Technology & automotive transportation: The future is now

Imagine that your cross-town drive time is cut in half and so are vehicle accidents — with a robot at the wheel!

By Christopher Dolan

In the 1960's I grew up watching Star Trek, on a little black-and-white TV set with rabbit ear antennas, no remote, and an adjustable dial to turn to one of the 10 or so available stations. Captain Kirk and company had "transponders" – futuristic hand-held telecommunication devices that did the unimaginable: let people talk to each other over long distances, wirelessly. I never thought I'd see it in my lifetime. Now, my eight-year-old cannot only make calls on my cell phone, she can download and watch "Cinderella" in the middle of the woods.

In 1973, Woody Allen came out with the movie "Sleeper," another futuristic storyline with fantastic technology like the "Orgasmatron" (See Figure 1) and the driverless car.

Unfortunately, to my knowledge, the "Orgasmatron" is still hypothetical while, on the other hand, in March of this year the first autonomous car set out from the Golden Gate Bridge and arrived in New York nine days later with the technology doing 99 percent of the driving on its own, reverting to the human only as it left highways and entered onto city streets.

The driverless car (Figure 2) will revolutionize transportation and every other associated industry and profession. We, as lawyers and policy makers, need to pay close attention to these developments so as to make sure that the dual goals of the tort system, accountability and consumer protection, evolve as well.

Figure 2: The driverless car

Figure 1: Woody Allen and the Orgasmatron

According to the National Highway Transportation and Safety Administration (NHTSA), in 2011 America's 212 million licensed drivers crashed over 5.3 million times, injured 2.2 million people and killed another 32,367. Road traffic injuries have become the leading killer of young people aged 15 to 29 years. According to a World Health Organization Report, almost 1.3 million people die each year on the world's roads, making this the ninth leading cause of death, globally. Worldwide, road crashes cause between 20 million and 50 million non-fatal injuries every year.

Human factors are leading cause of accidents

Thought to be one of the most thorough studies of collision causation, The Tri-level Study of Traffic Accidents, commissioned by the NHTSA/DOT in 1979, undertook an expansive review of

collision data in an effort to quantify the causes of vehicle collisions on a percentage basis. The study determined that human factors are the most frequently cited causes of collisions followed by environmental and vehicle factors respectively. The DOT study revealed that human error was the most probable cause in 93 percent of these collisions. The leading human direct causes were improper lookout (23 percent), excessive speed (17 percent), inattention (15 percent), improper evasive action (13 percent) and internal distraction (9 percent).

The 2008 NHTSA National Motor Vehicle Crash Causation Survey analyzed a representative sample of 5,471 crashes in a 2.5 year period from 2005 to 2007 which demonstrated similar results identifying human factors as the greatest critical pre-crash event causing a collision. The 2008 NHTSA study revealed that about 36 percent of all vehicles involved in collisions were turning or crossing at intersections, 22 percent ran off the side of the road, 11 percent failed to stay in their proper lane, 12 percent of the vehicles were stopped and about 9 percent lost control prior to the crash. NHTSA not only broke down the crashes by critical pre-crash events, it specifically referenced how technology could be used to reduce, or eliminate these collisions, including electronic stability control, lane departure warning systems, collision-avoidance/warning systems and a "cooperative collision avoidance system" which would warn a driver about an imminent violation of a traffic control device at an intersection.

The 2008 Study found that:

> In cases where the researchers attributed the critical reason to the driver, about 41 percent of the critical reasons were recognition errors (inattention, internal and external distractions, inadequate surveillance, etc.). In addition, about 34 percent of the critical reasons attributed to the driver were decision errors (driving aggressively, driving too fast, etc.) and 10 percent were performance errors (overcompensation, improper directional control, etc.). The researchers also conducted an assessment of other factors associated with the crash, such as interior non-driving activities. In fact, about 18 percent of the drivers were engaged in at least one interior non-driving activity. The most frequent interior non-driving activity was conversation, either with other passengers in the vehicle or on a cell phone, especially among young (age 16 to 25) drivers. Among other associated factors, fatigued drivers were twice as likely to make performance errors as compared to drivers who were not fatigued.

Technology makes us better drivers

In short, we are not very good drivers and technology has rapidly developed to enable us to be better drivers largely by providing us with more information in the form of warnings. In the last five years we have seen a rapid growth in the area of adaptive technologies that interpret and react to changing conditions for us. Now, Silicon Valley (and even NHTSA) thinks what is best for us all is to remove us from the interface, i.e., take us out of the driver's seat.

In 2013 NHTSA released a policy on Automated Vehicle Development classifying the various levels of vehicle automation.

NHTSA defines vehicle automation as having five levels:

• **No-Automation (Level 0)**: The driver is in complete and sole control of the primary vehicle controls – brake, steering, throttle, and motive power – at all times.

• **Function-specific Automation (Level 1)**: Automation at this level involves one or more specific control functions. Examples include electronic stability control or pre-charged brakes where the vehicle automatically assists with braking to enable the driver to regain control of the vehicle or stop faster than possible by the driver acting alone.

• **Combined Function Automation (Level 2):** This level involves automation of at least two primary control functions designed to work in unison to relieve the driver of control of those functions. An example of combined functions enabling a Level 2 system is adaptive cruise control in combination with lane centering.

• **Limited Self-Driving Automation (Level 3):** Vehicles at this level of automation enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions that would require transition back to driver control. The driver is expected to be available for occasional control, but with sufficiently comfortable transition time. The current Google car in operational testing in California is an example of limited self-driving automation.

• **Full Self-Driving Automation (Level 4)**: The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any time during the trip. This includes both occupied and unoccupied vehicles.

NHTSA unequivocally states that these technologies will reduce not only the emotional toll that collisions cause, they cite hundreds of billions of dollars in reduced societal costs caused by loss of life, injury, disability, medical costs, days missed from work and property damage. Additionally, it is projected that these evolving technologies will result in improved vehicle performance as well as reduction in energy consumption, congestion, and greenhouse emissions resulting in improved commute times. While NHTSA is focused on safety and coordination of the development of multiple systems by various manufacturers, little is being discussed about how the civil law needs to adapt to secure accountability and consumer protection for those times when these systems, like humans, fail. It is important that consumer

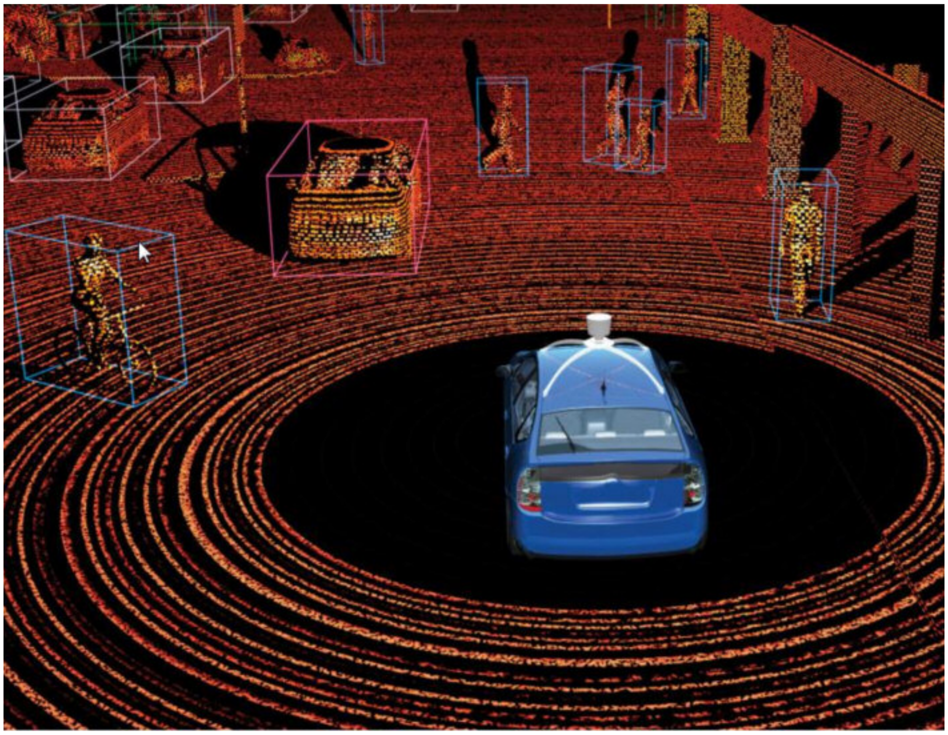

Figure 3: How a Google self-driving car sees the world.

lawyers not only understand what is happening, we need to inject ourselves into the policy dialogue that is going on largely without consumers having a voice in who will be held responsible when these systems fail.

Driverless technology's evolution

For anyone of my generation, the "baby boomers," this evolution brings to mind the movie "West World" where perfectly controlled robots, providing a life-like gunslinger experience, who were programmed such that they could never harm a human, malfunctioned and began wreaking havoc and disaster assassinating the guests. If you don't get the West World reference, it too, like Woody Allen's "Sleeper," came out in 1973. Google it and get a taste of how primitive our view of the future was.

To those who say "this will never happen," I just point to the moon. Indeed, driverless technology is most likely already creeping into your car in the form of lane assist, adaptive cruise control, ABS, back up sensors, automatic braking if an object is behind your reversing vehicle, fatigue warnings, heads-up displays and automatic park assist. We have gone from the relatively primitive technology of blind spot warnings to vehicle perception of not only shapes, but types of objects: people, dogs, bicycles, and their predicted movements (See Figure 3).

Self-driving cars are now allowed in Nevada, Florida, Michigan, California, and the District of Columbia, at least for testing purposes. States like Texas, Arizona, New Hampshire and Wisconsin have rejected autonomous car laws, and many states are considering their options right now.

Florida, Nevada, California and Michigan require that the operator of the autonomous vehicle being tested is an employee, contractor, or other person authorized by the manufacturer. Florida, Nevada and Michigan do not require a driver-license endorsement or specific permit to operate an autonomous vehicle. California requires the driver to hold a test vehicle operator permit.

In Nevada, operation is restricted to predetermined highways in limited geographic locations. That's not the case with the other states and here in California, where we have had more driverless miles racked up than probably anywhere else on the planet.

The California law today

The California experiment has perhaps been the most deliberate and thoughtful to date. The DMV conducted two public workshops in 2013 which led to the creation of autonomous vehicle regulations which were adopted on May 19, 2014 and became effective on September 16, 2014.

Pursuant to Cal. Vehicle Code section 38750, an "Autonomous Vehicle" means any vehicle that has integrated into that vehicle technology that has the capability to drive a vehicle without the active physical control or monitoring by a human operator. Section 38750 requires that a manufacturer seeking to test autonomous technology on California roadways obtain a permit which can only be issued if the manufacturer certifies that; (A) The autonomous vehicle has a mechanism to engage and disengage the autonomous technology that is easily accessible to the operator; (B) The autonomous vehicle has a visual indicator inside the cabin to indicate when the autonomous technology is engaged; (C) The autonomous vehicle has a system to safely alert the operator if an autonomous technology failure is detected while the autonomous technology is engaged, and when an alert is given, the system shall do either of the following: (i) Require the operator to take control of the autonomous vehicle, (ii) If the operator does not or is unable to take control of the autonomous vehicle, the autonomous vehicle shall be capable of coming to a complete stop

and; (D) The autonomous vehicle shall allow the operator to take control in multiple manners, including, without limitation, through the use of the brake, the accelerator pedal, or the steering wheel, and it shall alert the operator that the autonomous technology has been disengaged. Additionally a manufacturer must demonstrate that they have a system which will capture and store all data, in read-only format, for 30 seconds preceding any collision.

Prior to the start of testing in California, the manufacturer performing the testing must obtain an instrument of insurance, surety bond, or proof of self-insurance in the amount of $5 million. (Other states don't have an insurance requirement any different than their minimum policy levels.)

As of October 31, 2014, the DMV had issued Autonomous Vehicle Testing Permits to the following entities: Volkswagen Group of America, Mercedes Benz, Google, Delphi Automotive, Tesla Motors, Bosch and Nissan. It is the Delphi Automotive vehicle, fitted to an Audi, which recently drove across America. Google has racked up some 700,000 miles of autonomous driving.

Who is the operator?

Accountability for injury or harm caused by a vehicle has traditionally been levied at the "operator." So, the question is: who is the "operator" of an autonomous/driverless car? Vehicle Code section 38750(a)(4) states that an "operator" of an autonomous vehicle is the person who is seated in the driver's seat, or, if there is no person in the driver's seat, causes the autonomous technology to engage. Under current law it is an agent or employee of the manufacturer who will cause the technology to engage; therefore, for the immediate time being identifying the responsible party is straightforward. However, Vehicle Code section 38750(e)(2) contemplates approval of driverless cars (operating without the need for, or ability of, a driver and/or controls that could be manually operated) within as little as 180 days after the legislature had been "advised" by the developers and/or manufacturers of their desire and intent to do so. (As stated more fully below, Google appears ready to proceed.)

A disturbing trend amongst the majority of states permitting variations of the autonomous vehicle is a grant of immunity to manufacturers when systems for autonomous operation are installed as "after-market parts."

For example, Florida's law states:

> [t]he original manufacturer of a vehicle converted by a third party into an autonomous vehicle shall not be liable in, and shall have a defense to and be dismissed from, any legal action brought against the original manufacturer by any person injured due to an alleged vehicle defect caused by the conversion of the vehicle, or by equipment installed by the converter, unless the alleged defect was present in the vehicle as originally manufactured.

This blanket immunity is being adopted in other states and the District of Columbia. As automakers are partnering with technology providers to promote conversion of their vehicles to various states of autonomous mode, this immunity presents a significant moral hazard. Vehicle manufacturers, knowing that their vehicles will be converted, who create means and methods for adaptation, but who do not offer the features as OEM options, will claim immunity from the installation of devices that they have made attractive to purchasers. They will have no incentive to make the interface safer for their customers. The immunity is too broad and ill-defined as it is unclear whether the use of a software download, from a third party, into a vehicle's operating system would act to trigger immunity.

So far, in California, the immunity efforts have been thwarted by members of the Attorney's Information Exchange Group (AIEG.) Christine Spagnoli, an active leader in that organization, has informed me that AIEG is monitoring developments on a national level. The Consumer Attorneys of California (CAOC) is monitoring legislative developments locally.

No more red lights

A fascinating outline of the development of the driverless car, conflicts with Detroit, and a view into the future can be found in an article entitled "Inside Google's Quest to Popularize Self-driving Cars (Popular Science, September 2013, www.popsci.com)." The author, Adam Fischer, states "[i]n our self-driving future, not only would traffic jams become a thing of the past, every stoplight would also be green." Indeed, A 2012 Institute of Electrical and Electronics Engineers (IEEE) study estimates that widespread adoption of autonomous-driving technology could increase highway capacity five-fold, simply by packing traffic closer together.

Peter Stone, an artificial-intelligence expert at the University of Texas at Austin, thinks that intersecting streams of automated traffic will essentially flow through one another, controlled by a new piece of road infrastructure – the computerized intersection manager. He states that average trip times across a typical city would be dramatically reduced "[a]nd once you have these capabilities," says Stone, "all kinds of things become possible: dynamic lane reversals, micro-tolling to reduce congestion, autonomous-software agents negotiating the travel route with other agents on a moment-to-moment basis in order to optimize the entire network."

The V2V model from NHTSA

One model for the future is the vehicle to vehicle (V2V) approach whereby on-board dedicated short-range radio devices are used to transmit data regarding vehicle speed, direction, braking, etc., between vehicles (See Figure 4).

The National Highway Transportation Safety Administration (NHTSA) has declared regulatory jurisdiction over implementation of V2V technology into vehicles and trucks pursuant to the 1966 National Traffic and Motor Vehicle Safety Act.

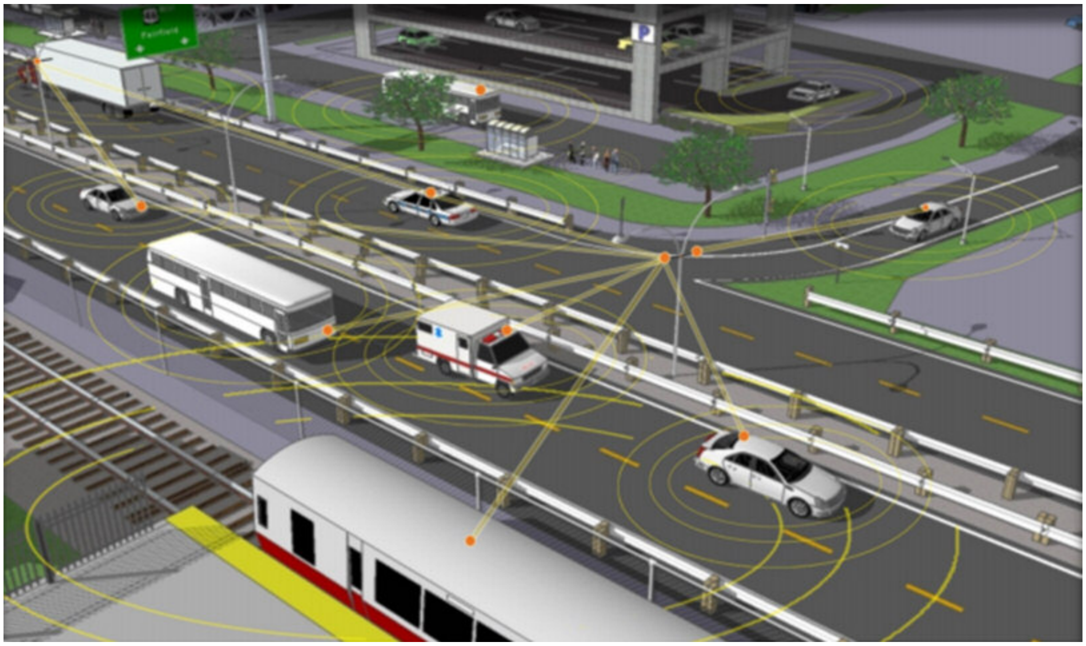

Figure 4: V2V Technology Model: Vehicles "talk" to each other and exchange vital information. Source: NHTSA Study, August 2014

NHTSA began its investigation into automated transportation in 1990 when it created the Intelligent Vehicle Highway Systems (IVHS) concept, which was later renamed as the Intelligent Transportation System (ITS). NHTSA created that ITS project stating that "the overall precept was that new transportation efficiencies could be found if current infrastructure could be married with advanced technology."

NHTSA, in its August 2014 Study entitled Vehicle–to-Vehicle Communications: Readiness of V2V Technology for Application (NHTSA V2V Study), outlined the federal government's vision of technology and transportation. Make no mistake; it is not an "if" but "when" scenario that NHTSA presents. One application cited in the study is Intersection Movement Assistance (IMA). IMA warns the driver of a vehicle when it is not safe to enter an intersection due to a high probability of colliding with one or more vehicles at intersections both where a signal is present (a "controlled" intersection) and those where only a stop or yield-sign is present (an "uncontrolled" intersection).

In Figure 5 on next page, the truck and sports utility vehicle are at risk of colliding because the drivers are unable to see one another approaching the intersection and the stop sign is disabled. Both drivers would receive warnings of a potential collision, allowing them to take actions to avoid it.

The price tag

Forward collision avoidance, blind spot warnings and lane assist technologies in V2V technology are similar to those found in many cars today with the exception that V2V systems would provide those benefits over a greater distance because of the technologies' ability to communicate beyond line-of-sight limitations caused by systems reliant on cameras and radar.

NHTSA currently estimates that the V2V equipment and supporting communications functions (including a security management system) would cost approximately $341 to $350 per vehicle in 2020. It is possible that the cost could decrease to approximately $209 to $227 by 2058 as manufacturers gain experience producing this equipment. These costs would also include an additional $9 to $18 per year in fuel costs due to added vehicle weight from the V2V system.

NHTSA estimates that as many as 81 percent of light vehicle crashes could be eliminated by integration of these technologies and that a fully mature V2V system could annually address about 4,409,000 police-reported or 79 percent of all vehicle target crashes, 4,336,000 police-reported or 81 percent of all light-vehicle target crashes, and 267,000 police-reported or 81 percent of all heavy-truck target crashes.

Lives saved, injuries avoided

NHTSA estimates that just two of many possible V2V safety applications, IMA (Intersection Movement Assistance) and LTA (Left Turn Assistance), would, on an annual basis, potentially prevent 25,000 to 592,000 crashes, save 49 to 1,083 lives, avoid 11,000 to 270,000 injuries, and reduce 31,000 to 728,000 property-damage-only crashes by the time V2V technology spreads through the entire fleet.

V2V systems are also predicted to have significant impacts on reducing congestion and improving fuel economy through a practice referred to as "platooning." In Volvo's platooning autodrive, its cars autonomously follow a professional driver in a lead car using

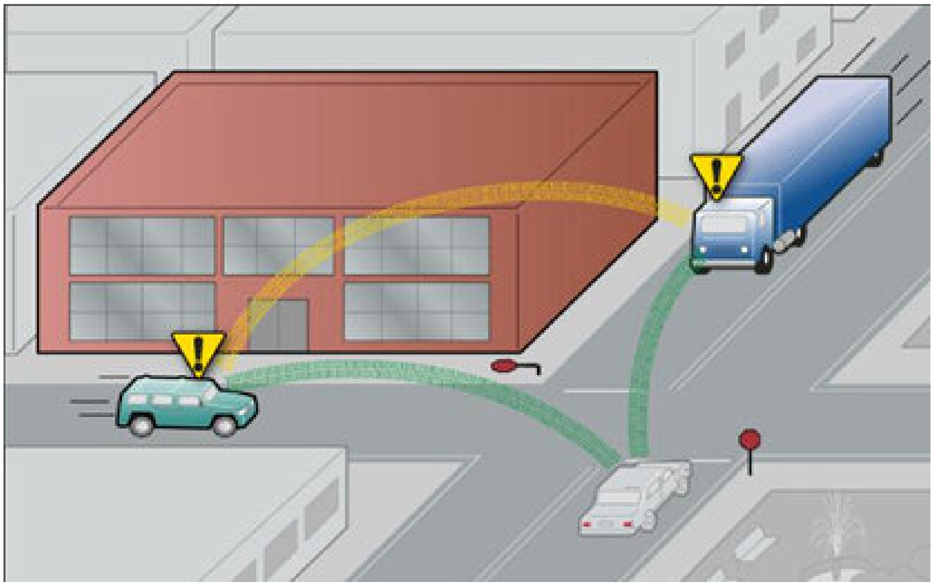

Figure 5: Truck and SUV at risk of collision because drivers cannot see each other. Source: NHTSA Study, August 2014

technology already built into every high-end Volvo sold today. The V2V communications standard soon to be announced by NHSTA would, at least in theory, enable all makes and models to platoon. Use of Lidar, a remote sensing technology that uses laser to illuminate a target and analyze the reflected light, is projected to eliminate the need for a lead driver.

Compared to a robot, you're a terrible driver

According to a September 2012 article written by Evan Ackerman in "Spectrum," the IEEE periodical, automation will result in higher efficiencies and reduced congestion.

Ackerman states that:

> [o]n a highway filled to capacity by human drivers (which is about 2,200 vehicles per hour per lane), about five percent of the available road space is taken up by cars. Five percent. This is because humans are so bad at driving that we need lanes that are twice the size of our cars, and at highway speeds, we have to keep between 40 and 50 meters away from the car in front of us.

Ackerman cited research being done at Columbia which purportedly determined that "if all vehicles on the road are equipped with both adaptive cruise sensors and communication, capacity can be increased by a factor of 3.7. And this increase is without any infrastructure modification: it's purely from making our cars smarter with technology that is commercially available today."

Ackerman sums it all up, saying:

> You're a terrible driver. Yes, you. Terrible. At least, you're terrible compared to a robot, which is smarter, faster, and more experienced. In fact, if we all just give up driving on highways and let robots take over for us, we could effectively end highway congestion as we know it by boosting the capacity of our existing roads by a staggering 273 percent.

That is the V2V model.

The V2I Model

In addition to V2V systems, NHTSA is investigating a Vehicle to Infrastructure (V2I) system which would have vehicles talking to a communications infrastructure rather than directly to each other. The infrastructure would then coordinate the movements of multiple vehicles traveling over its grid. According to NHTSA, "V2I communications involve the wireless exchange of critical safety and operational data between vehicles and roadway infrastructure. V2I communications are intended primarily to avoid motor vehicle crashes while enabling a wide range of mobility and environmental benefits."

Currently, the government is funding V2I projects in development and testing. V2I technology is focused on providing warnings to motorists of things such as red lights, stop signs, bad weather conditions, approaching curves and construction zones and other predictable features so that motorists can alter their driver behavior. Although NHTSA speaks about these systems not as autonomous but, instead as "warning devices," it appears this is done in an attempt to progressively introduce the idea to both reduce driver anxiety and manufacturers' concerns.

The DOT in conjunction with state and local agencies is implementing test beds in Michigan, California, Arizona, Florida, New York, Virginia, and Minnesota to analyze V2I and V2V communications systems. The goal is national interoperability of systems. Currently NHTSA's research and development of V2V and V2I programming and infrastructure is being funded by Congress's annual allocation of $100 million for Intelligent Transportation Systems development.

Tort law – roadblock to development?

With NHTSA's regulatory role expected to be considerable, it is anticipated that private enterprise will seek to claim that the states are pre-empted from creating their own set of laws governing development and implementation of driverless vehicles. Some have even called for an immunity of the type provided to vaccine manufacturers claiming that enormous life saving benefits derived from autonomous technology justify the

elimination of traditional tort liability against the manufacturers. Articles in scientific, legal journals and the popular press are already claiming that issues of tort liability will create a "roadblock" for development of autonomous vehicles. As of now, NHTSA has undertaken no regulation that could be considered preemptive.


Dolan

Chris Dolan is the owner of the Dolan Law Firm with offices in San Francisco, Oakland and Sacramento. He has been widely recognized for his excellence in trial advocacy, receiving the Consumer Attorneys of California Trial Lawyer of the Year Award, the Edward Pollock Award for service to the Plaintiff's Bar, the SFTLA Trial Lawyer of the Year Award, The Chief Justice's Award for Contribution to the Courts, and the SFTLA Civil Justice Award. Chris is rated AV Preeminent by Martindale Hubble, has been designated as one of the Top 100 Lawyers in California by the Daily Journal, is named as one of the Best Lawyers in America, and has been a Top 100 Super Lawyer for over a decade. He currently serves as president-elect of the San Francisco Trial Lawyers Association.

Next month
– Liability could be roadblock for driverless cars