# How Autonomous Vehicle Policy in California and Nevada Addresses Technological and Non-Technological Liabilities

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Automobile innovation has made major strides in the last 100 years as we have gone from the Model T to 500 horsepower supercars. However, some things haven't changed over time. *As discussed by Professor Bryant Walker Smith*, similar to today, people in 1907 negatively referred to their vehicles as, "[an] auto, autocar, car, machine, motor, motor car, and other terms equally as common but neither complimentary nor endearing." Motorists were considered in low regard and referred as "brutes," "fat-headed marauders," "honking highwaymen," and "flippant fool[s]" who wrote themselves "down both a devil and an ass." The automobile scholar Claude Berry finishes the passage saying, "One hopes the horseless carriages of the future will earn monikers that are more flattering."

However humorous this quote may be, it still holds a great deal of accuracy and truth to the automobile situation today. For the great majority, driving is a mundane activity that brings out the worst in drivers, and the car has transformed from a symbol of power from its heydays in 1950 to a contraption that is both a time sink and danger to our lives. Technologically, autonomous vehicle software is leaps and bounds beyond the policy and legal considerations, and there is a possibility to craft technology policy to advance the technology instead of hindering it.

This paper examines the technological and non-technological liabilities of autonomous vehicles, as well as policy aspects of robocars, using the Google self-driving car as an example. Self-driving cars have the potential to reduce the number of accidents and associated deaths and economic losses, but only if they are highly reliable. The possibility of software bugs, other technical problems, and associated liability and insurance issues raise barriers to the use of these vehicles. The State of Nevada has adopted one policy approach to dealing with these technical and policy issues. At the urging of Google, a new Nevada law directs the Nevada Department of Motor Vehicles (NDMV) to issue regulations for the testing and possible licensing of autonomous vehicles and for licensing the owners/drivers of these vehicles. There is also a similar law being proposed in California with details not covered by Nevada AB 511. This paper evaluates the strengths and weaknesses of the Nevada and California approaches, in light of the technical and legal challenges currently facing these new autonomous vehicles. Ultimately Nevada AB 511 and California SB 1298 do not effectively reduce either the technological or non-technological liabilities, but rather set the foundation for future policy for which I make recommendations.

## Importance of Autonomous Vehicles

Traditional driving is a costly practice in terms of lives, money, time, pollution, and real estate. In 2009 alone, there were 35,900 deaths due to automobile accidents, however in 1990, there were 46,800 deaths. Every year, Americans spend 230 Billion dollars to cover the costs of car accidents, accounting for approximately 2-3% of our entire GDP4. About 8% of our GDP is spent on the road in terms of opportunity cost of 1 trillion dollars from 50 billion hours wasted from people's time. Robocars could help curtail our dependence on foreign oil by limiting the amount of time spent in traffic by 6-8 billion hours, which could lead to a reduction of up to 6 billion gallons of fuel. Additional reductions could come about through ancillary benefits of promoting other alternative fuels such as ethanol or electric charging by being able to refuel when someone is at work.

From the technology side, robocars can go beyond simply automating a personal car but rather, provide radically new ways to approach transportation. We could build a new system of on-demand, cellphone-summoned robotaxis that can let one summon a specific vehicle for the trip to avoid driving around in a Yukon SUV individually. If someone has their own car, they could rent it out to other people and make money while it is not in use. Implementing some type of car share program would also lead to a reduction in the urban land devoted to the approximately 600 million parking spaces, estimated to be up to 10% of urban land in many cities. Autonomous vehicles could also change ground shipping dynamics by more effectively planning delivery routes instead of relying on humans to make real-time decisions. These aspirations are not as far-fetched as one might believe when looking at the current stage of the advanced technology.

## Technology Overview:

For a technological overview, let us focus on the Google Car. The heart of the system is a laser range finder mounted on the roof of the car. The device, a Velodyne 64-beam laser, generates a detailed 3D map of the environment by scanning more than 200 feet in all directions. Called LIDAR, it is currently costs $75,000 to purchase today, is accurate to 1 cm, has 64 lines of sight up to 50 meters for each one. The car then combines the laser measurements with high-resolution maps of the world, producing different types of data models that allow it to drive itself while avoiding obstacles and respecting traffic laws. The vehicle also carries other sensors, which include: four radars, mounted on the front and rear bumpers, which allow the car to "see" far enough to be able to deal with fast traffic on freeways. The third piece of equipment is a camera, positioned near the rear-view mirror, which detects traffic lights and helps the car's onboard computers recognize moving obstacles like pedestrians and bicyclists. The fourth and final piece of technology is the position estimator which is comprised of a GPS, inertial measurement unit, and wheel encoder, all of which help determine the vehicle's location and keep track of its movements.

Google relies on very detailed maps of the roads and terrain, which is essential to accurately determining where the car is. GPS-based techniques alone could be off by several meters, so combining GPS with Google Maps becomes a very powerful tool that overcomes the previous technological barrier. Additionally, Google engineers drive along the route one or more times to gather data about the environment, before having the self-driving car perform a road test. The autonomous vehicle compares the data it is collecting while it is driving to the previously recorded data on human driven tests to see if there are any discrepancies. This is useful to differentiate pedestrians from stationary objects like poles and mailboxes.

Google has pioneered a great deal of technology for the autonomous vehicle, but the current technology is far from perfect. There are two main problems with this technology. The first is from the recognition of the data from the camera, where the conversion of the visual data input to numbers output has its own issues. For instance, the camera can recognize objects from a far off distance, but it has trouble differentiating between two similar objects. Its only technological means to distill the difference is to compare with previously recorded human driven tests, which cannot model all the different possible situations.  This barrier to scaling can be troublesome because human driven tests can only measure so much, but Google is on the right path to address this issue by vigorously testing their vehicles.

The second technological issue is the issues of computers making cost-benefit decisions between different collisions. The speed of the decision, determined by the processing power of computers, does not pose an issue, but the final decision is what is contentious and has a wide range of implications. For instance, how would a computer react if a child ran into the street and in order to avoid hitting it, the car had to swerve into oncoming traffic and put the lives of the occupants in the car. This situation can quickly escalate when the car has many occupants in it, and the vehicle cannot be certain if the object running into the street is a dog or cat.  Determining the course of action relies on how much the car values it's own occupants versus the external world that is both a technological and legal issue that Google has yet to solve.

## Technology Liabilities: Artificial Intelligence

Despite all the innovation powered by Google, technological barriers remain. Trivial tasks for human drivers, such as recognizing an police officer or construction worker motioning a driver to proceed in an alternate direction, require a breakthrough in artificial intelligence that will lead to an improvement in cameras and decision making abilities by the computer. Even if intelligent cars could match human capabilities, there would be issues behind the reality of the road versus the theory. There are concerns with the driving "personality" of an autonomous vehicle, and it's "reservation system". When the car reaches an intersection, it will create a queue of when it should go compared to the other vehicles arrivals at the intersection. Queuing theory presents problems such as how to recognize bicyclists from other objects, and how the tendency of bicyclists can be different or the same as drivers in cars and other random objects that could cross the intersection like a cat or dog running into the street versus a child.

Another problem posed by the non-computer world is that human drivers frequently bend the rules by rolling through stop signs and driving above speed limits. How does a polite and law-abiding robot vehicle act in these situations? To solve this problem, the Google Car can be programmed for different driving personalities, mirroring the current conditions. On one end, it would be cautious, being more likely to yield to another car and strictly following the laws on the road. At the other end of the spectrum, the robocar would be aggressive, where it is more likely to go first at the stop sign. When going through a four-way intersection, for example, it yields to other vehicles based on road rules; but if other cars don't reciprocate, it advances a bit to show to the other drivers its intention.

## Technology Liabilities: Computer Bugs

Like all software systems, robocars will have bugs, and there will be the possibility of dangerous ones. There is a major software engineering challenge by getting consistent reliability of the cars. This will be much harder than getting them working in the first place. However, technology for robocars will be much better than a typical PC operating system and is getting better and cheaper thanks to Moore's Law.

Brad Templeton, a consultant to the Google Car, makes an analogy between autonomous vehicles and the Apollo Project. Space flights created one of the most reliable computing systems during its time, with 3 different computers programmed to do the same task by 3 completely different teams of programmers. When a decision is necessary, the programs get together and vote on what to do, usually agreeing with each other. There are times where one computer will disagree with the others, and this problem will be flagged even though the majority wins. If 1 system says there is a pedestrian in the road, and 2 do not, it will assume that there is a pedestrian there because of the potential adverse effects if it is wrong. The systems will go back later to explore this problem in more depth to see how the code can be improved to reflect the bug in just a single system. If Google implements this decision making process, it can help alleviate the issues posed by the technological deficiencies of the camera.

The variability in Operating Systems' (OS) can come from the 3rd and final computer which can be tailored to a specific region to more accurately reflect driving conditions.  This will help pioneer research for first movers into this technology as the Silicon Valley's research on local road conditions will provide spillover benefits to other OS's tailored to different regions of the world.  This diversity in codebases would provide extra protection against malicious attempts to hack the system, but it would also create different standards of safety across the vehicles. Although Google is using this 3 computer system architecture, it is unclear what types of OS's they are using and how much variation there is between the codebases.

## Full shutdown on bug discovery

When a product has a major safety flaw, there is usually a recall of the product.  Luckily, updating software is easy and can be done remotely such as through autoupdates for OS's. If there is a desire for a physical recall, it can take place in moments without the vehicle coming home and instead driving itself in for service when the owner is not using it. However, there is a time period between a problem being diagnosed and the car being fixed. In theory, one would disable the vehicle remotely and only start it back up when the problem is fixed. However in reality, this would be extremely disruptive to a person's life as they would have to tow their vehicle to the nearest mechanic or autonomous vehicle equivalent to solve the issue.

Google has not developed the technology to approach this problem, instead relying on the human driver to take control of the vehicle if there is ever a problem in their test vehicles. A possible path Google could take to approach this issue is to have different levels of shutdown for the vehicle depending on the bug. If it is a minor error, a simple warning light should come up just like in today's systems, but a bug that compromises the integrity of the system should lead to a shutdown of the autonomous system and require manual intervention until it is fixed.

## Computer attack

There will also be unpredictable technological risks, such as the potential malicious attack by terrorists. Future autonomous vehicles will rely heavily on GPS Satellite data and other systems that are vulnerable to jamming by hackers with malicious intents. The designers of autonomous vehicle systems should expect that the software in the car will be compromised, and should accordingly develop solutions to this problem.

Brad Templeton describes the solution in detail, describing how the driving system must be kept isolated from too many outside inputs and require a fail-safe "watcher" modules that are not connected to the outside world, and will stop the autonomous vehicle from doing dangerous activities. Software monoculture allows an attacker to discover a single flaw and suddenly attack millions of cars at once, but software multi-culture also has its own vulnerabilities as different code for different systems will lead to different levels of quality and security. Externally, Google has not posed any solution to these issues, but one possible solution is to strike a middle ground between monoculture and multi-culture. There could be variation in the codebases but not the OS's that execute the code, or vice versa, in a 3 computer system. Even the degree of multi-culture can be different, and to explore this solution in greater detail will require the technical expertise of a software engineer in Artificial Intelligence.

To address this issue we might look into the possibility of open source software. We have seen that open source has been a triumph in the space of browsers as Chrome and Firefox have claimed the majority market share of this area and roll out products that cater directly to user needs by having the users play an integral portion in its development. Open Source has even been successful in the context of Operating Systems where Linux has proven to be a viable alternative to Windows and Mac. Even Junior, Stanford's most recent autonomous vehicle, is run on an open source platform.

## Non-Technological Issues

Many have said that the technology in robocars is ahead of the current policy. According to Bernard Lu, senior staff counsel for the California Department of Motor Vehicles, he says that, "If you look at the vehicle code, there are dozens of laws pertaining to the driver of a vehicle, and they all presume to have a human being operating the vehicle." This can create particularly tricky situations such as deciding whether the police should have the right to pull over autonomous vehicles, a question yet to be answered. Even the chief counsel of the National Highway Traffic Safety Administration admits that the federal government does not have enough information to determine how to regulate driverless technologies. This can become a particularly thorny issue when there is the first accident between autonomous and self driving vehicles and how to go about assigning liability.

## Liability

Sven Bieker, the executive director of the Center for Automotive Research at Stanford, outlined the challenges he saw which put fully autonomous robocars two decades away, which revolved around issues of civil liability. It will be hard for manufacturers to avoid liability for any safety problems with their robocars, even when the systems were built to provide the highest statistical safety result if it traded off one type of safety for another.

This question of liability arose during an interview on the future of autonomous vehicles with Roger Noll. Although Professor Noll hasn't read the current literature on this issue, he voiced concern over what the verdict of the first trial between an accident between an autonomous vehicle and normal car will be. He believes that the jury will almost certainly side with the human driver despite the details of the case, as he eloquently put in his husky Utah accent and subsequent laughter, "how are we going to defend the autonomous vehicle; can we ask it to testify for itself?"

To answer Roger Noll's question, Brad Templeton's blog elaborates how he believes that liability reasons are a largely unimportant question for two reasons. First, in new technology, there is no question that any lawsuit over any incident involving the cars will include the vendor as the defendant so potential vendors must plan for liability. For the second reason, Brad Templeton makes an economic argument that the cost of accidents is borne by car buyers through higher insurance premiums. If the accidents are deemed the fault of the vehicle maker, this cost goes into the price of the car, and is paid for by the vehicle maker's insurance or self-insurance.

Instead, Brad Templeton believes that the big question is whether the liability assigned in any lawsuit will be significantly greater than it is in ordinary collisions because of punitive damages. In theory, robocars should drive the costs down because of the reductions in collisions, and that means savings for the car buyer and for society and thus cheaper auto insurance. However, if the cost per collision is much higher even though the number of collisions drops, there is uncertainty over whether autonomous vehicles will save money for both parties.

In this argument, Brad Templeton makes the assumption that we are operating in a perfectly free market, however automobile markets are far from this in reality. Industry secrets drive asymmetric information, and there are high barriers to entry which lead to large automakers creating concentrated market power which raises the HHI (Herfendahl Index) compared to other industries. The Herfendahl Index is a measurement of market power, calculated by simply taking the percentage of market power for each company, squaring it, and then adding up all the results from each company in the sector. Mathematically, this means that fewer firms will have a higher HHI (more concentration) versus a lower HHI for a free trade market. There are also taxes and subsidies that shift the supply and demand curves and distort the equilibrium quantity and price, as well as product differentiation.

## Insurance

Roger Noll mentioned that he would be very interested to see if the Google autonomous vehicle is currently insured. Current California automobile insurance legislation would not be favorable for autonomous vehicles. California's Proposition 103 dictates that any insurance policy's price must be based on weighted factors, and the top 3 weighted factors must be, 1.) driving record, 2.) number of miles driven and 3.) number of years of experience. Other factors like the type of car someone has (i.e. autonomous vehicle) will be weighed lower. Subsequently, this law makes it very hard to get cheap insurance for a robocar.

This question of insurance depends on the probability of an accident, which for autonomous vehicles would be much lower than the average driver. But how low would it be? Bryant Walker Smith, a fellow at Stanford Law School's Center for Internet and Society, uses a Poisson distribution and the national crash and mileage estimates to calculate that Google's cars would need to drive themselves more than 725,000 miles without incident to have a 99 percent confidence level that they crash less frequently than conventional cars30. If we only look at fatal accidents, this minimum skyrockets to 300 million miles. To put this into perspective, the Google Car has driven around 200,000 miles without an incident they are at fault. In light of the technological and non-technological issues, legislation has been written with the help of Google lobbying to address these issues as well as pave a way for future regulation.

## Nevada Policy: AB 511 Outline

The story of Nevada AB 511 begins when Bruce Breslow, director of Nevada's Department of Motor Vehicles, got a call from a lobbyist working on Google's behalf just two weeks on the job. Breslow agreed to meet with Google engineers in California and try out the technology himself. Breslow was won over, saying, "it was amazing technology. The car sees better than you do. The car sees a 360-degree panorama. It sees the height of the curb. It sees three cars ahead, three cars behind. It can see beyond a blind spot." Breslow later helped arrange a twenty mile ride around Carson City, the state capital, for Nevada Governor Brian Sandoval.

The parts of AB 511 we will focus on Section 8, which requires the DMV to adopt regulations authorizing the operation of autonomous vehicles on highways within Nevada. Section 8 defines an "autonomous vehicle" to mean a motor vehicle that uses artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator.

## Nevada Policy: AB 511 Section 8

This short piece of legislation accomplishes the goal of setting good standards for the DMV to follow. By setting general standards (part a), insurance requirements (part b), and safety standards (part c), this sets a precedent for these areas without being too limited with details, leaving them to be decided by the DMV instead of the politicians. The legislation goes on to establish guidelines for the testing (parts d and e) which are extensive and we will cover in the regulation portion the paper, and finally, the legislation leaves open the possibility of future standards to be instituted (part f). Although these pieces of the policy set the foundation for testing cars in Nevada and future regulation, they do not provide enough details to sufficiently address the liabilities posed by technical and non-technical issues. For instance, part b only discusses insurance briefly, saying the state must, “Set forth requirements for the insurance that is required to test or operate an autonomous vehicle on a highway within this State.”

The definitions set in the second part of Section 8 are not specific enough. Following the open-ended standards set in the earlier part of the Section 8 is good for continuity, but not technically addressing the problem. According to Ryan Calo, Director of Privacy and Robotics for Stanford Law School’s Center for Internet and Society (CIS), the bill's definition of “autonomous vehicles” is unclear and circular. In the context of this legislation, autonomous driving is seen as a binary system of existence, but in reality, it falls more under a spectrum. The text says “Autonomous vehicle means a motor vehicle that uses artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator,” but many vehicles available today have autonomous features, just falling short of complete computer control. Under the bill’s language of autonomous vehicles, it would mean that the self-parking Lexus LS 460L and self driving Mercedes S63 in stop and go traffic would fall under the definition of an autonomous vehicle.38 However, testing and certifying this technology on par with the Google Car would be cumbersome. Despite the harmless intent behind the legislation, it can be misconstrued in controversy over legal interpretations.

Legal hurdles arise in both current and old legislation alike. In California, there is an antiquated law that says women cannot drive a car in a housecoat. This law only applies to a certain part of California, and is an example where policymakers could look closely at the laws of forty-nine other states and countless municipalities to ensure our laws behind the autonomous vehicles are in compliance. Another California law supposedly holds that “No vehicle without a driver may exceed 60 miles an hour.” One could interpret this law as saying that robocars may travel up to 60 MPH in California, which could be a positive aspect while initially testing out the vehicles in urban street traffic, but create complications when testing autonomous vehicles on the freeway.

This special legislation and testing process raises the question about whether Google will consider testing their vehicle in Nevada since they have already done so in California. The answer seems to be yes, as Jay Nancarrow, PR manager at Google, said Google will probably apply to test in Nevada to examine how the vehicle behaves in different terrain and weather. The cars have had little exposure to snow, and this experience will be crucial in order to scale the technology.

This sentiment is shared by Google’s Product Manager Anthony Levandowski, who said, “I’m really excited about seeing Senator Padilla’s work on bringing and building a framework for testing and helping enable the groundwork for consumers to have access to this wonderful new technology." As an engineering student at UC Berkeley in the early 2000s, Mr. Levandowski pioneered the development of the school's first autonomous vehicle to enter in the DARPA Grand Challenge. He built a self-driving motorcycle called "Ghostrider" that was designed to be used for the military in the battlefield. Although the vehicle did not win (it crashed after 50 yards on the course), it proved the versatility of the technology from the early days and the pioneering spirit that Google holds dearly.

Overall, AB 511 did not address either the technological liabilities and barely mentioned the non-technological liabilities that are necessary to overcome for future success of autonomous vehicles. Since it was the first type of legislation to ever approach the issue of autonomous vehicles, it is understandable that the policymakers did not want to go into specifics and instead rely on future regulation to determine the details.

## California Policy: SB 1298

State Senator Alex Padilla of District 20 introduced California's first ever autonomous vehicle legislation. Similar to the Nevada situation, Google lobbied Padilla, a Democrat that is well liked across the political spectrum, and who has a successful track record of getting bills signed into legislation. During his first term alone, Padilla proposed 69 bills and got 50 of them signed into legislation. SB 1298 would require the adoption of safety standards and performance requirements to ensure the safe operation and testing of "autonomous vehicles" on California public roads. The bill would allow autonomous vehicles to be operated or tested on the public roads on the condition they meet safety standards and performance requirements of the bill. SB 1298's 66 lines of text is also considerably longer than AB 511's 12 lines of relevant text (the entirety of AB 511 is much longer but consists of irrelevant information for the purposes of autonomous cars).

Section 1 part B is similar to Section 8 in AB 511, where it defines an "autonomous vehicle" as, "Development is actively under way of new technology that, through the use of computers, sensors, and other systems, permits a motor vehicle to operate without the active control and continuous monitoring of a human operator. Motor vehicles with this technology, referred to as autonomous vehicles..." The key point here is that there does not have to be a finished product but rather have a product "under development", which accurately reflects the current stages of autonomous vehicle technology and makes sure it doesn't assign too much promise to the technology. This is important because it keeps in mind current legal considerations of over assigning liability if it is treated as a finished product, which addresses the non-technical issue of liability in an indirect way. In order to more specifically address the issue of liability, regulation is the key to moderating what qualifies as an "autonomous technology" and what is "under development". However, this definition alone falls to the pitfall about the binary definition of autonomous vehicles as discussed in the earlier Nevada legislation.

One of the main benefits of SB 1298 is that it clarifies this point of contention of the binary definition. Section 2 lists the different that do not qualify as autonomous technology, “A vehicle equipped with one or more crash avoidance systems, including, but not limited to, electronic blind spot assistance, automated emergency braking systems, park assist, adaptive cruise control, lane keep assist, lane departure warning, traffic jam and queuing assist, or other similar systems that enhance safety or provide driver assistance, but are not capable, collectively or singularly, of driving the vehicle without the active control and continuous monitoring of a human operator, is not an autonomous vehicle.” This is a good first step to avoid the binary issue of autonomous technology, however, this legislation could go a step further. This definition does briefly address the technical aspect of what an autonomous vehicle is, but it does not come close to addressing any of the technical issues behind bugs, OS’s, and open source that was discussed earlier because the current list of technology does not overlap with these technical issues. In order to address this issue, a definition of different levels of autonomous technology is required, instead of just aggregating all these technologies in the direct center of the binary system. Also, this legislation will require specific regulation to see what other new technologies will be considered as “autonomous technology”, as it will accurately reflect what type of technology exists in the marketplace.

SB 1298 has clear intentions to have company developed vehicles by saying in Section 2, Part B that, “autonomous vehicles have been operated safely on public roads in the state in recent years by companies developing and testing this technology” and how these companies have set the standard for what safety standards will be necessary for future testing by others. This part of the legislation implicitly supports Google’s autonomous vehicle because it has the most extensively tested fleet of vehicles out of all the companies, and all this testing has been nearly exclusively done in California. This bill is an improvement over AB 511 by putting more control in the hands of Google to focus on developing the technology, which is a signal by the policymakers to create a climate favorable for Google’s innovation within the constraints of keeping society safe.

Another forward looking aspect of the bill is when SB 1298 discusses the definition of a manufacturer of autonomous vehicles, which implies that it is answering a question of how to scale the technology. The bill reads in Section 2 part D that, “A "manufacturer" of an autonomous vehicle is the person as defined in Section 470 [outside of SB 1298] that manufactures the autonomous vehicle as an originally completed vehicle or, in the case of a vehicle not originally equipped with autonomous technology, the person that modifies the vehicle to convert it to an autonomous vehicle.” The last portion of the text is crucial because it articulates that autonomous vehicle production can come from those who convert existing cars instead of having to build cars from scratch. This can give rise to a whole new industry that we currently do not have and provide sought after manufacturing jobs since we could pioneer a competitive advantage through technology over low cost manufacturing overseas. The most important issue here will be how to go about regulating the technology because one will want to make sure that manufacturers do not cut corners with the hardware installation which could endanger lives.

## Policy Options

To avoid setting a dangerous precedent for liability in accidents, policymakers can consider protecting the car companies from frivolous and malicious lawsuits. Without such legislation, future plaintiffs will be justified to sue Google and put full liability on them. There are also potential free riding effects of the economic moral hazard of putting the blame on the company that makes the technology, not the company that manufactures the vehicle. Since we are assuming that autonomous vehicle technology will all come from one source of Google, then any accident that occurs will pin the blame primarily on Google, the common denominator, not as much as on the car manufacturer. There is equal importance in both the correct installation of the technology and the initial invention because hardware malfunctions can arise due to poor implementation.

Policy that ensures the costs per accident remains close to today's current cost will save money for both the insurer and customer. This could potentially mean putting a cap on rewards towards the recipients or punishments towards the company to limit shocks to the industry. Overall, a policymaker can choose to create a gradual limit on the amount of liability placed on
the vendor based on certain technology or scaling issues that are met without accidents.

Legislation to overturn Proposition 103 would help encourage bad drivers to transition to a robocar, instead of punishing them for doing so in the current framework of Proposition 103. However, this would be the hardest out of all the policy measures to implement because a ballot proposition can only be suspended by a two-thirds vote and a court agreeing the change matches the intent of the original ballot proposition. If Prop 103 is overturned, this can be used to encourage first mover adoption through incentives, which is critical to the success of infant technologies.

The final policy recommendation is to provide more R&D funding for autonomous vehicles to tackle the second generation technical problems discussed earlier. Technologically, autonomous vehicles are safe enough to be tested on almost any road, but a source of special funding to focus on the research that will be responsible for scaling the technology would be beneficial. To make the decision more politically palatable, the funding could go to universities such as Stanford to pioneer the initial research and have Google act as the intermediary between the basic research and commercialization to span the valley of death problem.

## Concluding Remarks

SB 1298 manages to cover some of the shortcomings of AB 511, such as how to improve upon the definition of an autonomous vehicle, as well as looking more towards the future by giving Google more responsibility and alleviating some of the non-technical liability by considering their product "under development". However, both pieces of legislation fail to address the specific technical liabilities such as bugs in the code base or computer attacks, and non-technical liabilities such as insurance or accident liability. The bill was most likely written to put the onus on corporations to address these technical problems and instead focus on creating a favorable climate for Google and other companies to scale. However, since there are still a great deal of technology barriers remaining, widespread implementation of the autonomous vehicle is still far away.

The next step forward is to ensure the regulation behind the laws are aligned, as the future of the cars will rely on the implementation of the laws. From the examination of AB 511 and SB 1298, we are on the right trajectory to develop autonomous vehicles, with legislation being debated in Florida, Hawaii, and Oklahoma.

However, not all legislation has been successful, as Arizona's bill failed on February 9, 2012 in the House Transportation Committee after members expressed concern that the technology was not ready and the rulemaking burden on the state's Department of Transportation would be too great. The Arizona Committee is justified saying that the technology is not ready, that is, not ready for widespread implementation. However, they fail to realize that the technology is ready for testing, as proven by Google's success on the road. This ruling shows that there might be a need for policy to address the misinformed public on the advanced nature of the technology and how it is ready to test on the road.

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