Steering the Law

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Abstract

Google's autonomous car has created quite the buzz in the media as well as the automotive industry and legal system. A vehicle that nearly eliminates safety issues while maximizing efficiency on the road is one that justifiably requires the attention of any potential stakeholders. This investigation will examine the several ways in which the Car may revolutionize the automotive industry, while clashing with the legal system of California, by asking: In what ways and with what results will Google's autonomous car impact traffic laws and regulations in the next 5-10 years in California? It will be proven that although California state laws do not appear to prohibit automated vehicles, they can nonetheless discourage their introduction by complicating their operation, which may force major reform to adapt for AI in personal vehicles.

The investigation will primarily focus on the California state amendment and the barriers it will pose to the introduction of the Google Car, however the limitations and counter issues such as technological dependence and liability will also be assessed. Key resources consulted will include Forbe's Chunka Mui's 11-part series titled, *"Google's Driverless Car is Worth Trillions"*, Google's online editorial blog, and Bryant Walker Smith's Stanford lecture, "*Automated Vehicles are Probably Legal*". International and other state laws will not be examined, as the investigation will confine strictly to the state of California, and its regulations.

By the end of this investigation, it will be clear that Google's driverless car is a revolutionary technology that will change the automotive industry positively forever, but will face serious speed bumps with regards to the California state amendment. Despite these issues, this investigation will prove that the Google Car will eliminate many of the key safety and efficiency issues faced by non-autonomous vehicles, and will therefore force reform in the state legal .system

Table of Contents

Introduction

Since 2009, California has been ranked the most dangerous state for drivers in the United States, with over 3071 traffic fatalities and 2816 fatal accidents annually[1]. Eighty-four percent of these accidents were attributed to distracted-driving, such as drunk driving and the use of cell phones while operating a vehicle[2]. Despite the fact that state and national laws attempt to minimize accidents through strict driver consequences, these issues persist. Google has developed an autonomous car to solve these problems, thus Google's *Driverless Car Project* may make issues such as unbearable commuting times and traffic fatalities problems of the past.

This brings to mind the following question: **In what ways and with what results will Google's autonomous car impact traffic laws and regulations in the next 5-10 years in California?** In 2008, Google introduced the *Google Driverless Car Project*, with Sebastian Thrun, director of the Stanford Artificial Intelligence Laboratory, at the forefront[3]. Although the development of vehicle's AI, *Google Chauffeur*, continued, the Google Car was not introduced to the general public until late 2010. Insurance agencies and legal experts responded instantly[4], targeting the vehicle's safety standards and AI. The technology, however, is based on simple artificial intelligence concepts: The AI in these autonomous vehicles utilise video cameras, environment radar sensors and a 64-beam laser to "see" traffic and surroundings[5]. In fact, the Massachusetts Institute of Technology has long researched and supported autonomous vehicles, in an effort to constantly improve algorithms for their various AI prototype. The long-term vision for the *Google Driverless Car Project* however, is to standardise autonomous vehicles, improve safety, accessibility, and effectiveness in transportation. Throughout this report, the impact of the Google Car (also referred to as the Car) on California state laws will be examined. In fact, the aforementioned legal article will be used as a primary resource throughout this essay, and will play a major role in the verification of any arguments presented. This paper will cover ways in which Google can adapt the Google Car to meet national standards to the best of their abilities, while pushing for reform in California State Laws. Although numerous secondary sources will be utilized, major ones include Forbe's Chunka Mui's 11-part series titled, *"Google's Driverless Car is Worth Trillions"*, Google's online editorial blog, and most importantly, Bryant Walker Smith's Stanford lecture, "*Automated Vehicles are Probably Legal*".

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[1] "Accident Statistics in California." NavBug. http://www.navbug.com/accident_blog.php?idArticle=11 (accessed June 1, 2014).

[2] "Injury Prevention & Control: Motor Vehicle Safety." Centers for Disease Control and Prevention. http://www.cdc.gov/Motorvehiclesafety/statecosts/ca.html (accessed June 11, 2014).

[3] "Google's driverless car." TED. http://www.ted.com/talks/sebastian_thrun_google_s_driverless_car (accessed June 9, 2014).

[4] Worstall, Tim. "Google's Driverless Car Problem Isn't Technology, It's Liability And Regulation." Forbes. http://www.forbes.com/sites/timworstall/2013/08/21/googles-driverless-car-problem-isnt-technology-its-liability-and-regulation/ (accessed June 11, 2014).

[5] "Google's driverless car." TED. http://www.ted.com/talks/sebastian_thrun_google_s_driverless_car (accessed June 9, 2014).

The legalities regarding cell phones and the safety features of the Google Car will be evaluated, with respect to State regulations. Next, state speed limits and pedestrian protection will be discussed, in which safety and efficiency will be examined in context. These arguments will lead to, perhaps, the overlying issue, which discusses much-needed reform in liability laws, to segregate "regular" vehicles from Google Cars. **Hence, although California state laws do not appear to prohibit automated vehicles, they can nonetheless discourage their introduction by complicating their operation, which may force major reform to adapt for AI in personal vehicles.**

Safety and Cell Phones

As driver attentiveness will not be necessary while travelling, cell phone laws must be changed completely to allow the use of technology while "driving". Not only will this clear a path for Google's Android OS integration, but it will change the definition of a "car" from simply a machine that gets one from point A to point B, to a socially integrated technology with advanced safety.

Foremost, the *Google Driverless Car Project* consists of two functional concepts. The initial concept, introduced in 2008, was that of an autonomous car that simply exists within current vehicles[6]. For instance, Google retrofitted a Toyota Prius with *Google Chauffeur* and autonomous-vehicle parts, as one of their first publically demonstrated concepts. These Cars have every quality of a non-autonomous vehicle, including a steering wheel and gear shift, but also have the capability of driving independently. The Car uses its AI and laser/environment sensors to drive autonomously, and if needed, a driver can take control of the wheel and driver as well[7]. Due to its autonomous technology, the Car minimizes the risk of an accident on the road[8].

Figure 1: An autonomous Toyota Prius, with self-driving and driver-controlled capabilities[9]

[6] Ibid.
[7] Ibid.
[8] Mui, Chunka. "Fasten Your Seatbelts: Google's Driverless Car Is Worth Trillions (Part 4)." Forbes. http://www.forbes.com/sites/chunkamui/2013/02/12/googles-trillion-dollar-driverless-car-part-4-how-google-wins-2/ (accessed June 26, 2014).
[9] "Google's Self-Driving Technology." DailyTech. http://www.dailytech.com/Tesla+Interested+in+Googles+SelfDriving+Technology/article31502.htm (accessed June 1, 2014).

The newer functional Google Car (introduced in 2014), is a completely autonomous vehicle manufactured by Google independently, which has no driver-controlled capabilities[10]. It does not have a steering wheel, gear shift, accelerator, or any conventional personal vehicle features (including its uncanny exterior), and is controlled solely by the Car's AI.

Figure 2: The completely self-driven Google Car, manufactured by Google in Detroit

Although the two functional Cars have their clear differences, the technological structure of both vehicles is nearly identical (however, the Prius is retrofitted with autonomous technologies, whereas the Google-manufactured Car has them integrated[11]). Both vehicles use light radar (LiDAR) sensors to generate three-dimensional maps of the environment, in order to pinpoint a GPS location and send environment data to the Car's AI[12].

The Car uses a Velodyne High-Definition LiDAR sensor-a laser-operated instrument, to create a three-dimensional panoramic image of its environment[13]. Rather than a single laser firing through a rotating mirror, the sensor utilizes 64 lasers, mounted on upper and lower laser blocks[14].

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[10] Google Blog, "Just press go: designing a self-driving vehicle," last modified May 27, 2014, http://googleblog.blogspot.ca/2014/05/just-press-go-designing-self-driving.html

[11] Ibid.

[12] "Google's self-driving car passes 700,000 accident-free miles, can now avoid cyclists, stop at railroad crossings | ExtremeTech." ExtremeTech. http://www.extremetech.com/extreme/181508-googles-self-driving-car-passes-700000-accident-free-miles-can-now-avoid-cyclists-stop-for-trains (accessed June 11, 2014).

[13] "'Eyes' of Google's Self-Driving Car May Bust Crooks." PCMAG. http://www.pcmag.com/article2/0,2817,2402516,00.asp (accessed June 11, 2014).

[14] Ibid.

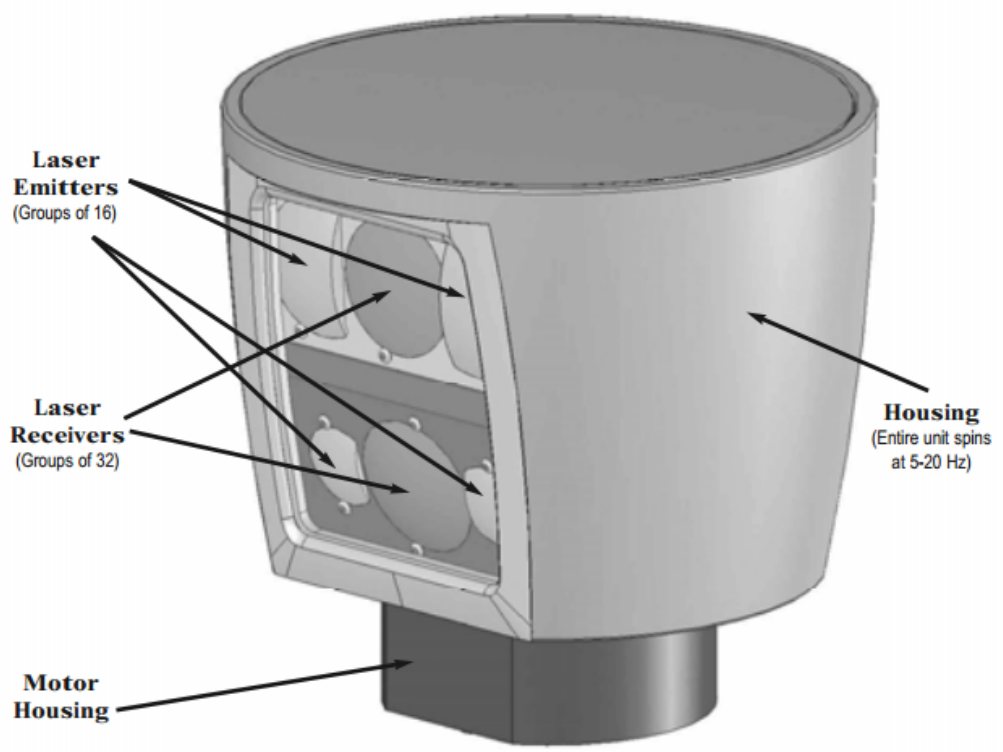

Figure 3[15]: Velodyne HD LiDAR 64-laser sensor, and its external housing unit. The laser emitters and receivers constantly rotate 360 degrees, to map its surroundings accurately.

The Velodyne sensor collects the three-dimensional environment data and processes it through the internally calibrated Digital Sensor Recorder (DSR)[16]. DSR is a point-cloud data viewer that processes sensor packets to determine an extremely precise GPS location[17], as well as an environment map, which is then directed to the *Google Chauffeur*. The AI then examines the environment for pedestrians, obstacles, road conditions and traffic lights/speeds/laws, to generate a data model of its surroundings and proceed according.

The Cars have several other sensors, including 4 (rear and front bumper) radars, a near-view mirror camera, a GPS, inertial measurement unit, and wheel encoder[18].

[15] HD Li-DAR Sensor User's Manual. California: Velodyne, 2011.
[16] Ibid.
[17] Ibid.
[18] "How Google's Self-Driving Car Works." IEEE Spectrum. http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works (accessed June 11, 2014).

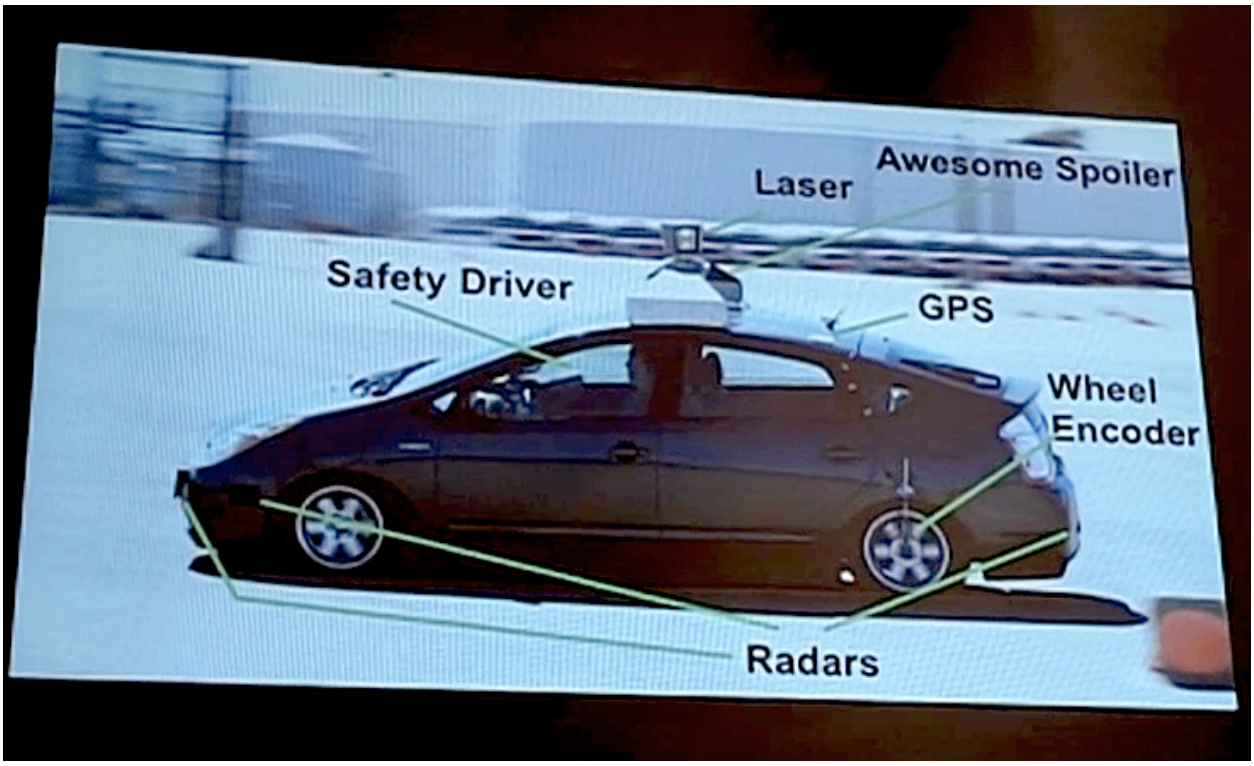

Figure 4: Google's presentation outlines where the Car's main sensors are located

The radars and camera exist solely for the Car to see vehicles that are approaching from a longer distance (outside of the Velodyne sensor's scanned diameter), as well as the detection of approaching traffic lights[19]. The GPS unit operates in conjunction with the Velodyne sensor, to send a precise location data-packet to the AI (if the GPS was used alone, the location could be off by several meters, according to the lead tech). Whereas a human driver could easily get lost without a phone/handheld GPS, the Car's in-home system ensures that it is always on the right path, with the safest and most efficient route.

The inertial measurement unit (patented by Google, *patent US 6622090 B2*) operates with the GPS system to access Google's geospatial database and assist in mapping the environment location in real time[20]. Mapping the environment using a geospatial tool creates a three-dimensional image that leaves no flaws behind, and maximizes the safety of the driver. These sensors all operate simultaneously, in order to create an extremely precise/detailed environment map (*Figure 5*). While human drivers can see the road ahead of them, as well as adjacent vehicles through peripheral vision and approaching vehicles through mirrors, the Car can see the road 360 degrees simultaneously[21]. It recognizes street lights and rules automatically, and much quicker than a human driver would, which

[19] Ibid.
[20] "Patent US6622090 - Enhanced inertial measurement unit/global positioning system mapping and navigation process." Google Patents. https://www.google.com/patents/US6622090 (accessed June 11, 2014).
[21] "How Google's Self-Driving Car Works." IEEE Spectrum. http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works (accessed June 11, 2014).

leads to marginally safer and more efficient driving.

In the words of Sebastian Thrun, Google's project leader, the Google Car is significantly safer than human drivers. The amount of time, research and development on Google's part ensures this, as Google hopes to eliminate the threat of traffic accidents and fatalities. According to Chris Urmson, the Google project director, the Car is "spending less time in near-collision states", and is "driving more smoothly and more safely than trained professional drivers"[22].

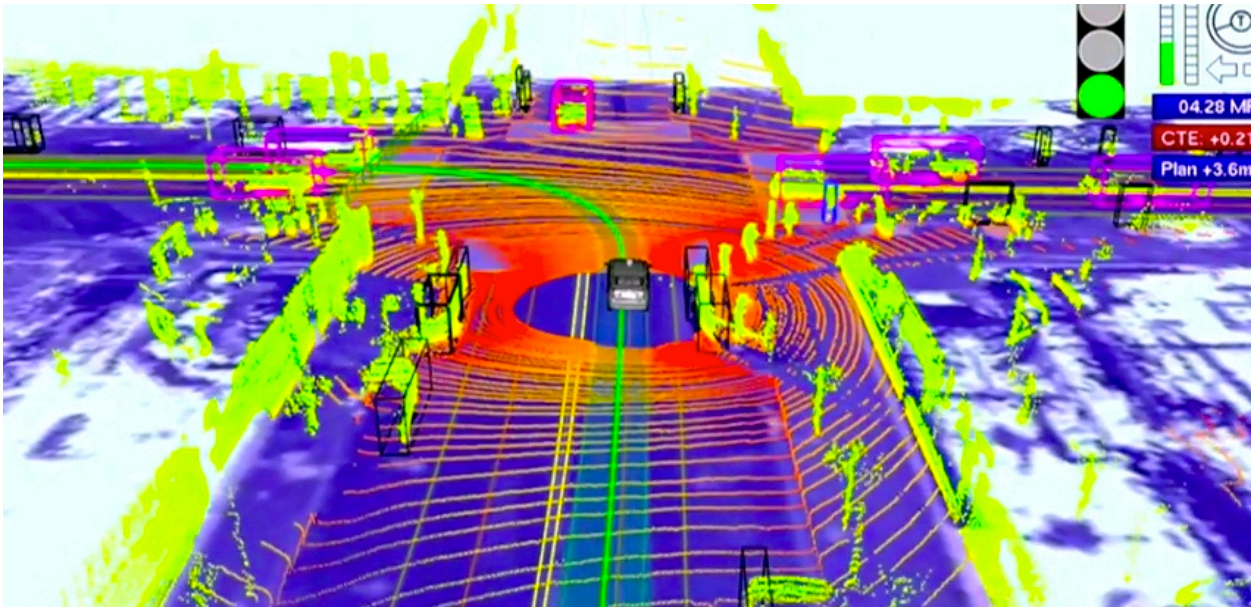

Figure 5[23]: The environment data map generated by the Car's AI, after processing the various sensor packets. Conditions, pedestrians, obstacles, other vehicles, traffic lights/law/limits are all processed, while maintain a specific route

In 2012, the collective odometer of Google Cars recorded 300,000 miles in San Francisco, with a near-perfect record[24]. Only 1 accident was recorded in the Cars' 3 years of test drives, and it was credited to a non-autonomous vehicle rear-ending a Car[25]. Google has successfully proven that the Car is not only an extremely smart and connected technological innovation, but also an extremely safe one. For these reasons, the introduction of the Car will force reform in cell phone road laws, to allow the use of cell phones/devices while traveling in a personal vehicle.

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[22] Simonite, Tom. "Google: Our Robot Cars Are Better Drivers Than Puny Humans | MIT Technology Review." MIT Technology Review. http://www.technologyreview.com/news/520746/data-shows-googles-robot-cars-are-smoother-safer-drivers-than-you-or-i/ (accessed June 11, 2014).

[23] "How Google's Self-Driving Car Works." IEEE Spectrum. http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works (accessed June 11, 2014).

[24] University, Singularity. "Google's Self-Driving Car Passes 300,000 Miles." Forbes. http://www.forbes.com/sites/singularity/2012/08/15/googles-self-driving-car-passes-300000-miles/ (accessed June 11, 2014).

[25] Ibid.

According to the California Vehicle code, section 23123, hand held telephones are prohibited for use by the driver of a vehicle. The law states, "*A person shall not drive a motor vehicle while using a wireless telephone unless that telephone is specifically designed and configured to allow hands-free listening and talking, and is used in that manner while driving*"[26]. This law exists to ensure that drivers are giving their full attention to the road, and therefore driving safer. However, the attention of the "driver" is not necessary in the Car, and so this law would serve no purpose in the State Amendment. If the objective is to ensure driver safety in the end, the Car accomplishes this goal without the need of the attention of the driver, due to its abundance of sensors, monitors and traffic/collision detection software. A vehicle that can see 360 degrees, automatically recognize limits, and avoid pedestrians/collisions requires absolutely no driver attention, and hence, drivers should be free to use their cellphones while "driving".

In fact, the use of cell phones in the Car can open several OS integration opportunities for Google, specifically for the Android operating system. Google has been planning to introduce Android to personal vehicles, as evidenced by the Open Automotive Alliance[27]. Google has been planning to bring Android to Audi, GM, Honda and Hyundai vehicles, and most definitely its own Car[28]. The company's plan is to develop the Android platform to enable the Car itself to become an Android connected device[29]. With this addition, the entire problem of cell phones and driving can be overlooked, as the Android OS with voice-automation capabilities will allow drivers to send and receive calls, texts, and emails. In fact, said capabilities will bypass law 23123 easily, as the "driver" of the Car will never physically be required to dial a number.

With Android integration, the Car will have many of the features of a smartphone, while abiding by all State laws. Not only can this pose an opportunity for Google to innovate their OS in new ways, but driver safety will be significantly improved, as all communication features can be voice controlled by *Google Now*[30]. This means that "drivers" of the Car can take control of the vehicle at any necessary time, although with Google's safety precautions and technological features, this scenario is unlikely. Without a doubt, the technology of the Car and its pronounced safety features will force California State laws to be reformed, in order to allow the use of cellphones and devices while driving, as Google's AI is a significantly safer driver than any human.

If "driver" attentiveness is unneeded while travelling in the Car, the integrated Android OS, and/or the driver's cell phone can become the main focus. Travelling in a

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[26] *"California State Amendment- Vehicle Code- 23123"*. Government of California.

[27] "Google launches the Android-based Open Automotive Alliance with Audi, Honda, GM, and more." The Verge. http://www.theverge.com/2014/1/6/5279116/google-open-automotive-alliance-android-car-announcement (accessed June 11, 2014).

[28] "About the Open Automotive Alliance." Open Automotive Alliance. http://www.openautoalliance.net/#about (accessed June 11, 2014).

[29] Ibid.

[30] "Google Driving Directions: 'Google Now' Assistant Remembers Where You Parked Your Car." Latin Post . http://www.latinpost.com/articles/11774/20140505/google-driving-directions-now-assistant-remembers-when-parked-car.htm (accessed June 11, 2014).

personal vehicle can change from simply holding a steering wheel and pressing the brakes, to extra time where drivers can communicate with family, peers, and colleagues, or even complete any unfinished work on their mobile devices/computers[31]. Instead of wasting hours of their lives motionless while driving a vehicle to work or home for instance, instead drivers of the Car can spend their time as they wish, and not "waste" time driving a vehicle that can drive itself. According to the U.S. Census Bureau's American Community Survey, the average American spends more than 100 hours a year commuting to work[32]. With a massive population of 38.04 million people, the total time spent commuting to work in California was approximately 3,800,000,000 hours. Almost 4 *billion* hours. With all this extra time while commuting, drivers of the Car can turn their attention to their cell phones and the vehicles communication features, and stay in touch at all times.

However, a counter-issue that presents itself is that of American society's dependence on technology. The average smartphone user spends 119 minutes, or almost 2 hours a day using their gadget[33]. To put this in perspective, the average person spends 97 minutes with their significant others[34], 36 minutes with their family[35], and 66 minutes eating per day[36]. Studies from the *Pew Research Center's Internet and American Life Project* indicate that electromagnetic waves emitted from cell phones drastically reduce the user's ability to concentrate, calculate, and coordinate[37]. These two statistics side-by-side paint a dangerous future of a society of young adults dependant on cell phones, with a lack of concentration, calculation, and most importantly, social skills. Although the Car and its Android integration may force reform in California cell phone laws to allow "drivers" to use their devices, there will be severe backlash and possible long-term societal consequences.

[31] Mui, Chunka. "Fasten Your Seatbelts: Google's Driverless Car Is Worth Trillions (Part 3)." Forbes. http://www.forbes.com/sites/chunkamui/2013/01/30/googles-trillion-dollar-driverless-car-part-3-sooner-than-you-think/ (accessed June 26, 2014).

[32] "Americans Now Spend Over 100 Hours a Year Commuting." About US Government. http://usgovinfo.about.com/od/censusandstatistics/a/commutetimes.htm (accessed June 11, 2014).

[33] "To have and to hold: We now spend more time looking at our PHONE than with our partner." Mail Online. http://www.dailymail.co.uk/sciencetech/article-2333261/We-spend-MORE-time-phones-partner.html (accessed June 8, 2014).

[34] Ibid.

[35] Mccann, Jaymi. "No time for the family? You are not alone: Parents and children spend less than an hour with each other every day because of modern demands." Mail Online. http://www.dailymail.co.uk/news/article-2363193/No-time-family-You-Parents-children-spend-hour-day-modern-demands.html (accessed June 11, 2014).

[36] Ibid.

[37] "Correspondence: Are we too dependent on the cell phone?." Your Commonwealth. http://www.yourcommonwealth.org/2011/02/28/latest-are-we-too-dependent-on-cell-phones/ (accessed June 11, 2014).

Speed and Liability

Mass implementation of the Google Car will force California State speed limit laws to be increased, as artificially intelligent "drivers" are extremely efficient and marginally safer.

Imagine driving at 90 kilometers per hour without your hands on the wheel, not worrying about the most efficient route to reach your destination, or even the fact that your car is worryingly close to every other car in the vicinity. This is the concept of a vehicle platoon (or otherwise "road-train")-a convoy of tightly spaced and closely coordinated vehicles[38]- which Google hopes to achieve with the Google Car.

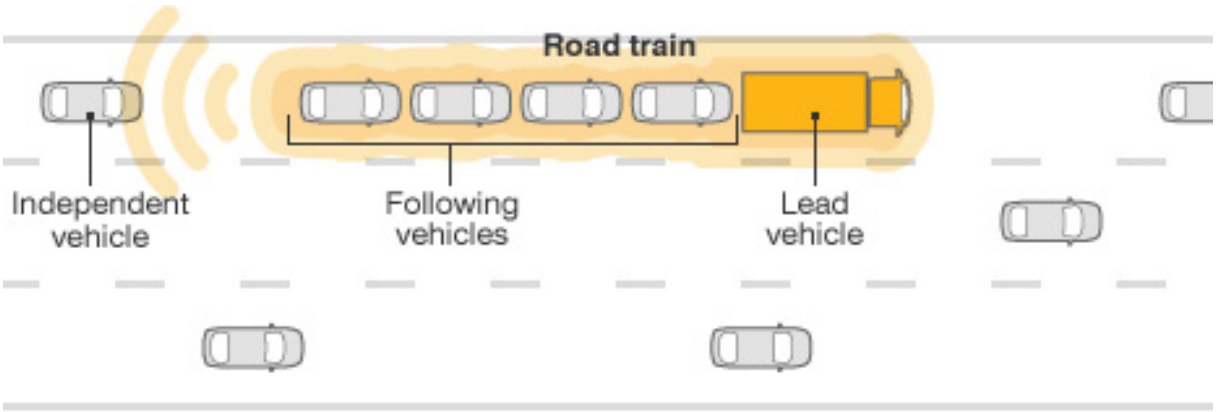

Figure 6: How vehicle platoons, or road trains, operate on a highway[39]

Vehicle platoons build upon the concept of faster transportation due to decreased unused space on the road, as following vehicles tail a lead vehicle with minimal following-distance, and simply exit the platoon once they wish to take an alternative route[40]. Platoons are a concept that focus on long-distance driving, specifically for use on interstate and general highways, to maximize speed. In the case of the Google Car, this will be implemented using a vehicle communication network.

Upon receiving sensor data, the Car then uses a vehicle-to-vehicle (V2V)[41] device to communicate position, speed, and acceleration data to other Google Cars wirelessly, in order to create an IEEE standard 802.11p internet-based Google Car platoon[42]. With this capability, all of the Cars in the platoon can accelerate or brake simultaneously, easily

[38] Ulsoy, Ali Galip, and Huei Peng. Automotive control systems. New York, NY: Cambridge University Press, 2012.
[39] "Platoon: GPS-based road trains set to test on European roads?." Autoblog. http://www.autoblog.com/2009/11/13/platoon-gps-based-road-trains-set-to-test-on-european-roads/ (accessed June 11, 2014).
[40] Ibid.
[41] "US to push for mandatory car-to-car wireless communications - CNET." CNET. http://www.cnet.com/news/us-to-push-for-mandatory-car-to-car-wireless-communications/ (accessed June 11, 2014).
[42] Ibid.

maximizing speed and handling[43]. The need for waiting at traffic lights would be removed, as a synchronized Car platoon would move as one, allowing unused road space to be diminished significantly[44]. This system would allow for closer headway between Cars by eliminating reacting distance, and therefore reducing air resistance (greater fuel economy), and allowing substantially lower commute times during peak periods.

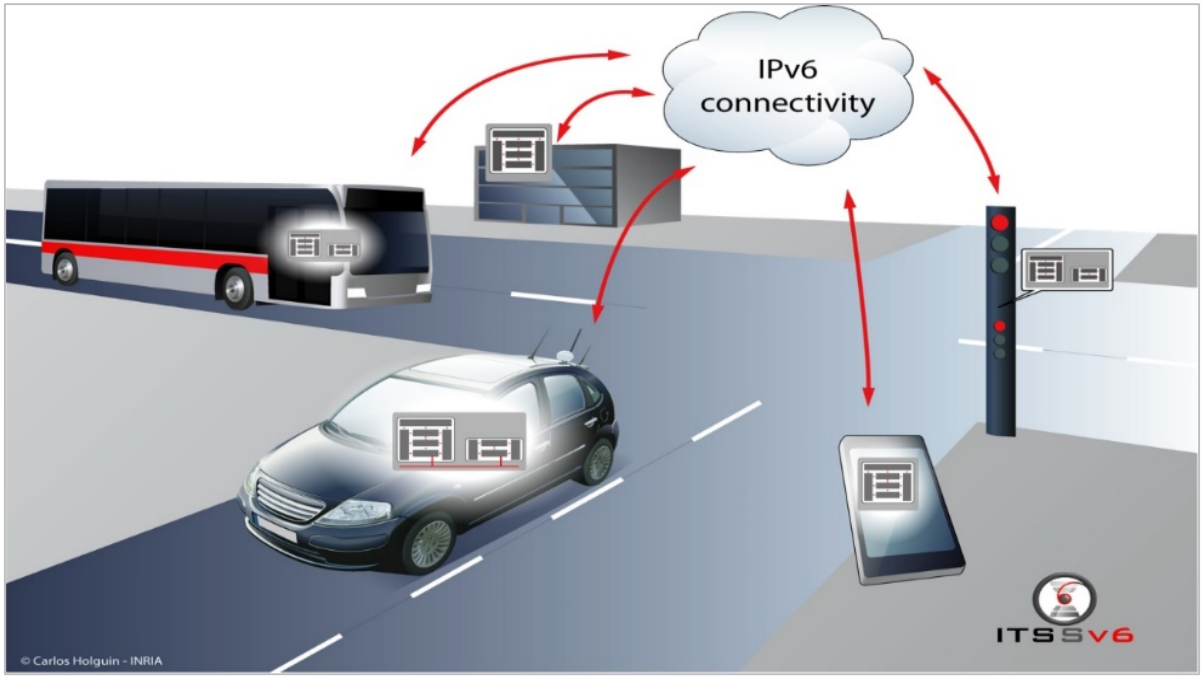

Figure 7: How the implementation of 802.11p internet-communication will work. IPv6 is the latest internet protocol which provides identification and location systems between devices on a communal network.[45]

However, vehicle platoons clearly conflict with following-distance requirements in the California State amendment, and will definitely force reform in several regulations, specifically tailgating laws. The maximum speed limit on most California highways is 65 mph, although drivers may drive 70 mph where posted[46]. The California law states, "The driver of a motor vehicle shall not follow another vehicle more closely than is reasonable and prudent, having due regard for the speed of such vehicle and the traffic upon, and the condition of, the roadway" (California Motor Vehicle Code, Section 21703)[47]. Although "reasonable" and "prudent" are vague terms, the California driver's handbook states, "To

[43] "Out of control: Driving in a platoon of hands-free cars." New Scientist . http://www.newscientist.com/article/dn22272-out-of-control-driving-in-a-platoon-of-handsfree-cars.html#.U5fmUPldWSp (accessed June 11, 2014).
[44] Ibid.
[45] "V2V - Vehicle to vehicle communication (System for safety)." Automobile Innovations. http://automobileinnovations.blogspot.ca/2013/06/v2v-vehicle-to-vehicle-communication.html (accessed June 11, 2014).
[46] California driver handbook. Sacramento, CA: The Department of Motor Vehicles, 2008. http://apps.dmv.ca.gov/pubs/hdbk/speed_limits.htm (accessed June 11, 2014).
[47] *"California State Amendment- Vehicle Code- 21703"*. Government of California

avoid tailgating, use the "three-second rule": when the vehicle ahead of you passes a certain point such as a sign, count "one-thousand-one, one-thousand-two, one-thousand-three." Counting these numbers takes approximately three seconds".[48] According to the state law, these regulations exist to allow drivers more time to see and avoid potential road hazards[49].

In a Google Car platoon however, if the lead Car's AI detects a hazard, it will wirelessly communicate said hazard to each following Car, and the entire platoon will simultaneously avoid the threat[50]. This state law will undergo major change upon the mass implementation of Google Cars, to allow platooning between Cars, and therefore removing tailgating as an issue entirely. Experts have weighed in on this issue as well, with both negative and positive outlooks. "If every driver behaved the same, and made consistent, rational decisions, congestion would be dramatically reduced,"[51] says Jeff Muttart of Connecticut's Crash Safety Research Centre. "But that's not how humans are. An autonomous car would do better"[52]. Experts believe that the Car can remove outliers such as drivers who drive too far under, or over, the speed limits on highways, by allowing each vehicle to maintain a consistent, uniform speed[53]. In fact, the use of Car platoons can not only increase safety and efficiency on the road, but a decrease in fuel consumption can be achieved, by up to 30% (*Figure 8*). There are numerous, clear, advantages to higher speeds and platooning.

[48] California driver handbook. Sacramento, CA: The Department of Motor Vehicles, 2008.
[49] Ibid.
[50] Mui, Chunka. "Fasten Your Seatbelts: Google's Driverless Car Is Worth Trillions (Part 1)." Forbes. http://www.forbes.com/sites/chunkamui/2013/01/22/fasten-your-seatbelts-googles-driverless-car-is-worth-trillions/2/ (accessed June 11, 2014).
[51] Cheney, Peter. "How self-driving cars will ease traffic congestion." The Globe and Mail. http://www.theglobeandmail.com/globe-drive/culture/commuting/how-self-driving-cars-will-ease-traffic-congestion/article15876882/ (accessed June 11, 2014).
[52] Ibid.
[53] Ibid.

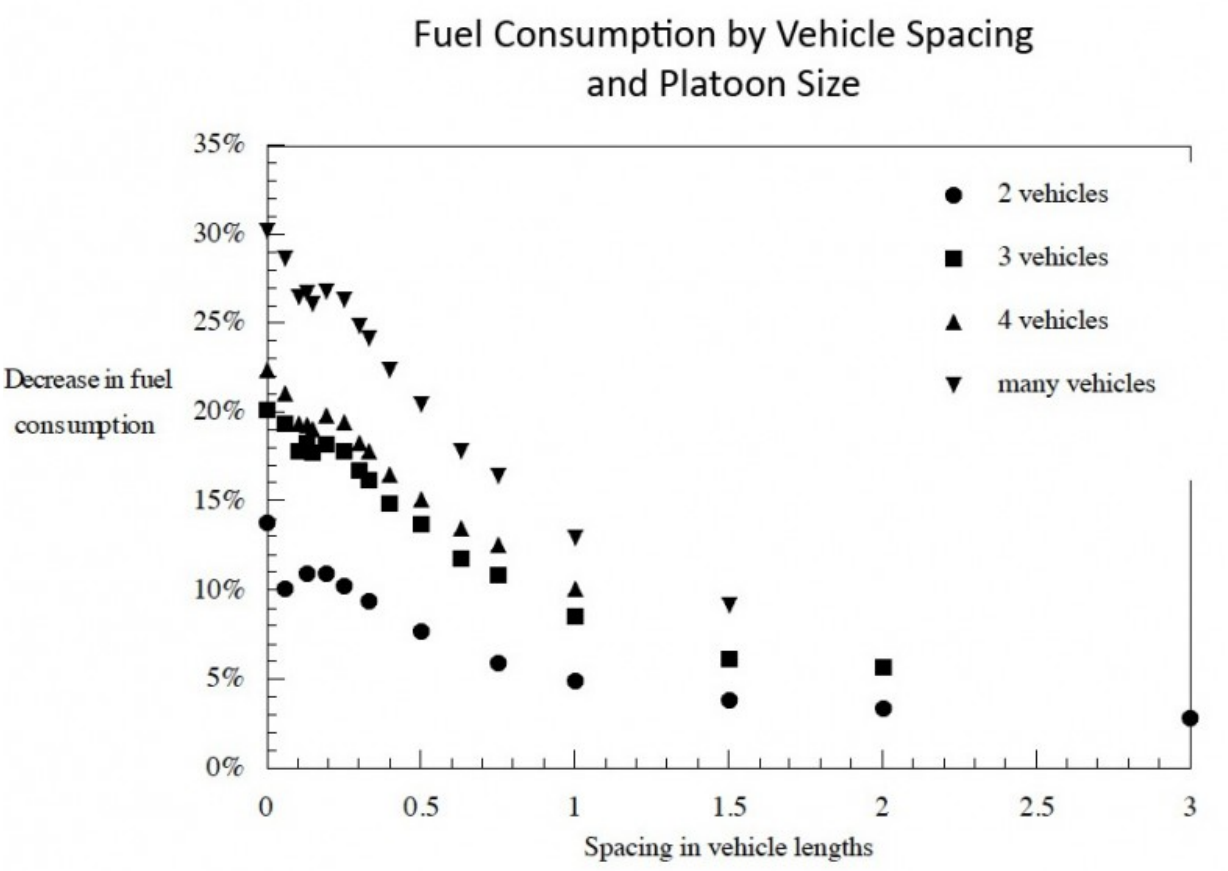

Figure 8[54]: As car spacing between vehicles in a platoon decrease, the decrease in fuel consumption becomes significantly greater, reaching 30% at the maximum

California's Motor Vehicle Code (section 22400) states, "No person shall drive upon a highway at such a slow speed as to impede or block the normal and reasonable movement of traffic, unless the reduced speed is necessary for safe operation, because of a grade, or in compliance with law"[55]. Google Cars would require new (and higher) speed limits, and if implemented, the Cars will always drive within these limits (as per the *Google Chauffeur* AI, which ensures the vehicle obeys road laws at all times)[56]. Increased speed limits on highways can significantly reduce travel times, and lead to a more efficient (*Figure* 9) and effective transportation system.

[54] "Driving Miss Hazy: Will driverless cars decrease fossil fuel consumption?." Rocky Mountain Insititute. http://blog.rmi.org/blog_2013_01_25_Driving_Miss_Hazy_Driverless_Cars (accessed June 11, 2014).
[55] *"California State Amendment- Vehicle Code- 22400"*. Government of California.
[56] "Inside Google's Quest To Popularize Self-Driving Cars." Popular Science. http://www.popsci.com/cars/article/2013-09/google-self-driving-car (accessed June 11, 2014).

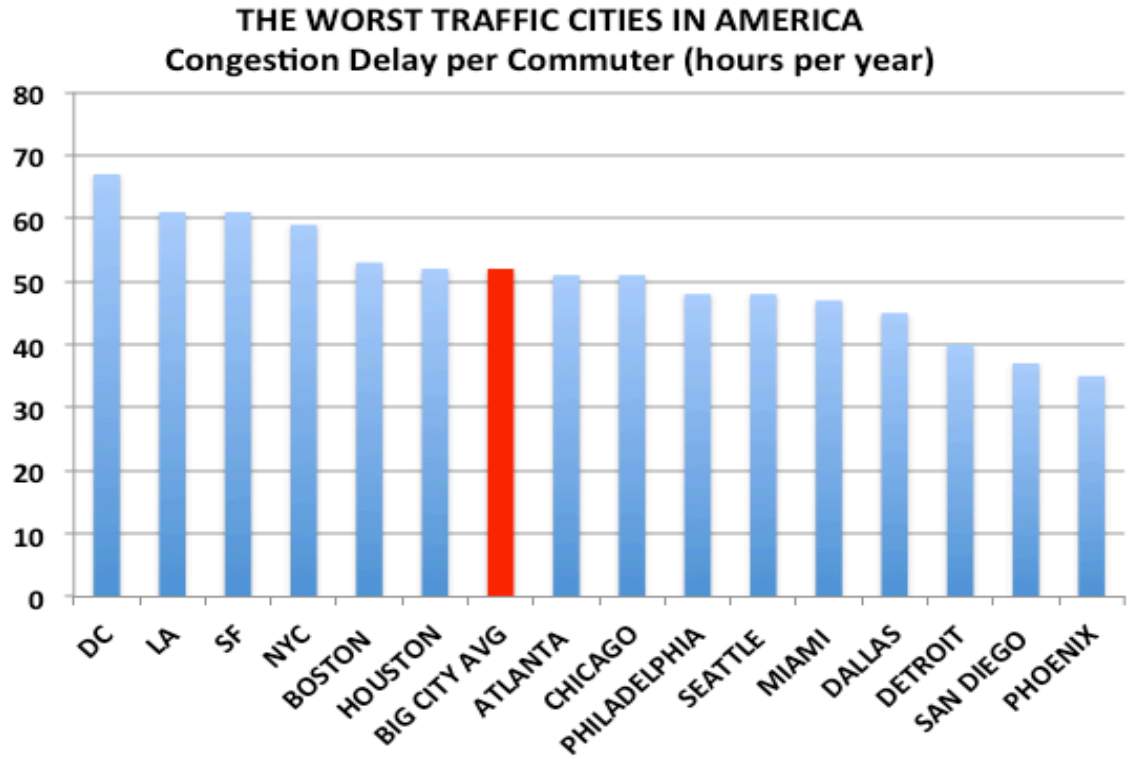

Figure 9[57]: The average US commuter spends 38 hours a year stuck in congested traffic. A platoon system of Cars can greatly reduce this wasted time, by eliminating the issue of traffic congestion.

The advantages to the Car, from a traffic and efficiency standpoint, are overwhelming. A change in tailgating and speed laws will certainly be a must, in order to reap these benefits. If the laws undergo these reforms however, speed limits for human-driven vehicles will certainly differ from Cars. In the first few years of their sale, the Car will not make up a majority of personal vehicles, and just as HOV and designated bike lanes exist to segregate specific transportation vehicles, Google Car lanes could also be implemented. In this manner, platooning and significantly higher speed laws could apply only to Cars in these lanes. However, many predict that after the initial few years of the Cars sale to the mass market, it will eventually own the automobile industry, and *everyone* will own a Car[58]. In fact, 10 years down the road, it may come to a point where it is actually illegal for humans to drive, due to the overwhelming number of autonomous vehicles, and the humans' larger error margin.

[57] Werbach, Adam. "The American Commuter Spends 38 Hours a Year Stuck in Traffic." The Atlantic. http://www.theatlantic.com/business/archive/2013/02/the-american-commuter-spends-38-hours-a-year-stuck-in-traffic/272905/ (accessed June 11, 2014).

[58] Mui, Chunka. "Fasten Your Seatbelts: Google's Driverless Car Is Worth Trillions (Part 5)." Forbes. http://www.forbes.com/sites/chunkamui/2013/03/01/googles-trillion-dollar-driverless-car-part-5-how-automakers-can-still-win/ (accessed June 26, 2014).

However, this raises a counter-issue, regarding "driver" liability in the Car. If all vehicles on the road are Google Cars in the next 5-10 years, who is to blame[59] if a collision does occur, or a law is broken. While Google has put in their full effort in eliminating any possibility of such problems, the issues may still exist, with an extremely minimal chance.

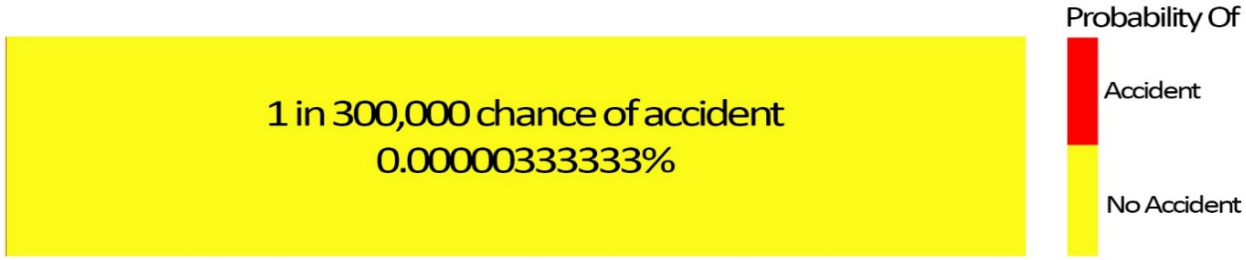

Figure 10[60]: The minimal probability of a Google Car accident, as per the Cars' test-drive records (although the 1 accident was due to the fault of a human-driven vehicle)

Liability for the Car will depend on several factors, such as environmental signaling systems, AI vision/sensors, and Car connectivity, none of which have to do with the actual "driver" or owner of the vehicle. Clearly, liability for a collision or law disobedience should befall on Google, the manufacturer of the Car. Instead of fining or adding demerit points to drivers of the Car who break laws, such as driving on a red light, Google must be held responsible for *Google Chauffeur*'s mistake, and the issue must be reported and fixed immediately[61]. Using IPv6 connectivity with the Google Database Server, any bugs that cause accidents and issues can wirelessly reported immediately. A Car that presents an unreasonable risk of crashes, injury, or law disobedience would impose obligations on the National Highway Traffic Safety Administration (NHTSA)[62], and Google would be independently obligated to remedy the defect. If the bug is not fixed in all potential subjects, the NHTSA would prohibit Google selling potential defective vehicles. With almost nonexistent driver liability, consumers may be attracted to the concept of buying a Car, which Google may use as a promotional tactic.

In many states such as California and Washington, "both a person operating a vehicle with the express or implied permission of the owner and the owner of the vehicle are responsible for any act or omission that is declared unlawful. The primary responsibility is the owner's"[63]. While liability befalls solely on drivers currently, due to the Car's autonomous capabilities, the shift to manufacturer liability *must* be made, through reforms in the aforementioned laws. Google must be forced to ensure maximum safety and

[59] Panda, Partha. "Look mum, no hands!." The Actuary. http://www.theactuary.com/features/2014/02/look-mum-no-hands/ (accessed June 11, 2014).
[60] "Google: Our Robot Cars Are Better Drivers Than Puny Humans | MIT Technology Review." MIT Technology Review. http://www.technologyreview.com/news/520746/data-shows-googles-robot-cars-are-smoother-safer-drivers-than-you-or-i/ (accessed June 11, 2014).
[61] Smith, Bryant Walker. "1." In Automated vehicles are probably legal in the United States. Stanford: The Center for Internet and Society, 2012. 47.
[62] Ibid.
[63] California driver handbook. Sacramento, CA: The Department of Motor Vehicles, 2008.

reliability with the Car, until a point is reached where errors/accidents are impossible. Although such a feat may seem superficial, with an already exceptional road record, improvements in the Car's AI and sensor capturing during its initial sales years can pave a path towards a *perfect* personal vehicle.

Of course, this issue of liability only becomes an issue with the extremely miniscule chance (0.00000333333%) of an accident or error in the Car. With its V2V communication, paired with its Velodyne sensor and the continuously improving *Google Chauffeur* AI, the Car is a vehicle built to maximize safety. Also, the highway platooning system nearly eliminates the risk of an accident as well, as Cars travelling uniformly at a constant separated difference ensure that reckless driving is not an issue. Human drivers may switch lanes without indicating correctly, they may turn and accelerate too sharply and quickly, whereas the Car's AI eliminates "human error" entirely, and drives strictly as required. With tweaks in California speed and liability laws, the mass implementation of the Car can allow for faster speeds and more efficient driving, with less driver responsibility and a fleet of nearly-perfect personal vehicles.

To Conclude

It is clear that the introduction of the Google Car to the automotive industry and general consumers will certainly create legal backlash in the state of California. Throughout this paper the following question has been kept in mind: In what ways and with what results will Google's autonomous car impact traffic laws and regulations in the next 5-10 years in California? Due to its strict focus on non-automated vehicles, the California state amendment and related legal documents clearly limit the introduction of the Car[64]. However, the fact that the Car's benefits outweigh its minimal disadvantages will force California laws to undergo reform, in order to allow for a more efficient and effective personal transportation system. With increased safety and technology in the Car, tailgating, platooning and high speeds will no longer be threats on the road, and laws must be changed in order to reflect this.

Although technological dependence and liability may be two of the many potential counter-issues, the clear advantages to mass implementation of Cars (safety, fuel consumption, travel times, traffic congestion to name a few)[65] are beneficial enough to overlook relatively minor counter issues. Although the California state law may prove to be a speed bump in the vehicle that is the *Google Driverless Car* project, it is one that can easily be driven over. Although California state laws do not appear to prohibit automated vehicles, they can nonetheless discourage their introduction by complicating their operation, which may force major reform to adapt for AI in personal vehicles.

Often times, when revolutionary technology presents itself to the mass market, the government and legal system play a role in limiting and perhaps even stopping its success. However, Google has worked tirelessly to ensure that their Cars' advantages will force reform in a firm system, which begs the question: will the Google Car steer the law, or will the law drive it?

[64] Mui, Chunka. "Fasten Your Seatbelts: Google's Driverless Car Is Worth Trillions (Part 1)." Forbes. http://www.forbes.com/sites/chunkamui/2013/01/22/fasten-your-seatbelts-googles-driverless-car-is-worth-trillions/2/ (accessed June 26, 2014).

[65] Mui, Chunka. "Fasten Your Seatbelts: Google's Driverless Car Is Worth Trillions (Part 4)." Forbes. http://www.forbes.com/sites/chunkamui/2013/02/12/googles-trillion-dollar-driverless-car-part-4-how-google-wins-2/ (accessed June 26, 2014).

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Appendix A: California State Amendment: Vehicle Code

Following Too Closely

21703. The driver of a motor vehicle shall not follow another vehicle more closely than is reasonable and prudent, having due regard for the speed of such vehicle and the traffic upon, and the condition of, the roadway.

Distance Between Vehicles

21704. (a) The driver of any motor vehicle subject to the speed restriction of Section 22406 that is operated outside of a business or residence district, shall keep the vehicle he is driving at a distance of not less than 300 feet to the rear of any other motor vehicle subject to such speed restriction which is preceding it.

(b) The provisions of this section shall not prevent overtaking and passing nor shall they apply upon a highway with two or more lanes for traffic in the direction of travel.

Amended Ch. 226, Stats. 1969. Effective November 10, 1969.

Caravans

21705. Motor vehicles being driven outside of a business or residence district in a caravan or motorcade, whether or not towing other vehicles, shall be so operated as to allow sufficient space and in no event less than 100 feet between each vehicle or combination of vehicles so as to enable any other vehicle to overtake or pass.

Following Emergency Vehicles

21706. No motor vehicle, except an authorized emergency vehicle, shall follow within 300 feet of any authorized emergency vehicle being operated under the provisions of Section 21055.

This section shall not apply to a police or traffic officer when serving as an escort within the purview of Section 21057.

Amended Ch. 46, Stats. 1972. Effective March 7, 1973.

Definitions

21706.5. (a) For purposes of this section, the following terms have the following meanings:

(1) "Emergency incident zone" means an area on a freeway that is within 500 feet of, and in the direction of travel of, a emergency shall so indicate. Officials of the fire department or police department or the Department of the California Highway Patrol who are present shall make every effort to prevent the closing off entirely of congested highway traffic passing the scene of any such emergency.

Fire Hoses

21708. No person shall drive or propel any vehicle or conveyance upon, over, or across, or in any manner damage any fire hose or chemical hose used by or under the supervision and control of any organized fire department. However, any vehicle may cross a hose provided suitable jumpers or other appliances are installed to protect the hose.

Safety Zones

21709. No vehicle shall at any time be driven through or within a safety zone.

Coasting Prohibited

21710. The driver of a motor vehicle when traveling on down grade upon any highway shall not coast with the gears of such vehicle in neutral.

Towed Vehicles Swerving

21711. No person shall operate a train of vehicles when any vehicle being towed whips or swerves from side to side or fails to follow substantially in the path of the towing vehicle.

Amended Ch. 44, Stats. 1959. Effective September 18, 1959.

Unlawful Riding and Towing

21712. (a) A person driving a motor vehicle shall not knowingly permit a person to ride on a vehicle or upon a portion of a vehicle that is not designed or intended for the use of passengers.

(b) A person shall not ride on a vehicle or upon a portion of a vehicle that is not designed or intended for the use of passengers.

(c) A person driving a motor vehicle shall not knowingly permit a person to ride in the trunk of that motor vehicle.

(d) A person shall not ride in the trunk of a motor vehicle.

of probation that the person be confined in a county jail for not less than 48 hours nor more than six months. The court shall order the person's privilege to operate a motor vehicle to be suspended for a period of six months, as provided in paragraph (9) of subdivision (a) of Section 13352 or restricted pursuant to subdivision (f).

(h) If a person is convicted of a violation of subdivision (a) and the vehicle used in the violation is registered to that person, the vehicle may be impounded at the registered owner's expense for not less than one day nor more than 30 days.

(i) A person who violates subdivision (b), (c), or (d) shall upon conviction of that violation be punished by imprisonment in a county jail for not more than 90 days, by a fine of not more than five hundred dollars ($500), or by both that fine and imprisonment.

(j) If a person's privilege to operate a motor vehicle is restricted by a court pursuant to this section, the court shall clearly mark the restriction and the dates of the restriction on that person's driver's license and promptly notify the Department of Motor Vehicles of the terms of the restriction in a manner prescribed by the department. The Department of Motor Vehicles shall place that restriction in the person's records in the Department of Motor Vehicles and enter the restriction on a license subsequently issued by the Department of Motor Vehicles to that person during the period of the restriction.

(k) The court may order that a person convicted under this section, who is to be punished by imprisonment in a county jail, be imprisoned on days other than days of regular employment of the person, as determined by the court.

(l) This section shall be known and may be cited as the Louis Friend Memorial Act.

Amended Sec. 2, Ch. 595, Stats. 2004. Effective January 1, 2005.
Amended Sec. 1, Ch. 475, Stats. 2005. Effective January 1, 2006.
Amended Sec. 661, Ch. 538, Stats. 2006. Effective January 1, 2007.
Amended Sec. 3, Ch. 193, Stats. 2009. Effective July 1, 2010.
Amended Sec. 2, Ch. 301, Stats. 2010. Effective January 1, 2011.
Amended Sec.611 Ch.15, Stats. 2011. Effective 04, 4, 2011.
Amended Sec. 64, Ch. 39, Stats. 2011. Effective 06, 30, 2011.

Speed Contests: Specified Injuries

23109.1. (a) A person convicted of engaging in a motor vehicle speed contest in violation of subdivision (a) of Section 23109 that proximately causes one or more of the injuries specified in subdivision (b) to a person other than the driver, shall be punished by imprisonment pursuant to subdivision

Added Sec. 2, Ch. 432, Stats. 2006. Effective January 1, 2007.
Amended Sec.612, Ch.15, Stats. 2011. Effective July, 1, 2011.

Vehicle Impoundment: Speed Contests and Reckless Driving

23109.2. (a) (1) Whenever a peace officer determines that a person was engaged in any of the activities set forth in paragraph (2), the peace officer may immediately arrest and take into custody that person and may cause the removal and seizure of the motor vehicle used in that offense in accordance with Chapter 10 (commencing with Section 22650). A motor vehicle so seized may be impounded for not more than 30 days.

(2) (A) A motor vehicle speed contest, as described in subdivision (a) of Section 23109.

(B) Reckless driving on a highway, as described in subdivision (a) of Section 23103.

(C) Reckless driving in an offstreet parking facility, as described in subdivision (b) of Section 23103.

(D) Exhibition of speed on a highway, as described in subdivision (c) of Section 23109.

(b) The registered and legal owner of a vehicle removed and seized under subdivision (a) or their agents shall be provided the opportunity for a storage hearing to determine the validity of the storage in accordance with Section 22852.

(c) (1) Notwithstanding Chapter 10 (commencing with Section 22650) or any other provision of law, an impounding agency shall release a motor vehicle to the registered owner or his or her agent prior to the conclusion of the impoundment period described in subdivision (a) under any of the following circumstances:

(A) If the vehicle is a stolen vehicle.

(B) If the person alleged to have been engaged in the motor vehicle speed contest, as described in subdivision (a), was not authorized by the registered owner of the motor vehicle to operate the motor vehicle at the time of the commission of the offense.

(C) If the registered owner of the vehicle was neither the driver nor a passenger of the vehicle at the time of the alleged violation pursuant to subdivision (a), or was unaware that the driver was using the vehicle to engage in any of the activities described in subdivision (a).

(D) If the legal owner or registered owner of the vehicle is a rental car agency.

(E) If, prior to the conclusion of the impoundment period, a

Notice to Owner

22854. The Department of Justice upon receiving notice under Section 22853 of the removal of a vehicle from a highway, or from public or private property, shall notify the registered and legal owner in writing at the addresses of such persons as shown by the records of the Department of Motor Vehicles, if the vehicle is registered in this state, of the removal of such vehicle, and give the name of the officer reporting such removal, the grounds upon which the removal was authorized and the location of the vehicle. If the vehicle is not registered in this state, the department shall make reasonable effort to notify the legal or registered owner of the removal and location of the vehicle. The notice to the registered or legal owner shall list the amount of mileage on the vehicle at the time of removal.

Amended Ch. 239, Stats. 1975. Effective January 1, 1976.

Notification to National Law Enforcement Telecommunication System

22854.5. Whenever an officer or employee of a public agency directs the storage of a vehicle under this chapter, the officer, employee, or agency directing that storage may notify the National Law Enforcement Telecommunication System by transmitting by any means available, including, but not limited to, electronic means, the vehicle identification number, the information listed in paragraphs (1), (2), and (3) of subdivision (b) of Section 22852, and the information described under Section 22853.

Added Sec. 1, Ch. 622, Stats. 2003. Effective January 1, 2004.

Appraisers

22855. The following persons shall have the authority to make appraisals of the value of vehicles for purposes of this chapter, subject to the conditions stated in this chapter:

(a) Any peace officer of the Department of the California Highway Patrol designated by the commissioner.

reserve peace officer, or other employee of the Department of Parks and Recreation designated by the director of that department.

Amended Sec. 8, Ch. 292, Stats. 2003. Effective January 1, 2004.

Lien Sales: Liability Exclusion

22856. Notwithstanding any other provision of law, no cause of action for despoliation of evidence shall arise against any towing company that sells any vehicle at, or disposes of any vehicle after, a lien sale, unless the company knew, or should have known, that the vehicle will be needed as evidence in a legal action.

Added Ch. 457, Stats. 1989. Effective January 1, 1990.

Chapter 11. Parking Lots

Offstreet Parking Facilities: Regulation by City of Los Angeles

22950. Any city having a population of over 2,000,000 inhabitants shall regulate offstreet parking facilities within its jurisdiction in a manner not inconsistent with any provisions of this chapter.

Repealed and added Ch. 802, Stats. 1976. Effective January 1, 1977.

Street and Alley Parking

22951. No operator of any offstreet parking facility shall park the vehicle of a patron of the facility in any street or alley.

Repealed and added Ch. 1041, Stats. 1965. Effective September 17, 1965. Supersedes Ch. 66.

Towing or Removal: Violations

22952. Every person engaged in the operation of offstreet parking facilities is guilty of a violation, who:

(a) Tows or removes or authorizes the towing and removal of any vehicle within 24 hours of the expiration of the period for which a particular fee is charged. This subdivision shall not affect or limit any parking lot operator from charging parking

Appendix B: "Automated Vehicles are Probably Legal in the United States"

5 Federal Motor Vehicle Safety Standards Do Not Categorically Prohibit Automated Driving

The National Highway Traffic Safety Administration (NHTSA) regulates the performance of motor vehicles in part through the promulgation and enforcement of rules,[258] including the performance-based[259] standards to which manufacturers, importers, and distributors must certify their new vehicles.[260]

Neither these Federal Motor Vehicle Safety Standards (FMVSSs) nor NHTSA's other rules appear to directly preclude the sale or importation of automated vehicles.[261] These rules, for example, assume but do not expressly require the presence of a driver[262] (defined as "the occupant of a motor vehicle seated immediately behind the steering control system"[263]), do not categorically prohibit drive-by-wire-systems,[264] require no specific description of the technology

[258] *See generally* 49 U.S.C. § 30101-30102, 30111; 49 C.F.R. §§ 501-599.

[259] 49 U.S.C. § 30102(a)(8) ("'[M]otor vehicle safety' means the performance of a motor vehicle or motor vehicle equipment in a way that protects the public against unreasonable risk of accidents occurring because of the design, construction, or performance of a motor vehicle, and against unreasonable risk of death or injury in an accident, and includes nonoperational safety of a motor vehicle."), (9) ("'[M]otor vehicle safety standard' means a minimum standard for motor vehicle or motor vehicle equipment performance.").

[260] *See* 49 U.S.C. §§ 30102 (definitions), 30112(a)(1) ("Except as [otherwise provided], a person may not manufacture for sale, sell, offer for sale, introduce or deliver for introduction in interstate commerce, or import into the United States, any motor vehicle or motor vehicle equipment manufactured on or after the date an applicable motor vehicle safety standard prescribed under this chapter takes effect unless the vehicle or equipment complies with the standard and is covered by a certification issued under section 30115 of this title."), (b) (excluding from this restriction "the sale, offer for sale, or introduction or delivery for introduction in interstate commerce of a motor vehicle or motor vehicle equipment after the first purchase of the vehicle or equipment in good faith other than for resale"), 30115 ("A manufacturer or

these devices as well. NHTSA has previously taken a cautiously permissive approach to certain laser devices projecting in the visible spectrum.[279]

In addition to specifying particular performance standards, NHTSA imposes specific obligations on an entity that alters a vehicle. In particular, "[w]ith respect to the vehicle alterations it performs, an alterer: (1) Has a duty to determine continued conformity of the altered vehicle with applicable Federal motor vehicle safety, Bumper, and Theft Prevention standards, and (2) Assumes legal responsibility for all duties and liabilities for certification under the Vehicle Safety Act."[280] The conversion of a conventional motor vehicle to an automated vehicle would constitute an alteration if the changes are significant and made before the vehicle is first sold to a consumer.[281]

Furthermore, an automated vehicle that presents an "unreasonable risk" of crashes, death, or injury[282] would impose obligations on NHTSA as well as on the relevant manufacturer and its dealers.[283] In chief, the manufacturer would be independently obligated to provide notice of and a remedy for such a defect,[284] NHTSA would otherwise be required to order that manufacturer to do so,[285] and a dealer would be prohibited from selling a vehicle that remains defective.[286]

Such a vehicle could be defective even if it complies with NHTSA's performance standards. The statutory provisions governing recalls apply to vehicles and equipment that "contain[] a defect related to motor vehicle safety" as well as those that "do[] not comply with an applicable motor vehicle safety standard."[287] A defect "includes any defect in performance, construction, a component, or material of a motor vehicle or motor vehicle equipment,"[288] and motor vehicle safety "means the performance of a motor vehicle or motor vehicle equipment in a way that

6 State Vehicle Codes Do Not Categorically Prohibit Automated Driving

This section surveys the statutory vehicle codes of every US state plus the Uniform Vehicle Code and a selection of other domestic codes. It also reviews some of the case law related to these codes, though by no means comprehensively. It generally does not consider administrative agency rules or practices implementing vehicle codes. And it looks at relevant ordinances in only a tiny fraction of US municipalities.[294]

Because of the broad way in which the term and others like it are defined, an automated vehicle probably has a human "driver."[295] Obligations imposed on that person may limit the independence with which the vehicle may lawfully operate.[296] In addition, the automated vehicle itself must meet numerous requirements, some of which may also complicate its operation.[297] Although three states have expressly established the legality of automated vehicles under certain conditions, their respective laws do not resolve many of the questions raised in this section.[298] Other states that wish to address the question of legality might consider the draft provisions provided as an initial basis for eventual legislation.[299]

6.1 An Automated Vehicle Probably Has a Driver

Unlike the Geneva Convention, no state statute expressly requires that a vehicle have a driver. However, state vehicle codes do variously impose obligations on a vehicle's "driver," "operator," or "owner" or on any "person" who "drive[s]" or "operate[s]" or has "actual physical control of" that vehicle. They also establish certain vehicle requirements that similarly reference the "driver" or "operator." These provisions raise the threshold question of whether an automated vehicle has any such person or persons—and, if so, whom.

"Driver" is a broad concept[300]—so much so that, at least textually, even nonhuman persons can be drivers.[301] In addition, an owner who is not driving her vehicle may nonetheless be responsible for it.[302] This expansive view of responsibility suggests that various persons could be deemed to operate an automated vehicle.[303]

6.1.4 Various Persons Could Be an Automated Vehicle's Driver

These expansive definitions suggest that even an automated vehicle probably has a driver—and quite possibly multiple drivers—under existing state law. The driver determination will ultimately depend on the particular technology, jurisdiction, and statutory provision at issue. However, in a highly generalized descriptive sense, any person who directly commands a vehicle to perform some act or omission likely qualifies as its driver with respect both to that act or omission and to the consequences that follow proximately from it. "Directly commands" implies that the person issues specific instructions without any human intermediary.[365] It also implies that the person has the means to issue these instructions and some degree of culpability in their issuance. This definition applies to natural persons and might apply to corporate persons.

On the human side, physical presence would likely continue to provide a proxy for or presumption of driving.[366] In other words, an individual who is physically positioned to provide real-time input to a motor vehicle may well be treated as its driver. This is particularly likely at levels of automation that involve human input for certain portions of a trip.

In addition, an individual who starts or dispatches an automated vehicle, who initiates the automated operation of that vehicle, or who specifies certain parameters of operation probably qualifies as a driver under existing law. That individual may use some device—anything from a physical key to the click of a mouse to the sound of her voice—to activate the vehicle by herself. She may likewise deliberately request that the vehicle assume the active driving task. And she may set the vehicle's maximum speed or level of assertiveness.

This working definition is unclear in the same ways that existing law is likely to be unclear. Relevant acts might occur at any level of the primary driving task, from a decision to take a particular trip to a decision to exceed any speed limit by ten miles per hour.[367] A tactical decision like speeding is closely connected with the consequences—whether a moving violation or an injury—that may result. But treating an individual who dispatches her fully automated vehicle as the driver for the entirety of the trip could attenuate the relationship between legal responsibility and legal fault.[368] Nonetheless, strict liability of this sort is accepted within tort law[369] and present, however controversially, in US criminal law.[370] It is often connected with a generalized

Appendix C: Google (Car) Blog

Google | Official Blog

Insights from Googlers into our products, technology, and the Google culture

Just press go: designing a self-driving vehicle

Posted: Tuesday, May 27, 2014 g+1 12k Tweet 4,641 Like 19k

Ever since we started the Google self-driving car project, we've been working toward the goal of vehicles that can shoulder the entire burden of driving. Just imagine: You can take a trip downtown at lunchtime without a 20-minute buffer to find parking. Seniors can keep their freedom even if they can't keep their car keys. And drunk and distracted driving? History.

We're now exploring what fully self-driving vehicles would look like by building some prototypes; they'll be designed to operate safely and autonomously without requiring human intervention. They won't have a steering wheel, accelerator pedal, or brake pedal… because they don't need them. Our software and sensors do all the work. The vehicles will be very basic—we want to learn from them and adapt them as quickly as possible—but they will take you where you want to go at the push of a button. And that's an important step toward improving road safety and transforming mobility for millions of people.

It was inspiring to start with a blank sheet of paper and ask, "What should be different about this kind of vehicle?" We started with the most important thing: safety. They have sensors that remove blind spots, and they can detect objects out to a distance of more than two football fields in all directions, which is especially helpful on busy streets with lots of intersections. And we've capped the speed of these first vehicles at 25 mph. On the inside, we've designed for learning, not luxury, so we're light on creature comforts, but we'll have two seats (with seatbelts), a space for passengers' belongings, buttons to start and stop, and a screen that shows the route—and that's about it.

A very early version of our prototype vehicle, and an artistic rendering of our vehicle

We're planning to build about a hundred prototype vehicles, and later this summer, our safety drivers will start testing early versions of these vehicles that have manual controls. If all goes well, we'd like to run a small pilot program here in California in the next couple of years. We're going to learn a lot from this experience, and if the technology develops as we hope, we'll work with partners to bring this technology into the world safely.

If you'd like to follow updates about the project and share your thoughts, please join us on our new Google+ page. We're looking forward to learning more about what passengers want in a vehicle where their number one job is to kick back, relax, and enjoy the ride.

Posted by Chris Urmson, Director, Self-Driving Car Project