

## ***Nevada SB-140 & AB-511***

Google began its Nevada campaign with the hiring of Las Vegas based lobbyist David Goldwater, tasked with shepherding two bills through the state legislature [21]:

- SB-140: allowing for the licensing of autonomous vehicles on designated Nevada highways for testing purposes.
- AB-511: granting the driver an exemption to the “distracted driving ban” against texting when the vehicle is not under manual operation.

Passage of the bills was effectively smoothed by early socialization of the technology - state lawmakers, including the governor, were taken for rides in Google’s “fleet” of modified Prius vehicles and came away as enthusiastic backers. The bills passed easily with opposition from automakers unable to affect the outcomes. As with other state bills to follow, the Nevada legislation set high level directives and stipulated desired outcomes without specifying actual procedures. Specifics of how to author regulations for issuing licenses were left to the state Department of Transportation to complete later, leaving many state employees scratching their heads on how to write regulations for a technology they knew basically nothing about. However, in David Breslow, the head of the Nevada DMV, Google found an enthusiastic ally. Breslow directed his staff to work closely with Google employees in crafting the regulations. Within nine months the first autonomous vehicle license was issued to a Google car, complete with an infinity branded symbol on its license plate.

## ***California SB-1298***

In 2012, Google forged ahead again, this time in California, with a more ambitious agenda now in mind. The playbook was essentially the same and the outcome equally predictable, now buoyed with a sense of urgency created by the quick passage of the Nevada bills. California lawmakers were primed to act, and state senator Alex Padilla authored SB-1298. Opposition from the Alliance of Automobile Manufacturers was overcome and Governor Jerry Brown signed the bill into law in November 2012. Of specific note are the following points:

- SB-1298 contains a mandate not only for licensing for testing purposes, but also for public operation.
- SB-1298 contains also contains language opening the door to the possibility of vehicles without a licensed human driver standing by. This is in opposition to the Nevada bill, which not only required a licensed human driver be available behind the wheel, but that a 2<sup>nd</sup> licensed driver be present as a passenger.
- SB-1298 directs the California DMV to complete detailed regulation by the end of 2014, with the intent of review and revisions leading to public licensing by June of 2015.

An important test in the gap between imprecise legislative intent and actual regulatory behavior occurred in May of 2014, when Google proposed a new version of its prototype vehicle for testing in California - without a steering wheel. This eventuality had been foreseen by Howard Posner, who in 2012 as a member of the California assembly’s transportation

committee had unsuccessfully suggested the bill be altered to explicitly require a human driver present in the car [22]. The California DMV’s reaction to the new Google vehicle: insist on a steering wheel and the presence of a human driver. In September 2014 Google relented and installed a “temporary” steering wheel [23]. Although legislative action had been very successfully steered by Google in both Nevada and California, state regulatory departments tasked with the actual implementation of the laws maintain degrees of autonomy – if perhaps only in delaying certain aspects of the technological momentum until fully satisfied.

### Michigan SB-169 & Colorado SB-13-016

Also worthy of brief discussion are the 2013 legislative actions proposed in Michigan and Colorado. Unlike the bills in Nevada and California, neither bill received support from Google, and it seems relatively clear why – neither advances on the precedent already established in California. In fact, both bills while perhaps more permissive than Nevada’s SB-140 (which permitted testing only on designated state highways) pulled back on important advancements in California – the mandate for public operation and language permissive for a sometime future of autonomous operation without a licensed driver present. Google, which had initially participated in the Michigan’s SB-169, publically pulled away its support citing the testing only limitations. Regardless, SB-169 passed, with the full weight and backing of its champion Governor Rick Snyder, and the approval of Detroit’s “big three” as well as Toyota [24]. On the other hand in Colorado, SB-13-016 was “indefinitely withdrawn” by its sponsor, Republican state senator Greg Brophy. Brophy cited Google’s influence on Democratic opponents on the state senate’s transportation committee as the reason for his decision. [25]

### Federal Regulation by NHTSA

On May 13<sup>th</sup>, 2013, NHTSA (National Highway Transportation and Safety Administration) released a “Preliminary Statement of Policy” regarding self-driving cars, primarily to act as a set of guidelines for states to follow. Perhaps the potential for contradictory legislation by individual states, and the resulting chaos this could introduce (into a national vehicular code system previously harmonized by decades of cross state agreements honoring each other’s licenses) was a call to action.

NHTSA’s policy statement establishes a definition of autonomous vehicles around four levels as follows:

Level	Definition	Example / Explanation
Level 0	No Automation	Driver always in complete control
Level 1	Function-specific Automation	E.g. stability control or brake assist
Level 2	Combined Function Automation	Two or more automated functions
Level 3	Limited Self-Driving Automation	Google car circa 2013, BMW X5 w/traffic jam assist

Of note is the classification of Google's test vehicle at the time, as only Level 3. NHTSA essentially did not recognize any existing technology of being capable of (or approved for) Level 4 operation, a finding in line with other recommendations issued in their statement. These included the following:

- A statement encouraging states to allow testing of self-driving cars.
- Tempered by the suggestions that states do not include provisions for public operation at this time.
- However, in the event of a state not heeding the recommendation against public operation, that specific provisions for a licensed driver in the driver's seat be included.
- That special training and licensing requirements be met for human operators of self-driving vehicles.

NHTSA's statement also indicates the agency's commitment to running their own technology study, scheduled to conclude in 2017. Explicit mention is made of the inclusion of VVV ("vehicle to vehicle") and V2I ("vehicle to infrastructure") technology into the study, a clear indication of their intent to evaluate the technological directions of both Google as well as the traditional automakers.

It seems possible that the response of the California DMV to Google's steering wheel free prototype was made with one eye focused on staying within some level of current compliance with NHTSA's policy statement.

## The Insurance Industry

Questions of liability in an accident involving at least one party operated by a self-driving vehicle are also unclear and open to interpretation. Nevada's regulations indicate the operator who pushes the start button remains liable [26] – a resolution only possible in conjunction with regulations requiring a licensed driver be present in the vehicle. Michigan's SB-169 states nothing to otherwise contradict the state's existing "Owner Liability Law" placing liability with the vehicle owner. But SB-169 does go on to absolve auto manufacturer's of product liability for conversions of standard automobiles to autonomous driving vehicles by a third party [27]. The Alliance of Automobile Manufacturers unsuccessfully petitioned Governor Brown of California not to sign into law SB-1298 over similar concerns of not being absolved from product liability if one of their vehicles, modified for self-driving by another party (i.e. Google), were to be involved in an accident, and publically voiced their displeasure with the bill [28].

Ultimately though it should not be forgotten that basic auto insurance liability practice dictates that insurance policies "follow the vehicle" and not the driver. In this sense at least, the unit of issuance of automotive insurance policies line up well with self-driving cars. But when a car meets the standards of NHTSA's Level 4 autonomous vehicle, what is actually being insured, the vehicle or the manufacturer of the self-driving tech? In the eyes of many the logical conclusion is the latter, in essence predicting a future model of liability coverage moving from

a per vehicle policy instead to a manufacturer product liability policy [29] – a cost which would be passed on to the consumer by being built into the sticker price of the vehicle itself.

Even in a scenario where market forces conspire to keep individual vehicle policies in place, the automobile insurance industry could still face a complete disruption of its current business model. Predictions of a 90% reduction in vehicle accidents in a world fully populated with Level 4 autonomous vehicles would have enormous revenue implications.

Figure 3: Human Cause as Primary Factor in Accidents

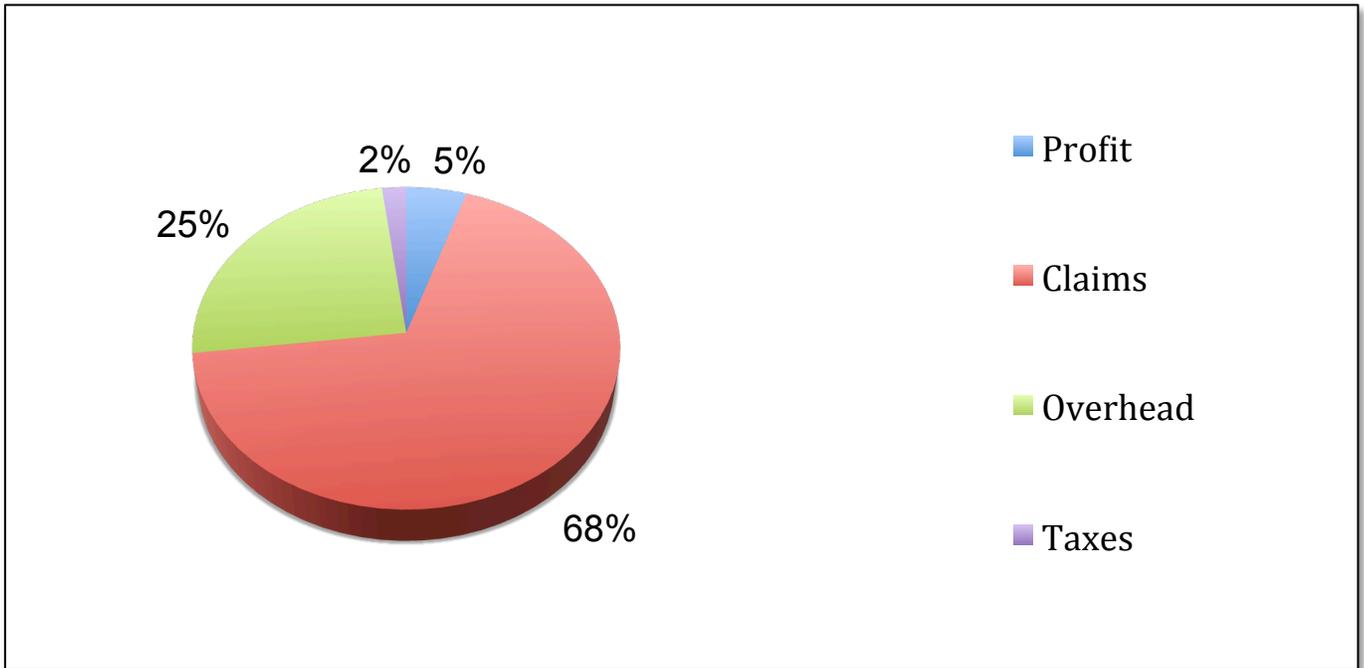
Total Crashes per year in U.S. <sup>11</sup>	5.5 million
% human cause as primary factor <sup>12</sup>	93%
Economic Costs of U.S. Crashes <sup>13</sup>	\$300 billion
% of U.S. GDP <sup>14</sup>	2%
Total Fatal & Inurious Crashes per Year in U.S.	2.22 million
Fatal Crashes per Year in U.S. <sup>15</sup>	32,367
% of fatal crashes involving alcohol	31%
% involving speeding	30%
% involving distracted driver	21%
% involving failure to keep in proper lane	14%
% involving failure to yield right-of-way	11%
% involving wet road surface	11%
% involving erratic vehicle operation	9%
% involving inexperience or overcorrecting	8%
% involving drugs	7%
% involving ice, snow, debris, or other slippery surface	3.7%
% involving fatigued or sleeping driver	2.5%
% involving other prohibited driver errors (e.g. improper following, driving on shoulder, wrong side of road, improper turn, improper passing, etc.)	21%

Source: The Eno Transportation Foundation

According to the NAIC (National Association of Insurance Commissioners), the US auto insurance industry collected roughly \$200B in insurance premiums [30], 87% in private policies and the remaining 13% in commercial. Of this windfall, 68% of the cost of premiums was applied to paying accident claims – actual cost of repairs, determination of fault, rental replacements, etc.

The cost breakdown of collected premiums appears below:

Figure 4: Breakdown of Auto Insurance Premiums [31]



Assuming these ratios hold true, then a 90% reduction in accidents and the resulting 90% costs in claims, could theoretically reduce the auto insurance industry to a \$20B industry, leaving little room for all the large insurance firms currently in today's market. Of course this is very coarse math, but whatever the actual specifics, a world full of Level 4 autonomous vehicles can only be perceived as a massive threat and disruption to the health of the existing industry.

### Privacy Concerns

In March 2014, the Consumer Watchdog society voiced its concerns over SB-1298 to the CA DMV. John Simpson, the director of the Privacy Project, made the following statement in his published report [32].

“The DMV's autonomous vehicle regulations must provide that driverless cars gather only the data necessary to operate the vehicle and retain the data only as long as necessary for the vehicle's operation”.

He then went on to single out concerns over Google.

“Failure to act will mean substantial privacy risks from the manufacturers' driverless car technology if there are not protections from what Google is best known for: the

collection and use of voluminous personal information about us and our movements.” Though based on entirely different motives, his concerns were somewhat reinforced by an earlier event in August 2013, when then acting head of the NTSB Deborah Hersman, the top ranking safety official in the United States government, spoke directly about requiring EDRs (electronic data recorders, i.e. “black boxes”) in driverless cars [33] – a comment targeted squarely at Google’s test vehicles. Hersman’s comments were based on safety concerns and having data to analyze should a traffic incident occur, especially one resulting in no survivors. Google had in fact already acknowledged that their test vehicles were already logging telemetry information for analysis and operational improvement.

Perhaps lost in this Google focused discussion was the fact that 96% of 2013 model vehicles already had EDRs on-board, due to a NHTSA proposal to create a mandatory requirement for EDRs on new cars [34].

## Section 5: Winners vs Losers

### **Winner: Semi and Fully Autonomous Car Adopters**

In the near term we expect auto manufacturers who produce premium semi-autonomous features to enjoy increased sales and brand recognition. Makers of software that process large volume of sensor data and wirelessly connect cars (eg: IBM) will be a significant part of the value chain as well.

There are still a lot of technical, regulatory and government support uncertainties for the fully autonomous cars. We expect Google to be an important player in licensing maps/traffic data and software to auto makers. It is likely that over the long term, fully autonomous cars will become the reality and Google will be a leader of the new robo-taxi eco-system.

### **Winner: Component Suppliers and Sensor manufacturers**

The number of sensors and electronic devices in cars is increasing quickly, resulting in more revenue for sensor and component suppliers. As an example both Google and IBM are working with supplier Continental to develop parts for autonomous cars.

### **Winner: Rental & Ride Sharing Companies**

With the robo-taxi model, rental, taxi and ride sharing businesses will converge. The market size will grow substantially as more people move from car-owners to ride-sharers. The younger generation and older adults will be the early adopters of the new model.

### **Loser: Traditional Auto Manufacturers**

Auto manufactures who do not embrace autonomous driving technologies will see their brand being connected to inferior cars. They will suffer from lower margins and reduced sales. The robo-taxi model will further squeeze their market size, making them irrelevant over the long term.

### **Loser: Taxi Services and professional drivers**

Traditional Taxi services will be disrupted by the lower cost robo-taxi model. The need for professional drivers will reduce significantly. The role of professional driver could be replaced with crisis control personnel, who may be patrolling around or seating in a service center to perform remote diagnostics and manual intervention of autonomous cars. The way passengers interact with the car will be significantly different also. Instead of relying on steering wheels and brake pedals, passengers will be able to use natural user interface such as spoken commands or gestures to control their cars.

### **Loser: Auto Insurance Companies**

Number of accidents will reduce sharply, leading to reduce insurance premiums. There will be new models for liability and collision coverage due to the driving responsibility shift from the driver to the car.

### **Loser: Auto Service Industry**

There will be fewer accidents and potentially fewer cars with the robo-taxi model. Auto Service industry will be consolidated with few survivors.

## Section 6: Summarize and Predict Opportunity

In the previous sections, we've seen the main differences in the approach taken by automakers and Google toward delivering self-driving cars to the market. We can best describe these approaches as incremental and disruptive, respectively. We've also seen the effects that autonomous vehicles will have on the market. In Section 3 we described the technologies used by automakers and Google. Next, in Section 4, we presented a study on the legal hurdles and challenges faced by automakers and more so by Google. Finally, in Section 5, we predicted the winners and losers in the overall market.

In this section, we will make an attempt at predicting the overall release trajectory for self-driving cars and estimating areas of future opportunity.

As previous sections state, automakers plan to release their self-driving technology piecemeal. At first, newer features will be released in the luxurious car segment only, slowly trickling down to mass-market vehicles. This trajectory follows their existing mode of operation in releasing features like adaptive cruise-control and lane departure warning/correction. The self-driving reality will therefore be reached gradually.

Google, on the other hand plans to design a fully autonomous car from the get-go. There has been a lot of speculation about how exactly Google plans to release its vehicles to the market. Previous course research paper states that Google may lease its technology to an automaker or enter into a partnership with it. We, however, believe that a more likely scenario is that Google will enter a taxi-service market. This approach has numerous benefits for Google:

1. It allows Google to release its vehicles in markets where regulatory requirements are most lenient.
2. It allows Google to build a standalone and quirky set of cars without having to worry whether the consumers will want to buy them. (Google can likely avoid going through an established car manufacturer in building these cars.)
3. It fits best with Google's model of being driven, as opposed to driving.

In terms of areas of opportunity, we state just a few. Generally, manufacturers of laser/sonar/camera components will likely see a large growth in demand. Some of the components are still extremely expensive (like lidar technology used by Google cars), so a new entrant into the market has a better chance to be profitable.

On the taxi service front, we expect a number of interesting services to mushroom up, be it driving seniors to the doctors or driving kids to soccer practices. Ride-sharing will become more common and instrumental in reducing congestion in urban areas. Startups focusing on any of these technologies are likely to benefit greatly.

Finally, the transportation of goods industry is going to see a phenomenal benefit from self-driving vehicles. We expect service focused on maintenance, resupplying, and management to benefit greatly from the development of self-driving vehicles.

Clearly, the future is bright for self-driving vehicles. The question that remains is how fast do we expect to see a fully autonomous vehicle on our roads. Our guess is: sooner than everybody thinks!

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