http://fortune.com/2016/09/29/tesla-autopilot-crash-germany/*); C. Davies, "In New Model X Crash, Tesla Suggests Autopilot Not To Blame," Slash Gear, July 6, 2016 (*https://www.slashgear.com/in-new-model-x-crash-tesla-suggests-autopilot-not-to-blame-06447354/*).

[63] "Witness Saw Uber Robot Car Drive Through Red Light Three Weeks Ago in San Francisco," Consumer Watchdog, December 20, 2016 (*http://www.consumerwatchdog.org/newsrelease/witness-saw-uber-robot-car-drive-through-red-light-three-weeks-ago-san-francisco*); J. Hood, "California Orders Uber's Self-Driving Cars Off The Road," Consumer Affairs, December 15, 2016 (*https://www.consumeraffairs.com/news/california-orders-ubers-self-driving-cars-off-the-road-121516.html*).

mous mode: Volvo,[64] Mercedes and Google.[65] But news reports indicate that Mercedes and Google added a salient limitation on their pledge: that "their technology is at fault."[66] Of course, that caveat will leave the owner of the robot car exposed to liability in cases where the manufacturer insists the crash was not the fault of its hardware or software—necessitating an inquiry into the drivers' fault.

The search for truth and justice in such circumstances will require the full powers of the civil justice system. The right to challenge corporate mistakes and reckless profit-driven conduct, in an impartial judicial forum with all the procedural protections of the civil justice system, starting with trial by jury, and including the strict liability of hardware and software manufacturers, will be critical.

3.2 Insurance

The determination of fault and compensation for injury and property damage are matters made by courts. However, the evolution of the automobile as the predominant form of transportation in the United States led to the establishment of mandatory minimum auto insurance coverage requirements—known as "compulsory financial responsibility laws"—in Massachusetts in 1927; today every state but New Hampshire requires such coverage. Thus motorists, as a condition of owning or leasing a vehicle for operation on public roads, must buy insurance that will cover, to at least a minimum extent, that motorist's liability should he or she cause injury or damage to another person or their property. California, for example, requires most motorists to obtain a policy that would pay up to $15,000 in bodily injury compensation per person (for a maximum of $30,000 among all injured parties) and $5,000 in property damage.[67]

In the event of a crash, persons who suffer loss or damage as a result of the at-fault driver make a claim upon the at fault driver's insurance coverage. The insurance company is required to make an objective determination of the fault of its insured (the exact requirements for that determination vary depending upon state law, and in California are governed by Proposition 103—see below), and pay the claim.

Mandatory auto insurance coverage assures that motorists will have the means to provide at least a minimum level of compensation for modest accidents they cause—hence the term "financial responsibility." Absent such insurance, the at-fault motorist risks a potentially devastating civil judgment against his or her home or other assets. Auto insurance also alleviates what would otherwise be a significant burden on courts to adjudicate even minor disputes involving car accidents.

The cost of insurance and the underwriting and marketing practices of insurance companies have long been a source of public dissatisfaction and are often highly controversial. Regulation of insurance rates and practices is a matter of state law. The requirement that motorists purchase third party insurance coverage from private insurance companies has necessitated the establishment of consumer protections to assure that consumers are treated in a fair and non-discriminatory fashion when buying insurance, and in the event an insurance claim has been filed. However, the degree of protections afforded consumers varies sharply from state to state, as a 2013 report by the Consumer Federation of America found.[68]

3.2.1 Insurance and autonomous vehicles

In 2015, United States-based insurance companies held a total of $8.4 *trillion* in assets.[69] They wrote roughly $192 billion net auto insurance premiums nationwide

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[64] M. Harris, "Why You Shouldn't Worry About Liability for Self-Driving Car Accidents," IEE Spectrum, October 12, 2015 (*http://spectrum.ieee.org/cars-that-think/transportation/self-driving/why-you-shouldnt-worry-about-liability-for-selfdriving-car-accidents*).

[65] M. Ballaban, "Mercedes, Google, Volvo To Accept Liability When Their Autonomous Cars Screw Up," Jalopnik, October 7, 2015 (*http://jalopnik.com/mercedes-google-volvo-to-accept-liability-when-their-1735170893*).

[66] *Id.*

[67] Other insurance coverage, though typically optional, is often purchased by consumers to protect their own vehicles against fire or weather damage (comprehensive coverage), or crashes that don't involve a third party—such as with a tree or other object (known as collision coverage). In states where many motorists operate without insurance, consumers often find it prudent to purchase "uninsured motorist" coverage, so that if they are hit by an uninsured motorist, their expenses are covered.

[68] "What Works? A Review of Auto Insurance Rate Regulation in America," Consumer Federation of America, November 12, 2013.

[69] "Annual Report On The Insurance Industry," Federal Insurance Office, U.S. Department Of The Treasury (September 2016), p. 12.

in 2015 (not including commercial insurance) and projected they would pay $145 billion in claims.[70]

The insurance industry initially appeared to view self-driving vehicles as an existential threat. Within the insurance industry, there has been frequent speculation, sometimes verging on panic, at the prospect of that revenue stream evaporating with the advent of accident-free, driverless vehicles: if there are no accidents, the industry reasoned, then why would anyone buy insurance?

With the benefit of several years of hindsight, the insurance industry's immediate fears appear to have subsided. Under any transportation system in which a consumer is or may be required to operate a vehicle, or even simply to maintain it, state tort laws will hold them accountable. Consumers will continue to purchase insurance coverage to protect innocent third parties against injuries or property damage and to cover their own repair expenses.

Indeed, as automation technologies enable vehicles to operate without human intervention, the makers of the vastly more complex hardware and software will face increased tort liability for defectively designed or manufactured products. These firms will seek to purchase insurance product liability insurance coverage to pay such claims. Self-driving cars and trucks will create new markets for vehicle insurance coverage that do not exist today.

It is too early to know the full financial, economic or social impacts of robot cars will be at this juncture. But we do know that insurance coverage will remain an essential protection in the era of driverless vehicles.

For consumers, the pricing of insurance, historically a significant concern, is likely to become a major economic factor as vehicle automation increases.

As noted previously, while it seems logical that the evolution of auto safety systems will lead to fewer crashes, there is as yet no evidence behind the surmise that robot cars will lead to an *overall* reduction in crash frequency, severity or claims costs. The incorporation of electronics in today's cars and trucks, though rudimentary by comparison to the complex hardware and software needed to maneuver vehicles without human drivers, have already spiked repair costs and insurance premiums.[71] The far greater cost of repairing automated vehicles will likely lead insurance companies to dramatically inflate the price of liability, collision and comprehensive insurance coverage.

Moreover, risks that today are not especially relevant to cars and trucks—such as privacy, security or even mass terrorism—will be much more of a threat to robot vehicles. Insurance companies will likely assess the heightened risk/threat matrix of the new and untested technologies and the hybrid highway as a basis to argue for substantial rate increases in the near term.

Finally, there is a very real danger that insurance companies will pursue a new form of "redlining" to favor motorists who can afford more expensive cars with expensive computer-based systems and discriminate against those who cannot by refusing to sell them insurance, or adding surcharges to the price of insurance –practices with pervasive historical antecedents in the insurance industry.

Strengthened consumer protections against excessive insurance premiums will prove crucial for as insurance companies price the risk of highly automated vehicles—particularly since state insurance regulators often lack the authority (or desire) to bar abusive rates and practices.

3.2.2 The Proposition 103 Model

According to a 2013 report by the Consumer Federation of America, "California stands out from all other states in having the best regulatory system for protecting consumers."[72] Enacted by California voters in 1988, California's insurance reform

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[70] Insurance Information Institute (*http://www.iii.org/fact-statistic/auto-insurance,* last visited June 12, 2017).

[71] See Section 2.6.

[72] In 1984, the California Legislature amended its financial responsibility law to address the growing number of uninsured motorists. The amendment allowed police officers to request proof of insurance and to cite those who did not produce it. While Californians were required by law to purchase insurance, California's insurance law did not require insurance companies to sell it to all individuals; nor were there any limits on the price insurance companies charged. Many Californians could not afford to purchase auto insurance, particularly in neighborhoods that were subject to insurance "redlining," even if it was available. The inequities of the mandatory purchase requirement, combined with escalating auto, home and business insurance premiums, sparked a voter revolt that led to the passage of Proposition 103 in November, 1988. The measure (Insurance Code section 1861.1 et seq.) fundamentally rewrote California's insurance laws. For a detailed discussion of the origin, purposes and provisions of Proposition 103, see Harvey Rosenfield, Auto Insurance: Crisis and Reform, 29 University of Memphis Law Review 69 (Fall 1998). Much more information about Proposition 103 is available at *www.ConsumerWatchdog.org.*

law provides precisely the stronger protections consumers will require in the era of robot vehicles.

- *Review of insurance rates.* Proposition 103 applies to automobile, homeowner, business, and all other property-casualty insurance. It mandated a one-time rollback to November 1987 levels and a further 20 percent reduction in premiums. Over $2 billion in refunds were paid by insurance companies under this directive. The measure requires all property-casualty insurance companies to open their books and justify existing or proposed rate changes, subject to stringent controls on insurance company profiteering, waste, and inefficiency, and to obtain the Insurance Commissioner's approval before such changes may take effect. Insurance companies must show that their rates are based on verifiable loss data and legitimate expenses.
- *Prohibition on anti-consumer and discriminatory practices.* The measure bars "unfairly discriminatory" rates or premiums. It also subjects the insurance industry to lawsuits for violation of Proposition 103's provisions and California's civil rights, consumer protection and other laws.
- *Public disclosure and transparency.* The law authorizes the Insurance Commissioner to obtain any data—such as rate and premium data—from insurance companies that is needed to regulate their rates and practices. The Commissioner must disclose to the public all information –that insurance companies provide.
- *Public participation.* The law authorizes and encourages consumers to monitor and challenge existing rates, applications for rate changes, or any other practices that may be unlawful, either in the courts or before the California Department of Insurance. Under certain conditions, the Insurance Commissioner must hold a public hearing on such challenges. The law requires insurance companies to pay the legal fees and expenses of consumers who participate and make a "substantial contribution" to the outcome of a legal proceeding. The law also made the Insurance Commissioner, usually an appointed position, an elected post.

Preventing insurance companies from seeking unjustified rate increases will be critical as self-driving vehicles become more commonplace, particularly because initially insurance companies will have limited experience in assessing the risk they pose, and for that reason alone will seek to inflate projections of future claims and the cost of repairing or replacing vehicles.

- *Special protections against unfair automobile insurance premiums.* Particularly relevant to self-driving vehicles, Proposition 103 established a special set of rules that govern the pricing of automobile insurance.

  Auto insurance premiums must be determined principally by three specified rating factors—the insured's driving safety record; annual mileage, and years of driving experience—and, to a lesser extent, by any "optional" rating factors that "the commissioner may *adopt by regulation* and that have a substantial relationship to the risk of loss."[73] The use of any other criterion constitutes unfair discrimination and is unlawful.

  Making the driver's own safety record the principal determinant of premiums gives motorists a strong incentive to drive safely. The measure further requires insurers to offer a 20 percent good-driver discount to all qualifying consumers: individuals with a virtually clean driving record (one moving violation is permitted) for the preceding three years. This provides a further incentive for careful driving.

  Basing auto insurance premiums on a motorist's individual responsibility, as reflected by their driving record, will remain of paramount importance for consumers in the era of self-driving vehicles, because in every conceivable scenario the consumer may still bear potential liability in the event of a crash.

  As today, when a motorist is driving a vehicle, they bear responsibility for any injuries or property damage for which they are at fault. During times when the robot is driving the vehicle, the consumer occupant will very likely still have a legal duty to take control in the event of an imminent accident. Even when a self-driving vehicle is parked, the consumer will be responsible for maintaining it in proper condition. A consumer's driving safety record will be based on whether the automated car can avoid tickets and accidents in all these circumstances. And, as noted, the hardware and software manufacturers of auto-

[73] See California Insurance Code section 1861.02(a). The current list of authorized optional rating factors can be found at 10 CCR 2632.5(d).

mated vehicles will have a financial motive to dispute fault. Because there will never be a 100 percent guarantee that the occupant will not be responsible for a traffic violation if a vehicle fails to properly stop as a pedestrian enters a crosswalk or crosses into an intersection in heavy traffic or if a vehicle's sensor fails, or the computer is hacked, and a crash results, a motorist's driving safety record should be the predominant factor is setting premiums.

Similarly, annual mileage and years of driving experience, along with several of the optional rating factors previously adopted by the Commissioner, reflect the motorist's risk, without regard to whether the policyholder is driving a car equipped with automation technology. Cars equipped with improved technology will be rated, as they are today under Proposition 103, based on their repair or replacement cost for purposes of comprehensive (weather damage, fire and theft) and collision coverages.

Other optional rating factors that will remain applicable: the percentage use of vehicle by rated driver; type of vehicle; vehicle performance capabilities, including alterations made subsequent to original manufacture; and vehicle characteristics, including engine size, safety and protective devices, the vehicle's vulnerability to damage, repairability, and installed theft deterrent devices. Cars and trucks equipped with improved technology will be rated, as they are today under Proposition 103, based on their repair or replacement cost for purposes of comprehensive (weather damage, fire and theft) and collision coverages.

Assessing the overall impact of these reforms in its 2013 analysis, the Consumer Federation of America determined that California was the only state in the Nation where the average auto insurance premium went down between 1989 and 2010, saving motorists alone over $100 *billion* in premiums since the law took effect.[74]

Apart from preventing price gouging and discriminatory practices, Proposition 103 provides regulators and consumers with the tools and methodology to address other issues raised by autonomous vehicles.

For example, as noted above, insurance companies collect significant amounts of data about motorists; some have begun installing black boxes in their vehicles to track mileage and other metrics.[75] An even more troubling abuse is the recent phenomenon, previously noted, of insurance companies utilizing the vast trove of personal data collected by Google, Amazon, various credit bureaus and other firms to individualize a motorist's premiums based on algorithms that consider rating factors that have nothing to do with risk, such as the likelihood that a particular consumer will accept a modest overcharge without protest—a practice known as price optimization that is unlawful in nineteen states and the District of Columbia.[76] Under Proposition 103, such practices can be challenged in court and investigated by state Department of Insurance. Acting at the request of the Los Angeles Superior Court, where a class action has been filed, the California Department of Insurance is presently investigating whether Farmers Insurance is engaged in the practice, which is unlawful under Proposition 103.[77]

As another example, the evolution of the car industry into a more frequent litigant may create conflicts in the duties the insurance industry owes its policyholders. Some manufacturers of self driving hardware and software may purchase large quantities of insurance coverage against product liability suits. If so, significant conflicts of interest may arise: if the same insurance company sells insurance policies to motorists or owners of automated vehicles and to manufacturers, the legal duty to handle its policyholders' claims in good faith, which each insurance company owes its individual policyholders, could well collide with its financial incentive to protect the interests of the manufacturer that bought a product liability policy.

In other words, in the era of self-driving vehicles, manufacturers and insurance companies may have a vested financial interest in protecting each other's bottom line, in which case the threat to consumers when it comes to crashes is that every accident will be treated as "your fault." New rules to protect consumers against such conflicts will likely be necessary. Proposition 103 provides the Commissioner and the courts with the authority to adjudicate these unexpected secondary effects in an open and transparent forum.

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[74] "What Works? A Review of Auto Insurance Rate Regulation in America," Consumer Federation of America, November 12, 2013.

[75] See footnote 27. In response to advocacy by Consumer Watchdog, regulations promulgated pursuant to Proposition 103 bar insurance companies from collecting data about the location of an insured vehicle, except as part of an emergency road, theft, or map service. See 10 CCR § 2632.5(c)(2)(F)(i)5.

[76] See Section 2.2.

[77] In the Matter of the Rating Practices of Farmers Insurance Exchange And Mid Century Insurance Company (File No. NC–2017–00003).

4.0 The Industry Agenda to Roll Back Consumer Rights

Over the last five decades, Americans have benefitted from a paradigm change in consumer protection. Across the economy, rules have been put in place to expand the rights of consumers exposed to physically or financially injurious products or services. Many of these laws, such as those barring and punishing false advertising, defective products, sharp financial practices, have become deeply ingrained in consumers' bedrock expectations of the marketplace.

These norms have long been the target of a national attack by insurance companies, automakers and other powerful corporations, their lobbyists, and sponsored allies in academia, seeking to restrict consumer rights under the Personal Responsibility System. They are now recycling discredited anti-consumer proposals to limit corporate accountability, backed by big business, insurance companies and their network of lobbyists and academics, that have failed throughout the United States, and which California voters have rejected multiple times at the ballot box (Propositions 101, 104 and 106 in 1988; Propositions 200, 201 and 202 in 1996).

As noted previously, the suggestion that the transformation to a completely automated transportation system is imminent is a fantasy. But it's a fantasy that automakers and insurance companies are now attempting to exploit in order to press lawmakers to re-write consumer protection laws in their favor.

To do so, they are replicating themes that have proven successful in previous campaigns.

4.1 Restrictions on liability laws to encourage "innovation"

Manufacturers of hardware and software are quietly proposing to revise liability laws and rules so as to limit their financial responsibility for deaths and injuries caused by their automated or self-driving technology. Insurance companies, which profit primarily through the investment of premiums, have a similar financial motive to press for limits on liability, since the fewer and smaller claims payouts leaves more premium dollars for insurance companies to invest, particularly in states where regulators do not have the authority to limit rate increases to reasonable projections of future losses.

Among the proposals advanced by manufacturers and insurance companies are arbitrary caps on how much compensation juries can award to victims of negligence or intentional misconduct that causes deaths or injuries, and restrictions on how much attorneys can charge for their representation of such victims.[78]

A different approach, adopted by the George W. Bush Administration although most certainly unconstitutional,[79] called for NHTSA and other Federal agencies to override state consumer protection laws.[80] The Obama Administration later reversed it.[81] (The Trump Administration is reportedly preparing its own "guidelines" for self driving vehicles; according to the new Secretary of the Department of Transportation: "We don't want rules that impede future technological advances."[82])

Often, arguments in support of such proposals are couched in a threat: that absent such liability limits, manufacturers will not bring a product to the American marketplace. Thus the liability protections are described as "impediments" to innovation.

Perhaps the most illustrative example is the liability bailout of the American nuclear power industry in the 1950s. After World War II, Americans were enamored with atomic energy; the "peaceful use" of the atom was heralded as providing electricity so inexpensive for American households that it would be "too cheap to meter." There was catch. In what should have been understood as a grave warning sign of the risks of nuclear power, the insurance industry claimed it could not provide the insurance that the nascent atomic energy industry needed to cover its potential liability for a nuclear meltdown or other accident. *Potential liability is what stood in the way of "progress,"* supporters of nuclear power insisted. In 1957, Congress obligingly passed the Price Anderson Act, which immunizes the atomic energy industry from liability to the American public in exchange for a tiered fund consisting of a contribution from the nuclear industry of up to $13 billion, followed by an expected congressional bailout. Nuclear power has proven to be an economic disaster for

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[78] R. Nader, "Suing for Justice," Harpers, April 2016.

[79] D. Vladek, "The Emerging Threat of Regulatory Preemption," The American Constitution Society, January 2008.

[80] M. Levin and A. Miller, "Industries Get Quiet Protection From Lawsuits," Los Angeles Times, February 19, 2006 (*http://articles.latimes.com/2006/feb/19/nation/na-preempt19*)..

[81] P. Rucker, "Obama Curtails Bush Policy That Let Federal Rules Override State Laws," Washington Post, May 22, 2009 (*http://www.washingtonpost.com/wp-dyn/content/article/2009/05/21/AR2009052104016.html*).

[82] D. Shephardson, "U.S. Plans To Update Self-Driving Guidelines In Coming Months," Reuters, June 5, 2017 (*http://www.reuters.com/article/us-usa-selfdriving-idUSKBN18W2JR*).

American taxpayers and ratepayers.[83] (The $13 billion limit on the nuclear industry's liability is woefully inadequate: the Japanese government's latest estimate of the cost of the 2011 meltdown at Japan's Fukushima Daiichi Power Plant—still underway—is $188 billion.[84])

A report by the U.S. Chamber of Commerce's dedicated anti-liability law unit insists that legal liability will "chill this promising technology [autonomous vehicles] and the huge advances in overall public safety it promises."[85] It continues: "Where liability exposure poses a threat to an emerging technology, legislators should adopt reasonable constraints on liability."[86]

In a lengthy paper on legal liability and self driving vehicles published in 2016, RAND Corporation, which has received substantial funding from the insurance industry and has been a long-time advocate of restrictions on victim compensation rules, makes the same point:

> Current liability laws may well lead to inefficient delays in manufacturers introducing AV [autonomous vehicle] technologies. The gradual shift in responsibility for automobile operation from the driver to the vehicle may lead to a similar shift in liability for crashes from the driver to the manufacturer. Recognizing this effect, manufacturers may be reluctant to introduce technology that will increase their liability.[87]

4.2 Restrictions on liability laws to "lower insurance rates"

The insurance industry is now resurrecting a long-abandoned and discredited scheme known as "no fault" auto insurance. RAND's report concludes: "Th[e] shift in responsibility from the driver to the manufacturer may make no-fault automobile-insurance regimes more attractive."[88]

Insurance companies have long blamed liability laws for escalating insurance premiums, and proffered restrictions on compensation to auto accident victims—so-called "no fault" laws—as the solution. "No fault" barred or gravely limited compensation to people for so-called non-economic losses: principally the intangible pain and suffering uniquely experienced by a human being that cannot be reduced to a specific dollar value. In exchange, the insurance industry promised lower premiums and richer insurance benefits for objective out-of-pocket losses such as medical expenses and wage loss. At its peak, twenty-four states had adopted some form of "no fault" auto insurance.

As a practical matter, however, "no fault" proved to be a disaster for consumers. "No fault" auto insurance became vastly more expensive than the traditional liability system, and insurance companies quickly argued they needed to cut the benefits in order to bring prices under control.[89]

The turning point was the electoral contest over insurance reform in California. The insurance industry and its allies placed two "no fault" related proposals on the California ballot in 1988, as an alternative to Proposition 103. They were rejected by the voters by a three to one margin.[90] Insurance companies placed another "no fault" initiative on the ballot in 1996. It, too, was decisively rejected, with 65 percent of Californians voting against it.[91] Four states significantly altered or repealed their no-fault systems between 1989 and 1995: Georgia, Connecticut, Pennsylvania, and New Jersey, experiencing rate reductions as a result.[92] Today, only twelve states employ any form of "no fault" insurance.

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[83] R. Nader, "Nuclear Power's Insanities—Taxpayer-Guaranteed," Common Dreams, September 06, 2014 (*http://www.commondreams.org/views/2014/09/06/nuclear-powers-insanities-taxpayer-guaranteed*).

[84] Y. Obayashi and K. Hamada, "Japan nearly doubles Fukushima disaster-related cost to $188 billion," Reuters, December 9, 2016 (*http://www.reuters.com/article/us-tepco-fukushima-costs-idUSKBN13Y047*).

[85] U.S. Chamber of Commerce Institute for Legal Reform, "Torts of the Future: Addressing the Liability and Regulatory Implications of Emerging Technologies," March 2017, p.2.

[86] *Id.,* p. 54.

[87] J. Anderson, *et al.,* Autonomous Vehicle Technology: A Guide for Policymakers, RAND, 2016, p. 118.

[88] *Id.,* p. 116.

[89] H. Rosenfield, "Auto Insurance: Crisis and Reform," 29 U. Memphis Law Review 69 (Fall 1998), p. 87–97.

[90] *Id.,* p. 83–84.

[91] See *https://ballotpedia.org/California_Proposition_200,_No_Fault_Automobile_Insurance_(1996)* (last visited June 12, 2017).

[92] H. Rosenfield, "Auto Insurance: Crisis and Reform," 29 U. Memphis Law Review 69 (Fall 1998), p. 87–97.

4.3 Repealing protections against insurance company price gouging and discrimination

The insurance industry reliably opposes any form of regulation or consumer protection legislation, and the potentially destabilizing advent of self driving vehicles, with its host of unique and unprecedented risks to consumers, is certain to inspire the consideration of broader regulation at the state level. Proposition 103's protections will no doubt be considered a model for consumers in other states as automated vehicles are rolled out.

Insurance companies vehemently opposed Proposition 103 at the ballot box—spending a record $63 million in their campaign to defeat it—and many insurers have sought to evade or contest its reforms since they were upheld in a series of unanimous decisions by the California Supreme Court after the measure passed. The industry, as well as individual insurance companies, continues to fight the rate reductions and premium rollbacks in the courts.[93] So it is hardly a surprise that some insurance companies hope to exploit the discussion about insurance and liability in the era of autonomous vehicles to argue that, as one industry source candidly put it, "the Prop 103 model should be scrapped entirely."[94]

The industry contends that Proposition 103's protections against discriminatory rates and practices are outdated and will no longer be necessary once robots, not humans, are driving vehicles.[95] However, as discussed above, no fully autonomous vehicle is available for purchase today, nor has any date been set for the sale of such vehicles, and America is decades away from a fully autonomous transportation system (if it ever happens). Between now and that very distant future, our roads will be a "Hybrid Highway" of vehicles with greatly varying degrees of automation, ranging from none to a great deal. So long as consumers are subject to liability for injuries and property damage caused by the crash of a self-driving car or truck, they will require insurance coverage. And so long as insurance companies attempt to overcharge motorists for that protection, the protective provisions of Proposition 103 will remain essential.

Self driving vehicles will place the insurance industry at a crossroads. Rather than resist or work to undermine reform, insurance companies would be better advised to focus their resources on the extremely important consumer protection role they could choose to play as vehicle automation increases. Historically, the insurance industry has exhibited limited interest in safety and "loss prevention," perhaps because insurers are cost-plus, cash flow based institutions: their profits are largely based on their projected costs, so when claims rise, insurers can justify charging higher premiums, and earn more investment income.[96] These incentives have discouraged insurance companies from using their vast information database on vehicle hazards to alert manufacturers of vehicle dangers and press them—and lawmakers—for safety improvements. This moment in history, marking a rapid evolution in vehicle technology, is the time for the insurance industry to weigh in—with a commitment to strong Federal safety regulation, for example, and much more resources for affiliated organizations whose mission is public safety and loss prevention.

5.0 Guiding Principles

To protect consumers against the challenges posed by autonomous vehicle technology, Consumer

Watchdog believes six principles must be adopted.

1. *Protect the civil justice system.* The state-based civil justice system—open courts, impartial judges and citizen juries—is fully equipped to handle the determination of legal responsibility as our transportation system evolves over the coming decades. Disputes over who is at fault in a crash involving a self-driving car or truck will require the full power of civil justice system, with its procedural safeguards of an impartial judge, full public transparency, and trial by citizen juries,

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[93] "CA Supreme Court Rebuffs Insurance Industry Assault on Proposition 103 Rate Protections," Consumer Watchdog, May 11, 2017 (*http://www.consumerwatchdog.org/newsrelease/ca-supreme-court-rebuffs-insurance-industry-assault-proposition-103-rate-protections*).

[94] I. Adams, "Does Prop 103 Violate Itself?" Personal Insurance Federation of California, October 21, 2014 (*http://www.pifc.org/prop-103-violate/*).

[95] *Id.* See also R. Peterson, New Technology—Old Law: Autonomous Vehicles and California's Insurance Framework, Santa Clara University School of Law, May 21, 2012; D. Jergler, "Prop. 103 vs. Self-driving Cars Revving up in California," Insurance Journal, Sept. 17, 2014 (*http://www.insurancejournal.com/news/west/2014/09/17/340898.htm*); I. Adams, "Can Prop 103 Handle Driverless Cars?" R Street, August 27, 2014, (*http://www.rstreet.org/2014/08/27/can-prop-103-handle-driverless-cars/*).

[96] H. Rosenfield, "Auto Insurance: Crisis and Reform," 29 U. Memphis Law Review 69 (Fall 1998), p. 76.

to investigate and publicly expose the cause of crashes, compensate the victims for deaths, injuries and property damage, punish the wrongdoer, and force manufacturers to make changes in their products to prevent future harm. When their autonomous technologies fail, hardware and software manufacturers must be held strictly liable. Lawmakers should reject legislation to limit or restrict state consumer protection laws. Manufacturers must not be permitted to evade these consumer protections by inserting arbitration clauses, "hold harmless" provisions or other waivers in their contracts.

2. *Enact stronger state consumer protections against insurance company abuses.* According to a 2013 report by the Consumer Federation of America, "California stands out from all other states in having the best regulatory system for protecting consumers." Enacted by California voters in 1988, California's insurance reform law provides precisely the stronger protections consumers will require in the era of robot vehicles. The reforms, known as Proposition 103, have protected motorists (along with homeowners, renters, businesses and medical providers) against unjust insurance rates (including product liability insurance rates) and anti-consumer and discriminatory practices. The law's emphasis on rewarding drivers with lower insurance premiums based on their safety record, their annual mileage, their driving experience, and other rating factors within their control that are "substantially related to the risk of loss," will be critical in the new automotive era. Proposition 103's mandate for public disclosure and public participation in regulatory matters are essential components of a system that will be trusted by consumers.

3. *Enact auto safety standards.* Private companies cannot be trusted to develop and deploy robot cars and trucks without rules. The Federal auto safety agency, or in its absence, state auto safety agencies, must develop standards for the testing and deployment of the multiple technologies required by robot vehicles. These standards must address safety; security; privacy and the software that determines the robot's actions in the event of an impending collision and as it makes life and death decisions. They must be enforceable by consumers in courts of law.

4. *Stronger laws are needed to protect consumers' privacy.* The laws have not kept pace with the evolution of technology and the collection and monetization of consumers' personal data. Hardware and software manufacturers and insurance companies must be barred from utilizing tracking, sensor or communications data, or transferring it to third parties for commercial gain, absent separate written consent (which should not be required as a condition of accessing the services of the vehicle/manufacturer, and which should be revocable by the consumer at any time).

5. *Bar Federal interference in state consumer protection laws.* Neither Congress not Federal agencies should be permitted to preempt or override stronger state based civil justice, insurance reform or auto safety laws.

6. *Respect democratic and human values.* The sponsors of self-driving vehicles have promoted the myth that machines are infallible in order to justify the wholesale departure from a panoply of norms that form founding principles for the nation, beginning with the rule of law; individual and corporate responsibility; long held legal principles that distinguish between human beings and property; and the transparency of public officials and institutions that is a hallmark of democracy. The strategy of substituting robot values for human values has reached its apotheosis in the determination by robot car company executives to program computers to make life and death decisions, and to keep that decision-making process secret. Lawmakers will need to impose the rule of law and other attributes of American democracy upon the executives of the hardware and software companies that manufacture self-driving cars.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. BRIAN SCHATZ TO MITCH BAINWOL

Question. There is conflicting research on whether self-driving cars will increase congestion and vehicle emissions overall. For instance, vehicle-miles traveled could increase because automation lowers the opportunity cost of driving. Do you think the widespread deployment of self-driving cars will increase congestion or vehicle emissions? How do we ensure that this does not happen?

Answer. It is thought that self-driving vehicles will be initially deployed primarily in a ride-hailing, ride-sharing, or goods delivery fleet context. These vehicles will be part of Transportation as an Operating ecosystem that will allow better fleet management and more efficient transportation, which, coupled with the general trend toward drivetrain electrification, offers the possibility of reduced congestion and emissions. We are also excited about potential for self-driving vehicles to reduce traffic fatalities, improve transportation efficiency, and expand mobility to tradition-

ally underserved populations. We feel those reasons are quite compelling in the overall debate about permitting the deployment of self-driving vehicles.

Regardless of vehicle powertrain, it would be speculative to definitively state that self-driving vehicle deployment will increase vehicle emissions or congestion. However, it is well documented that current advanced driver assist technologies have a positive impact on congestion because the technology is preventing accidents that would otherwise occur due to driver error.

Note, attached is a projection from Moody's Investors Services that outlines the expected rate of use and ultimate saturation for HAV technologies, including fully autonomous vehicles.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. TAMMY DUCKWORTH TO ROB CSONGOR

Question. Data access is an issue raised by a number of stakeholders, ranging from public safety advocates, law enforcement, insurers, and environmental organizations. Considering the importance of data access for liability determinations, environmental impact determinations, and determining how safe this technology actually is, how will these issues be addressed to make sure the appropriate stakeholders have access to relevant data that is not proprietary information?

Answer. In order to develop self-driving cars and ensure they are safe, massive amounts of data are required to train AI neural networks. In addition, we will want to test them on real roads as well as simulated tests that will be based on data from previously driven miles.

All of this data can be collected from fleets of test vehicles, as well as customer vehicles. NVIDIA believes that the data obtained by customer vehicles must be treated in a fashion that anonymizes the data. No personally identifiable information should be retained, but rather just the sensor data and other vehicle data will be maintained in order that the driving system can be trained.

With respect to archiving data on the vehicle, it makes sense to have a data recorder that maintains recent driving activity that can be used to understand what happened in the case of an incident, and can be used to determine who is at fault.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. RON JOHNSON TO JOHN M. MADDOX

Question 1. A recent Deloitte research paper illustrates how the transportation industry is leveraging the wireless platform to innovate and grow. According to this paper, wirelessly connected self-driving cars could reduce travel times by nearly 40 percent and delays by 20 percent, annually generating $447 billion in savings and saving 21,700 lives. Can you describe the American Center for Mobility's work with wireless providers to speed up the delivery of self-driving vehicles?

Answer. Our current transportation system is comprised of people, vehicles, and roads (infrastructure). The American Center for Mobility (ACM) is convinced that modern communications networks will make up a critical and necessary component of our future transportation system, right alongside people, vehicle, and roads. This modern transportation communications network will enable the rapid distribution and collection of data, forming a data backbone which will create the possibility for a systems-approach for the efficient flow of people and goods.

Highly Automated Vehicles (HAVs) will rely heavily on this data backbone. HAV technology is critical to a future transportation system that continues to support our national economy, and deployment of these communications and vehicle technologies will help ensure our continued international economic competitiveness.

ACM is creating a national-scale proving ground for the future of transportation where these future transportation products and services can be tested, verified, and validated. In addition to testing for vehicles and roads, ACM is building a facility for critical testing and development of the communications systems that will form this data backbone.

ACM is collaborating with AT&T, and other companies who will be announced at a later date, to design, build, and operate a dedicated network so that manufacturers, developers, service providers, government bodies, and other stakeholders can rapidly develop and deploy beneficial transportation technologies in a collaborative fashion. This dedicated network will include, among other technologies, 4G/LTE cellular, Dedicated Short Range Communication (DSRC), Wi-Fi, cloud services, edge computing, and 5G when it is ready.

We anticipate that this transportation communications testing capability will be in high-demand and will enable the very rapid development of Connected and Automated Vehicle technology.

Question 2. As more connected and autonomous vehicles hit the road, they will need to "talk" to each other and everything around them in a secure manner to realize the full potential of the technology. There will be an enormous growth in data as vehicles and surrounding infrastructure become connected. How is the American Center for Mobility working with the wireless industry to ensure that the wireless infrastructure exists to handle the vast amounts of data needs that will come with autonomous vehicles?

Answer. The American Center for Mobility (ACM) is convinced that a modern communications network is a required component of our future transportation system to enable needed data systems. Highly Automated Vehicles (HAVs) present both challenges and opportunities regarding data and data sharing, as the vehicles themselves require that a large amount of data and information be sensed, acquired, amalgamated, analyzed for rapid decision-making, and acted upon through control decisions and operational monitoring. However, the processing, distribution, and eventual storage of these extremely large amounts of data is itself a significant challenge. It is highly unlikely that it will be practical to transfer and store *all* of the data from thousands, much less hundreds of thousands, of vehicles throughout the vehicle lifetime. Therefore, data selection and harvesting processes must be developed.

ACM is working with telecom, automotive, cybersecurity, computing, simulation, and infrastructure industry partners to create a model communications system whereby they can test, develop, verify, and validate their key technology and offerings.

We are also focused on partnering with key Standards Development Organizations (SDOs) to rapidly create, publish, and update critical voluntary standards around communications systems, as well as the vehicle and roads themselves. It is critical that we begin and accelerate the work to establish these voluntary standards to support the deployment on this technology and to help ensure our continued international economic competitiveness.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BRIAN SCHATZ TO JOHN M. MADDOX

Question 1. It is reported that driving a self-driving car for an hour will generate four terabytes of data. This data is very valuable for various applications—urban planning, for example. But there are currently a wide variety of approaches in state legislations when it comes to data ownership. What do you think are good principles of data sharing among car operators, car manufacturers, and the government?

Answer. Highly Automated Vehicles (HAVs) present both challenges and opportunities regarding data and data sharing, as the vehicles themselves require that a large amount of data and information be sensed, acquired, amalgamated, analyzed for rapid decision-making, and acted upon through control decisions and operational monitoring. However, the processing, distribution, and eventual storage of these extremely large amounts of data is itself a significant challenge. It is highly unlikely that it will be practical to transfer and store *all* of the data from thousands, much less hundreds of thousands, of vehicles throughout the vehicle lifetime. Therefore, data selection and harvesting processes must be developed.

While data best-practices for HAVs are still under significant development by vehicle manufacturers, testers, suppliers, and service operators, generally, these data practices will eventually likely include established processes for maintaining privacy and proper ownership, while providing for the collection of in-use event, incident, and vehicle information data for crashes, near crashes, malfunctions, degradations, failures, and unintended operation outside established operational domains. It is expected that this information will become extremely useful for vehicle development, safety monitoring, and operations activities as well as accident/event reconstruction purposes. All of these types of data can be useful for creating appropriate safety requirements, but privacy and ownership principles must be maintained.

Key principles must be established at the policy level, ideally federally to avoid a patchwork of requirements, and in concert with industry and consumer groups. The basic principles employed in today's vehicles are appropriate starting points, including the concept that the vehicle-level data ownership is dictated by vehicle ownership, unless voluntarily sharing is "opted-into" by the owner.

Lastly, data ownership and sharing policies must also take into account the reality that cellular phones, tablets, wearables, and other devices are already col-

lecting and transmitting large amounts and broad types of data, and that vehicle-based data is not the only source of privacy and ownership concerns in the transportation system.

Question 2. This year, there has been a lot discussion from both sides of the aisle on our Nation's deteriorating infrastructure. In your opinion, is our physical infrastructure ready for self-driving cars? If not, what has to change?

Answer. Our transportation system is the lifeblood of the U.S. economy. It supports all of our business and economic activities, including the basics of getting people to their jobs and goods to market. It underpins our society and our entire way of life. Our deteriorating infrastructure is already weighing down our economy with increased congestion, wasted fuel, and significant safety issues. Further lack of investment in our infrastructure will also hamper our ability to deploy Highly Automated Vehicle (HAV) technology in the long term at large scale and will reduce our international economic competitiveness.

While our current infrastructure is less than ideal, HAVs will initially be able to accommodate this, much like initial automobiles handled horse-trails 100 years ago. But quickly our existing infrastructure, if left unimproved, will increasingly inhibit widespread deployment of HAV technology and significantly reduce societal benefit.

In the short term, we should concentrate on improving the basics, including well-painted lane markings, high quality and consistent signage, and well-lit and delineated pedestrian crossings and bicycle lanes. We should move quickly to deploy Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) communications systems based on DSRC *and* cellular, as well as regularly updated detailed maps to provide HAVs with augmented data for safety and operations.

In the longer term, we should begin to establish best practices for new infrastructure designs for urban and rural areas, including managed lanes, further improved lane and road edge markings, traffic control systems, and parking.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. TAMMY DUCKWORTH TO JOHN M. MADDOX

Question. Auto manufacturers and technology companies continue to develop and push for highly autonomous vehicles to enter our transportation landscape and we understand that in order to bring these products to market they need to be tested not only on secure test tracks but also on actual roads. Many of these vehicles under development are being designed to have little if any human intervention features should something arise that requires someone or something to take control of the vehicle.

Is the role of insurance being addressed as autonomous vehicle technology is developed and how do you envision liability issues (product liability, strict liability, etc.) going to be addressed going forward as we move toward the Level 3–5 environment?

Answer. It is true that numerous companies are developing highly automated vehicles for deployment and operation over the next 1–5 years. Some of these vehicles will not require human intervention for normal operation. And indeed, best practices for development and full validation of these vehicles include a coordinated and diligent approach including both on-road and closed course testing, as well as a related computer-simulation approach.

The role, and nature, of insurance is being considered and logically must be addressed in this same time period. Currently, insurance companies and re-insurance companies are analyzing this technology as they would with any new technology: examining, collecting data where possible, and attempting to quantify the risk and potential benefit of the technology. However, it is largely understood that data is scarce and that the examination is still in early stages. Predictably, insurance companies are generally not offering a public view of their planning and analysis efforts or results.

The assumption in the vehicle developer community is that the current liability system in the U.S. will likely be in place throughout the near-term roll-out of the technology. However other countries and regions, including those with highly developed automotive industries, are critically examining whether other liability regimes, including shared liability, would provide greater societal benefit due to faster deployment or other means.

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