The Range of Policy and Legislative Issues Surrounding Autonomous Vehicles in America

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Introduction

Self-driving cars, Autonomous Vehicles (AV's), or Driverless Vehicles are all cars that can drive with the absence of human input to some degree. According to SAE's classification system, there are six levels of autonomy, ranging from zero autonomy (NAV's) to full autonomy (SAE, 2017). The issues involving autonomous vehicles are most contentious for vehicles that fall into categories 4 and 5, but it is important to understand the range of autonomy available to cars in order to appreciate the options available to law makers. The upper range of features offers leaps of capability to normal cars.

Self-driving cars are a burgeoning field in automotive industries and are becoming more and more popular, while the autonomous car manufacturers and inventors are seeking more and more autonomy. With pledges from many of the top car companies operating in America, companies are making a mad scramble for the automated car market (insideEVs.com, 2017). They could take over the road as we know it, transitioning to a safer and more efficient system. The legislation should be preemptive in creating laws and regulations regarding AV's, but doing so is not easy.

Self-driving cars are not an ethically straightforward issue. The question of who assumes liability when an accident occurs is one of special complexity since the driver is no longer in control of the vehicle's actions. This diverts responsibility to a number of potential parties. The manufacturers are responsible for making sure that the cars have been designed and tested well, but too much responsibility could stifle interest by companies. Liability on the owners or passengers could become morally indefensible if the passenger has no ability to intervene before a collision or accident, and public distribution of liability could sour public appeal. The question of liability differs when looking at different levels of autonomy, ranging from zero autonomy to full autonomy, depending on the activity and capability of the on-board systems.

Automated vehicles' monitor the environment, make decisions, and execute maneuvers. Lidar, Sonar, and Radar are all currently employed in AV's on the road to take in information about the environment around them, and of course digest the information about the car's systems states (Ashkay, 2-15). Computer algorithms then take that information and make complex decisions about which maneuvers to execute. Such system raise questions about security and privacy. Since have control of the car's acceleration, braking, and steering systems, they can have full control over the car, thus giving them the title of autonomous cars and offering consumers a more leisurely and perhaps safer drive.

Self-driving cars have the potential to offer consumers a safer, more efficient and more convenient car than normal cars. The on-board computers can potentially monitor and communicate with other cars using sophisticated communication systems and monitoring devices, but it can also eliminate human error. Thanks to this communication, it is plausible that stop lights could be replaced with systems on-board that organize and orchestrate multi-way crossings. Thus eliminating the need to make a full stop, and or wait for a green light. Increasing overall transportation efficiency could see it's effects in the economy. Self driving cars can also add convenience in that it can drop you off at work and drive home. This eliminates the need for large redundant parking lots in some cases, like at airports. Though the potential benefits of AV's are driving technology and innovation, there are also drawbacks.

Like all systems across all industries, automation drives workers out of jobs that once necessitated human workers. Taxi drivers are especially at risk of losing their jobs to automation, with talks of implementing AV Taxi services. Singapore is in the process of developing such a system as are companies in the U.S.(Fleetwood, 2017). Although the benefits and drawbacks of self driving cars are many, the technology is not yet fully realized. This provides time to prepare for such technology by making legislation.

The legislation that exists for vehicles on the road is not designed for AV's. The NHTSA and other governmental bodies which regulate on-ground transportation vehicles for use on public roads do not yet fully regulate AV's to the extent that they regulate NAV's. Only a fraction of States in the U.S. have passed state legislation, some of which provides research grants, and some of which provides regulations and guidelines.

Classifying a Vehicle by Autonomy

According to SAE's international standard of classification of vehicles according to autonomy, vehicles fall into six levels. This ranks vehicles according to the whether a car has control of execution of steering and acceleration/braking, monitoring of environment, whether the fallback performance of the *dynamic driving task** is to a human, and the number of modes of system capability(SAE, 2017). The six levels are largely divided between levels 2 and 3, where the car takes on a significant amount of automation.

Levels 0-2 rely on human monitoring of the environment, while providing varying levels of assistance with braking, steering and acceleration. Level 0 provides no full time assistance with the dynamic driving task and is not considered autonomous regardless of warning or momentary intervention systems(SAE, 2017). Level 1 systems provide either steering or acceleration/deceleration assistance but relies on the human for all other tasks(SAE, 2017). Level 2 systems provide assistance with both steering and acceleration/deceleration but rely on the human for all other tasks(SAE, 2017). The remaining levels are largely recognized a AV's in this effort for common definitions among industries.

Levels 3-5 may rely on the car's on-board monitoring systems for monitoring the environment. Level 3 cars remain autonomous but expect the driver to intervene upon request (SAE, 2017). Level 4 cars are expected to be able to remain autonomous whether or not the human responds to a request to intervene (SAE, 2017). Level 5 cars are fully autonomous and can perform under all circumstances in which a human can perform. Modules for human input are no longer necessary at level 5, but can be present.

When discussing autonomous vehicles and NAV's, the distinction is usually drawn between the 2nd and 3rd level. Creating legislation cannot be separated from its need to consider the distinctions between levels of automation as will be seen in later sections.

**Dynamic driving task is the continuous operation of the car for lane changes, turns, stops, and use of signals etc(SAE, 2017)*

Autonomous Vehicles as a New Consumer Product

Although SAE level 3 cars are on the road in limited numbers, but there are currently none available to consumers. That may change in a short time. A number of car manufacturers such as GM, Ford, Honda, and Tesla are investing heavily in self driving cars and have made pledges to put them on the road within the next 3-5 years (Fagella, 2017). Ford is investing $1 Billion into its automated car department, partnering with artificial intelligence firm, Argo AI to develop a fully autonomous vehicle by 2021 ("Ford Invests in Argo AI . . . ", 2017). In January 2017, Tesla CEO, Elon Musk implied that an autonomous vehicle of at least level 3 would be operable by the end of 2017 (Fagella, 2017). Ford President and CEO, Mark Fields stated, “The next decade will be defined by the automation of the automobile, and autonomous vehicles will have as significant an impact on society as Ford’s moving assembly line did 100 years ago,” ("Ford Invests in Argo AI . . . ", 2017). If car automation will have this significant of an impact, and in this short a time, car companies can be expected to scramble to meet the demand for such vehicles. In fact, consumers have already shown an appetite for autonomous vehicles.

Tesla is known for their innovative autonomous driving technology and this technology has made them more popular with consumers. The car company sold 59,228 Tesla Model S units in the U.S. since September 2015, when it introduced autopilot features to consumers, to September 2017 (insideEVs, 2017). This precipitous jump is clear in 2015 2nd and 3rd quarterly global sales of 11,532 and 11,597 respectively, to 4th quarter sales of 17,272 at the release of autopilot features ("Tesla Fourth Quarter & Full Year 2015 Update.", 2017). As of 2016, the Tesla Model S is the best selling upper luxury vehicle in the U.S. (Murphy, 2017). Autopilot features make cars more appealing to consumers and this is evidence that they have an appetite for this new technology. As consumer demand grows, legislation needs to aim to keep up with autonomous car technologies.

Liability for Accidents involving Autonomous Vehicles

In the matter of liability, AV's differ from conventional vehicles. That liability for AV accidents should fall on manufacturers, private consumers, or the public are equally plausible at this point.

Should too much liability should fall on manufacturers, there would be less incentive to enter the industry at all, and could scare away innovation in the field. Manufacturers of autonomous vehicles are ultimately responsible for the final product that ends up on the road. This means that the safety procedures of the vehicle are already set electronically and mechanically when the accident happens. Too much weight put on the responsibility of the manufacturer would likely end corporate interest in the industry. However, responsibility on the manufacturer supplies large incentive to highly develop safety features. On the other hand, if the manufacturers are not held responsible for accidents, there is less incentive to spend money developing safety features. According to Hevelke, this can provide a moral incentive to the government to implement laws which balance these two goals (Hevelke, 2017).

If liability falls on the consumer and owner of the vehicle, this implies that the consumer must be responsible for intervening when an accident is about to occur. Thus, this applies well to SAE levels

3 and 4, but not well to 5. Intervening before an accident would necessitate that the driver pay attention at all times, vigilant to the car's need for assistance. When a car asks that the passenger takes over control of the car, the passenger must be seated in a driving position and have immediate access to controls. It is also uncertain whether the passenger would have enough time to react with human reflexes to a call to make evasive maneuvers, placing unfair blame. Therefore, it can be morally wrong and defamatory to place blame on a person who has not had any real chance of performing such a duty(Hevelke, 2017). If a consumer was held responsible for an accident in a car that had no human-input controls, it would be also be defamatory, thus almost eliminating plausible consumer liability for fully-autonomous cars (Hevelke, 2017).

Putting consumers at risk for liability in accidents in fully autonomous cars would undercut some of the biggest advantages of AV's, such as enabling blind or disabled passengers to drive alone; further discussed in later sections, but fully autonomous cars are where some of the most interesting moral discussions take place. Level 5 AV's must make moral decisions during times when a collision is inevitable. For instance, if the car's braking system is unable to stop the inertia of a car in time to avoid hitting either a doctor crossing the street, or a burglar on the sidewalk, supposing it can identify this decision, it must decide which to make. Further, if the car were able to save the passengers of it's own car by striking another car or group of pedestrians, the parties involved would likely make different decisions over which the car should make.

For a utilitarian algorithm model, a car should decide to sacrifice its own passenger if it can save the lives of multiple pedestrians or other parties exterior to the vehicle. A utilitarian approach seeks to do the least harm possible in order to do the greatest good to the largest number of people. In this case, an example is the commonly discussed situation in which a train is approaching a fork in the tracks. On one side, there are five people tied to the track and going that way would kill all of them. On the other side of the fork, there is a single person tied to the tracks and going that way would kill him or her. Suppose that a decision must be made to pull a lever which will steer the train in on of the two directions and there is no other plausible course of action. The utilitarian approach would dictate that you kill the single person. This is a possible scheme for designing AV algorithms.

However, consumers are tentative about entering a vehicle that is designed to sacrifice them instead of the other party. A study by Bonnefon, Shariff, and Rahwan found that on a scale of 1 to 100, consumers were a median of 50 when asked how likely they were to buy a AV with self-protective measures to a median of 19 to buy an AV with self sacrificial measures (Bonnefon, 2016). With a rather low score of 50, consumers still show a significant preference for utilitarian AV's, but are unlikely to buy an AV that would sacrifice them or their co-passenger (Bonnefon, 2016). The utilitarian option puts consumers between a rock and a hard-place so to speak when it comes to AV's. There are, however many ways to approach AV software algorithms.

Of many positions presented by De Sio, there are obligatory, and necessary positions AV manufacturers could plausibly take (De Sio, 2017). One possible outcome is that if AV's function like a ship in that the sailors are obligated to provide for the safety of the passengers, even sacrificing their “lives” by obligation, that obligation would make manufacturers beholden to the lives of the passengers of the car, perhaps even providing a license to kill innocent bystanders by way of necessity, the way a doctor might sacrifice a single conjoined twin in the interest of the stronger of the two (De Sio, 2017). Human-human decisions aside, algorithms also make decisions about objects. An algorithm would be likely to be obligated to destroy an object over a human. Automated vehicles could be programmed to decide which objects to destroy. The incommensurability of objects makes this a problem for programmers who must decide which object to crash into, the ancient temple, or the truck full of Picasso paintings (De Sio, 2017). Fully autonomous vehicles can take on metaphorical roles within society and there is almost nearly limitless interpretations therein. The systems on-board AV's and their role in self-operation help to focus debates of this kind.

How Autonomous Vehicles Work

When making policies about AV's it is important to keep track of the technology that makes autonomy possible. Regulations should also consider how an autonomous car goes mechanically and electrically and be aware of the implications of these devices. Autonomous cars makes use of sensors and other devices which monitor the environment, and they use this information to make decisions and execute driving maneuvers. When new technology is introduced to collect information, there are certain privacy concerns that are introduced. Law makers should consider these.

Autonomous Vehicles use lasers, sound, cameras, and radio waves to sense the environment around them, as well as countless sensors that measure on board systems. Lasers are sent out by the vehicle in many directions and the vehicle reads the signals that bounce back, giving information about the distance of the objects it strikes (Ashkay, 2015). Sound is also used in Ultrasound-like systems which use acoustic location to find objects around the vehicle (Ashkay, 2015). Cameras can be used in conjunction with neural network software to identify, road markings to stay in-lane, and other obstacles like in the Tesla models ("Autopilot", 2017). Radio waves are used in RADAR systems which send and receive radio waves to identify objects (Ashkay, 2015). Tesla's RADAR technology can find objects as far as 160 meters away ("Autopilot", 2017). Since it can likely be assumed that AV's will have wireless communication devices, it is important to understand the privacy rights of individuals who use the on-board cameras while driving on private property, as well as understanding what kind of information might be extrapolated from data collected by non-camera systems. The accuracy of these devices may come into conflict with how much information consumers want their cars to collect. The monitoring of the environment is of course unnecessary unless the car is also driving.

Automated vehicles use this environmental-spacial information to execute maneuvers. It is entirely possible that with the help of sophisticated software, the maneuvers that cars can make will be very different from the driving style of current vehicles. Road and highway infrastructure could be altered to accept a more sophisticated set of maneuvers. This set of maneuvers may need to be limited in order to ensure that fugitives or other actors can not use them to their advantage. Automated vehicles hold lots of potential, but law makers should pay attention to what automated vehicles are capable of and where the limits are.

Advantages and Disadvantages

With new technology, there will be new advantages and disadvantages to consider. Automated vehicles offer automation technology to a massive sector. This holds both many advantages and disadvantages, which are important to consider when making new legislation.

Automated Vehicles offer lots of advantages to an average driver. Not having to drive gives more time to work or relax. Driving on the highway is often a long and arduous process for drivers, but automation would allow them to read a book, take a nap, watch a movie, or get some work done. The possibilities are endless for passengers. Overall, the time once spent driving could now be dedicated to other things, allowing people to be more productive. A parent can send the car to deliver his or her kids to school instead of taking the time to do it themselves. This would no doubt have a positive effect on the economy. Automation also provides a huge advantage to disabled or elderly consumers.

A major advantage of automated driving is that disabled people like the blind can have a lot more autonomy themselves. They do not have to call a taxi or have a friend or family member drive them to their destination. Otherwise disabled peoples have a similar advantage in that they may not have the capabilities to drive a normal car, but automated vehicles provide them with greater autonomy. Beyond this advantage, there is much to gain from the added safety and efficiency of AV's.

With around 30,000 road deaths in the U.S. in 2016, vehicle safety is a matter of public health. With driver error being attributed to about 94% of fatal crashes, that fatality number could be reduced about that much, given that automation eliminates human error (National Highway Traffic Safety Administration, 2015). Advances in automation stand to increase road safety, a big issue in public health. Public health is connected to environmental health through pollution and other means, a problem that can be reduced through better efficiency.

Communication between cars' computer system would mean that automated vehicles can talk to each other at intersections (Ackerman, 2016). Traffic lights at intersections are put in place to avoid accidents between humans who do not have the capabilities to cooperate at significant speeds. This communication between cars would make intersections more efficient (Ackerman, 2016). This system, however would force human drivers off the road as they would be unable to make the necessary communications to enter the system.

Automated cars reduce the need for parking spaces. Often, cars sit unused in parking spaces, unavailable to anyone who is not at the current location of the car. This problem is solved because cars can now drive home or elsewhere on their own, both reducing the need for redundant parking spaces and the need for multiple cars within families.

Finally, automation would allow professions that once employed human drivers, such as Taxi drivers, truck drivers, and postal delivery men to do the job without payed workers. There are already programs in development to have automated Taxi drivers. In 2016, Uber established the Advanced Technologies Center in Pittsburgh, Pennsylvania and began testing self-driving Taxi's with a backup driver (Fleetwood, 2017). Trucking companies would no longer burdened with workers who have to sleep and rest, they can have trucks drive 24/7. Also in 2016, Otto, an Uber company sent a delivery of beer from Fort Collins to Colorado Springs, Colorado, by automated truck (Hassler, 2017). This is an issue that is not unique to the driving industry. Automation has its advantages in all kinds of industries, and in all kinds of industries it is seen as both a blessing and a curse. Though jobs for truck drivers may disappear, it must be said that truck driving is grueling work, and some companies report a 300% employee turnover rate (Samuels, 2017).

This automation of worker positions is also the principle disadvantage of driverless cars. Not only would, professional drivers would have to move to other areas of work, but you would lose the human ability to, in the case of Taxi drivers, interpret the directions of people who don't know the exact address of their destination, or only have a picture of it. The disadvantages should also be considered while making new legislation.

Another disadvantage is an automated vehicle's vulnerability to cyber-attacks. Highly advanced communication and computer systems aboard autonomous vehicles may be more vulnerable to outside control due to close connection between online computer systems and the car's direct controls. This means that greater security provisions are needed in order to operate a car.

Current Legislation

The technology that exists in the market is already affecting legislation in the U.S., and several states have passed legislation related to autonomous driving.

The U.S. senate recently introduced a bill call the American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act (U.S. Senate, 2017). This bill, among other things, aims to work with the Department of Transportation and manufacturers to implement standards for safety and better cybersecurity, better inform the public about automated cars, and prevent the denial of licenses to those with disabilities to drive a fully automated car (U.S. Senate, 2017).

There have been a number of state laws passed in the U.S.. Of the fifty states, twenty one have implemented legislation for autonomous vehicles (National Conference of State Legislatures, 2017). Nevada was first to authorize autonomous vehicles, in 2011 (National Conference of State Legislatures, 2017). Many of the other twenty states have since authorized testing and operation of AV's (National Conference of State Legislatures, 2017). Michigan enacted legislation that gave manufacturers immunity when an AV's automated driving system is altered without their consent, and for mechanics who work on them (National Conference of State Legislatures, 2017). This reflects some of the similarities between AV legislation and NAV legislation. Pennsylvania has allowed the use of allocated funds of up to $40 million on research and development of automated driving systems (National

Conference of State Legislatures, 2017). Law makers are making good progress and keeping up with advancements in technology in many respects.

Law makers should stay vigilant to the new technologies and issues that come from automated vehicles and build on the progress they have made.

Conclusion

Driverless cars introduce many issues that were not present in the age of non-autonomous cars. The legislation is similar for both in some regards, but necessitates lots of new legislation in most. Cars with automation technology are growing more popular with consumers and are becoming more autonomous. This brings issues such as liability, privacy, security, advantages and disadvantages, and legislative shortcomings.

The popularity of automation technology in cars is growing and so is the technology. Companies like Tesla are leading the charge, with most companies eager to implement their own. Consumers have proved that their appetite for the technology is already there.

Liability becomes a problem when you extract the human driver from an accident scenario. Where to place blame after an accident becomes more complex, and an answer to this problem may not be easy to come by. This is a problem for both consumers and manufacturers.

Privacy and security become concerns as more and more computer technology is put into cars. Cameras and sensors collect information about the environment around them, while online system that control the car raise concerns about cybersecurity. Consumers and legislators should be aware of these concerns, and act accordingly.

Advantages in the health, private, and economical sectors are what make autonomous vehicles attractive, while disadvantages for people in professional driving jobs, and cybersecurity vulnerabilities bring up problems. Driverless vehicles could save lives by giving over control of the vehicle to computers, while also providing more leisurely and convenient car travel. The efficiency of driverless cars could cut down on driving time and greenhouse emissions, giving economical benefits as well as environmental ones.

Driverless cars introduce an entire category of laws that have yet to be defined or introduced. Legislators will have to work fast to build on what they have done, which is considerable, and keep up with new technology.

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